Norbert DADANIAK Reinhard LÜTJE Wolfgang EBERL

The "*Aphyosemion cameronense*"-group

You can blow out a candle,
but you can't blow out a fire
once the flame begins to catch
the wind will blow it higher

taken from the song "Biko", performed by Peter Gabriel,
written by Peter Gabriel Limited & Run Music Publication Limited 1980.

This book is dedicated to my wife Claudia DADANIAK, my children Verena, Christian and Stefanie, and also to my parents Johanna and Alwin HAFNER and my parents-in-law Hannelore and Erich SCHULZ.

In addition to all those who actively or passively work for the protection of animals and the environment.

Norbert DADANIAK

The work on this book, which extended over three years, cost many hours which should have been given to my family.
For this reason I dedicate this book exclusively to my family and especially my wife Heike LÜTJE and my children Bianca and David.

Reinhard LÜTJE

For Ute KRAUSE and Daniela VOGT, whose warmth and kindness have made such a deep impression on me.

Wolfgang EBERL

The Authors

Norbert DADANIAK. An aquarist for more than 30 years, his main interest has always been killifish. He joined the DKG in 1982, which enabled him to keep and breed many species from various genera. About 10 years ago he fell in love with the *Aphyosemion* of the "*cameronense*"-group and they became his specialty.

Reinhard LÜTJE. As a twelve-year-old he discovered the hobby of fish-keeping. Involved with killifish since 1983, he has built up experience with *Cyprinodon*, lampeyes, *Epiplatys* and *Aphyosemion*. Since 1992 he has specialised in photographing killifish.

Wolfgang EBERL. An aquarist since the age of seven, he joined the DKG in 1987. Cameroon trips 1989, 1990 and 1991; Gabon trips 1993 (twice), 1994 (twice) and 1996 (twice); slide lectures on killifish in Madrid, Marcinelle (Belgium), St. Chamond (France), Brno (Slovakia), Copenhagen, Zürich, Kingston-upon-Hull, Manchester, Buffalo/NY, Los Angeles, San Francisco, Erie/PA, Philadelphia/PA, Hamilton/Ontario and in the German towns of Herne, Remscheid, Walsrode, Plauen, Fürstenfeldbruck, Augsburg, Fürth, Rüsselsheim, Helmstedt, Einbeck, Schwäbisch Gmünd, Ludwigsburg and Friedrichshafen.

Norbert DADANIAK Reinhard LÜTJE Wolfgang EBERL

The "*Aphyosemion cameronense*"-group

Distribution, habitat, accompanying fauna,
systematics of the species and undescribed phenotypes,
maintenance and breeding

Translated by Peter WATKINS

Imprint

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Notice:

We can take no responsibility for any injury or damage which may occur in the use of aquaria or a killie set-up as advised in this book. The combination of electricity and water and also the use of technically faulty electrical appliances in fishkeeping represent a not inconsiderable risk! The setting-up of aquaria requires the appropriate equipment, experience and expertise. Check carefully that homemade tanks are waterproof!

No responsibility taken for the representation of national frontiers!

Contents

Foreword

Killifish - a word with many meanings. For many aquarists it still means fish which are short-lived, aggressive and fussy when it comes to feeding. But behind this word lies much more than the majority of aquarists suspect. The reason for this may be the fact that in most aquarium literature there are colour pictures of a wide range of killie species, but they usually do little to convey the effect produced by well grown, fully coloured and healthy killies.

Why have we written this book? In recent decades innumerable articles and books have been written about killifish. On the one hand these publications are addressed to the scientifically interested reader, and on the other hand they deal with special aspects such as the successful maintenance and breeding of specific species or even specific strains.

Our knowledge of killifish was greatly increased by the numerous collecting trips made by scientists and also aquarists since the early sixties. As a result the literature mentioned above became more and more comprehensive and detailed. The present publication will show that now in the mid-nineties it is even possible to write a whole book on just one species complex within the genus *Aphyosemion.*

Adult male of *Aphyosemion cameronense* "EMS 90/4"

Foreword

Innumerable lovers of the colourful *Aphyosemion* species spend a great deal of time looking after and observing their killifish. In the course of recent decades a wide variety of methods of keeping and breeding *Aphyosemion* species have been developed, but most publications describe only one or few of these methods.

In the chapters **Maintenance and Breeding**, **Diseases and other Problems** and **Behaviour: Aggressive and Peaceful Disposition**, we intend to discuss in detail the various methods of propagation. To this end the reader will find in this book photographs of killie set-ups, individual tanks and many other colour pictures that supplement our text.

A comprehensive book on killifish requires the scientific viewpoints. We have had no scientific training as such, but in the framework of the present work we want to look into the various publications on the systematics of this species complex, in order to show the relationships as clearly as possible.

Very few aquarists are interested in what species was described, when, why and by whom. This relatively dry section of this book is intended to show the reader that the final word on the correct naming of the species has not yet been pronounced. Those involved with killifish must sooner or later get accustomed to the use of scientific names for the species. For this killie enthusiasts use a special vocabulary, which will be introduced to the reader by degrees.

Very many of the fish that appear in this book we acquired from members of the Deutsche Killifisch Gemeinschaft e.V. (German Killifish Association), which since its foundation in 1969 has concerned itself with the maintenance, breeding and distribution of killies. In this association some 1,000 lovers of killifish have joined together and worked for the common interest.

This book is also meant to be a thank-you for the many days of close friendship and mutual support which we have been able to enjoy within the DKG.

May this book give its readers a similar feeling of the joy and fascination that we have experienced every day since we acquired our first killifish.

We hope to show as many aquarists as possible the way to successfully keeping and breeding killifish.

Düsseldorf (Germany), February 1995 and May 1996

Introduction

At the present time the genus *Aphyosemion* comprises about 100 species, of which a few might well be placed within other species. At the same time it is equally probable that, in the enormous rainforests of tropical Africa, there are undescribed species yet to be discovered.

If these species are compared with each other, we can identify groups of species which exhibit obvious similarities in body shape and the colouration of the male. In the past this has led scientists to divide the genus *Aphyosemion* into subgenera and species groups. Examples of this are the subgenera *Paraphyosemion*, *Chromaphyosemion*, *Kathetys*, *Fundulopanchax*, *Paludopanchax* and the groups centred around *Aphyosemion elegans*, *Aphyosemion ogoense*, *Aphyosemion coeleste* and *Aphyosemion cameronense*.

This list is not of course complete, as in this book we wish to discuss only the last-mentioned of these groups, but as comprehensively as possible.

The layout of this book. One of the basic principles is that we are writing a book for all aquarists. Thus the reader will find information on the place of origin, the way of life, the requirements in the aquarium, detailed hints on breeding and a description of the relationships within the "*cameronense*"-group. In this way there should be something of interest for everyone.

To begin with we explain the technical terms frequently used followed by a definition of the fish that we today include in the "*cameronense*"-group. After the geographical distribution we describe the habitats in the wild and the fish that can be found in them.

Several chapters are devoted to the maintenance and breeding in the aquarium, together with the attendant problems. These pages are meant for those aquarists who have decided to specialise in killies from the "*cameronense*"-group (this must be one of our aims!).

In the theoretical part of the book systematics and nomenclature are dealt with. We are aware that only very few aquarists are interested in this admittedly dry material. But it is to be hoped that some readers will find the relationships between the various fish interesting and that they will read through this part of the book with care. We point out some very surprising facts, which can fascinate a lover of the colourful *Aphyosemion* species just as much as the successful maintenance and breeding of these fish.

At the end of the book an attempt is made to provide an identification key for the males of this group, so that fish of imprecise origin can be classified roughly.

Graphics: tables, drawings, maps and colour pictures. To make this work more interesting, varied and clear, we have resorted to these graphics. For example, average rainfall can be explained better by means of tables than by page-long descriptions.

The use of drawings and sketches clarifies geographical data as well as the colouration characteristics of the male fish.

Above all, detailed maps are indispensable for the description of the geographical distribution of the species and phenotypes. We think it very important to illustrate our statements with these maps.

Introduction

With this book we wish to attempt for the first time to present the many known species and strains of the "*cameronense*"-group in a single publication. We consider it very important that the reader should be able at any time to compare the different colour patterns of the males. Only then can one comprehend the relationships that exist within the group.

The numerous rainforest streams of Cameroon and Gabon - the habitat of many colourful killies

Precursors of this Book. Those interested in killifish will sooner or later become aware of the Deutsche Killifisch Gemeinschaft e. V. (German Killifish Association), or of a sister association in their own country. In contrast to most aquarium fish, killies are rarely to be found in the trade, which is why these associations provide the easiest way of acquiring these most interesting fish.

For the aquarist eager for more information there are numerous excellent DKG publications available, as these deal exclusively with killifish.

The DKG publishes regularly the "DKG-Journal", the payment for which is included in the annual subscription. In the journal members recount their experiences in catching, keeping and breeding killifish. In addition first descriptions of new species are published in the DKG-Journal as well as in the corresponding publications of its sister associations.

The total number of *Cyprinodontidae* or egg-laying toothcarps (as they are also called in specialist circles) is so long that a single publication can never contain all the details of every species. So in recent decades the need for specialised literature has become more and more urgent. Leaders in this field have been the many scientific publications of experts like Scheel, Wildekamp, Radda & Pürzl, Berkenkamp, Huber, Seegers and Amiet.

As early as the seventies the Dane J.J. Scheel wrote a book concentrating on the killifish of the old world. In 1985 followed the publication of the first supplementary booklet of the DKG, written by Seegers. He went a step further and dealt only with the genus *Nothobranchius*.

The tendency towards greater and greater specialisation was revealed two years later in an outstanding publication: in 1987 Amiet published a book in English and French, which dealt exclusively with the *Aphyosemion* species of Cameroon. For the first time the killifish of a single genus and from one country were discussed fully in one book.

In 1990 followed the publication of Legros' essay "Le sous-genre *Chromaphyosemion*", which deals with just a single subgenus, namely the species and undescribed phenotypes centred around *Aphyosemion bivittatum*.

In 1992 appeared Huber's scientific publication on the genus *Rivulus* in English. Here we can also see the specialisation in certain species.

All these works show impressively that the immense amount of knowledge about killifish can only be contained and spread in comprehensive pieces of writing. The considerable amount of useful information that we extracted from the works mentioned spurred us on to write the book on the killies of the "*Aphyosemion cameronense*"-group which now lies in front of you.

Aphyosemion cameronense "LEC 93/3"

It would be presumptuous to claim that this book could follow in the steps of the above-mentioned works. This has not been our intention. Rather we want to present the unique killifish centred around *Aphyosemion cameronense* in a quite special way, so that as many aquarists as possible can share the fascination which comes solely from the observation of these little jewels in the aquarium.

The history of the origins of this book. In the DKG lovers of killies are able to exchange fish and experiences with each other. Anyone who specialises in certain genera or groups of species soon gets to know many aquarists who are interested in and keep the same species in a genus or species group.

On the occasion of the DKG Convention in May 1992 we spoke at length about the literature that has appeared to date on the genus *Aphyosemion* and "*cameronense*"-group in particular. We agreed that it is essential to publish the huge quantity of knowledge about these fish which has been accumulated by the numerous aquarists specialising in killies. Finally one of us put the rhetorical question: "Why don't we write a book on the killies that we have been working with for years now?"

During the following months this idea developed into the thought that we should use our various skills in putting together a comprehensive work on the "*Aphyosemion cameronense*"-group.

None of us individually would ever be in a position to bring together all the necessary information and publish it in the form lying before you. Early on the work was divided as follows: Norbert DADANIAK took on the practical section, which deals with maintenance, breeding, behaviour and diseases of these killifish. Reinhard LÜTJE succeeded in photographing the fish in such a way that first-class colour pictures are available to us. Wolfgang EBERL was responsible for the theoretical part, which is devoted to the distribution of the fish and the scientific aspects.

Aphyosemion amoenum "EMS 90/9"

Explanation of Important Technical Expressions

The many-sided nature of this book made the use of special concepts in zoology, geography and water chemistry essential. From the very beginning we wanted to choose a style which would permit as many readers as possible to understand what was written and to follow our lines of thought.

A compromise had to be made between these two requirements, and so we decided to explain the essential technical terms in this chapter.

So there now follows a list of these concepts, where each one is explained. These words keep re-appearing in the following text. This will enable the reader to quickly look up in this section what we mean by a certain term.

Killifish. This is the generally used term for the fish of the family *Cyprinodontidae*. The family is also called "egg-laying toothcarps", but this word is as unpopular as the scientific one.

The first settlers who made their homes in the area of the present New York were of Dutch descent. They therefore called the small fishes in the ditches "killies", which can be translated as "ditch fish".

These actual fish were from the genus *Fundulus* (these also belong to *Cyprinodontidae*, and so are related to *Aphyosemion* and all other killies). Later this term from the USA was extended to all these fish.

From it evolved the word "killifish", which in the course of time spread to Europe in every language in its shortened form. The term "killie" has therefore nothing to do with the word "kill".

***Aphyosemion*.** This synthetic concept was formed from the Greek words "aphye" and "semion" and describes two salient features of this genus. "Aphye" refers to small fish, namely anchovies, and the "semion" means "pennant", which relates to the much extended caudal fin of the males of this genus.

Genus. This zoological term is used for the classification of living organisms into a system that brings together related species. All killifish belong to the family of toothcarps, which are split into sub-families.

One of these families, the *Rivulinae*, contains the genus *Aphyosemion*. Each of these entities therefore embraces species that share certain physical characteristics, by which they can be differentiated from other genera, sub-families or families.

It would be asking too much of this book to examine more closely the relationships above the level of the genus *Aphyosemion*. So we are refraining from a deeper definition of the killifish genera such as the concept *Aphyosemion*.

SEEGERS (1980) explains this classification in exemplary fashion. We would therefore recommend the interested reader to refer to pages 11 to 15 in the publication referred to.

Subgenus. This lies between the genus and the species placed within it. The approximately 100 species of the genus *Aphyosemion* can by reason of physical characteristics be placed together in groups with striking points they have in common. This is why some of these groups have been described by scientists as subgenera. Useful in this respect are the body shape and colouration, as well as the shape, position and markings of the fins.

Examples of this are the subgenera *Paraphyosemion*, *Fundulopanchax*, *Gularopanchax*, *Paludopanchax*, *Chromaphyosemion*, *Kathetys* and *Raddaella*. Fish of a subgenus are more closely related to each other than to species of other subgenera.

Species group. This artificial term is also used to define related species and separate them from other species groups and subgenera. The only difference from a subgenus is the fact that the species groups have still not been described scientifically. The species *Aphyosemion bivittatum*, *Aphyosemion riggenbachi*, *Aphyosemion loennbergii*, *Aphyosemion splendopleure* and *Aphyosemion bitaeniatum* were generally known as the "*Aphyosemion bivittatum*"-group, until Radda established the subgenus *Chromaphyosemion* in 1971. The same happened again, for example, when in 1977 Huber raised the species *Aphyosemion bualanum*, *Aphyosemion exiguum* and *Aphyosemion bamilekorum* to the subgenus *Kathetys* (a further species of this genus - *Aphyosemion dargei* - was not described until 10 years later by Amiet).

The species related to *Aphyosemion cameronense* have not yet been placed together in a separate subgenus, although there are sufficient arguments to justify doing so. In the **Summing-up** we will discuss this problem further.

Male of the strain *Aphyosemion amoenum* "EMS 90/8" from the village of Son Mayo in Cameroon

Aphyosemion maculatum "GAB 90/19"

Species. Subspecies and species groups are divided into this next smallest unit. There are two important definitions of a species in the scientific sense.

First, all living organisms can be placed in a species which have quite distinct physical features that are present in every individual of that species. All the members of this species differ by reason of these characteristics from those of other species, since one or more of the specific features are not present on other species. In this connection the phenotype is of significance.

Secondly, a species can be thought of as a group of living organisms which interbreed freely and through countless generations. These creatures are separated from other species in that they will not cross with them. Under certain circumstances it is admittedly possible with killies to cross two species successfully, but the hybrids are scarcely viable and in any case infertile, so that further breeding after the first F-generation is not possible. In this case the term reproductive isolation is used.

SCHEEL worked intensively with the chromosomes of killifish, which is why his works lean clearly in the direction of genotype. Other scientists pay more attention to the physical characteristics of adult specimens.

Subspecies. Just as a genus can be sub-divided into subgenera, so species can be split into subspecies. In this area there is a wide divergence of opinion with regard to the genus *Aphyosemion*. Many authors are inclined to include similar fish in one species, while others would like to split these fish into several species or subspecies. The terms "splitting" and "lumping" or "sampling" are in general use, to describe whether species are split or lumped together. In the chapter "**The Variability of Killies in the "*Aphyosemion cameronense*"-group**", we will discuss this problem further.

Phenotype. In the past just as now, the externally visible features of adult animals were used in the description of the features of a single animal or a group of animals (viz the concept **Species**). In the case of fish, the fin rays and the scales on the sides of the body, together with the frontal scalation, are most important when it comes to determining the species.

In the "*cameronense*"-group only slight differences can be detected with regard to morphometric data (body measurements). Many scientists (Radda, Amiet) concentrate therefore on the colouration patterns of the males and females. As we ourselves do not have the facilities to count the fin-rays and scales of the *Aphyosemion*, we are restricting ourselves particularly to the body colouration of the fish.

Above all in the presentation of phenotypes of the group that have not yet been researched more fully, we rely on the sometimes extremely divergent colouration of the males. A possible rephrasing of the word "phenotype" would be "appearance". We mean by this quite simply the fish as we see them as living material.

Genotype. In connection with the reproductive isolation of species, it is essential to ascertain the number and shape of the chromosomes. Unfortunately we lack the necessary facilities to do this. It would be informative for someone to check scientifically the assertions made by us in this book. We will of course be happy to support interested persons with all the means available to us. More of this in the **Summing-up**!

Aphyosemion mimbon "LEC 93/18"

Strain. For killi-enthusiasts this word has a special meaning. In the chapter **The Variability of Killies in the "*Aphyosemion cameronense*"-group** we will show how greatly the males of a species differ from each other, if they come from different locations. This phenomenon has been known for a long time and has resulted in fish being given additional designations according to their place of origin.

The names of whole countries or regions were often used for this. With the ever increasing number of strains it became necessary to choose more precise labels. So "Nigeria", "Biafra", "Mémé" or "Santa Isabel" were replaced by names of towns, such as "Lagos", "Tiko", "Lébamba", "Makurdi", "Ijebu Ode" etc.

In contrast with most other aquarium fish, it is essential with killies to keep different strains permanently apart from each other and breed them only in pure lines. Of course it is possible to cross a male of *Aphyosemion amoenum* "Son Mayo" with a female of the "Sonbo" strain. As the fish are one species, the hybrids should be fertile. The strain arising from the cross would probably have a combination of the characteristics of the parent strains, but these would be lost in their distinctiveness.

There are strains that have been bred pure for many years. In 1978 *Aphyosemion pyrophore* "RPC 78/18" was caught at location 18 in the then People's Republic of the Congo (the French abbreviation being "RPC"; today this country is called just the "Republic of the Congo"). This fish still exists as a pure strain. Responsible killie breeders always use only fish of the same strain for breeding. The fact that there need be no ill effects from inbreeding is demonstrated by the splendidly coloured and healthy fish which are bred today. With the species taking about eight months from hatching to breeding, the present fish will be the 24th or 25th generation.

Many other strains from precise locations were named, and they have been successfully kept pure and reproduced by lovers of killifish for a long time.

Population. This originally meant the fish that live in a certain body of water. This term was then used for the later generations that were bred in captivity. Basically this word comes close to "strain". The only difference is probably the fact that with a population the place of origin is better known than with the old strains which in some cases were imported many decades ago.

One of the most widely distributed killifish in the hobby is *Aphyosemion australe*, but its precise place of origin is not clearly known at all. As this fish is called "Cape Lopez", one can assume that the first specimens of this species came from the immediate vicinity of this cape in Gabon.

With more recent strains, on the other hand, we know pretty well precisely from which stream they come. The population *Aphyosemion cameronense* "LEC 93/3" was caught on 8th January 1993 at about 13.00 in the "Nkogh'essy" stream, which is situated a few metres from the eastern edge of the village "Ebé" about 200 metres from the road in the forest. Ebé in its turn lies 48 km east of Koumaméyong on the National Road 4 past Ovan in the direction of Makokou in northern Gabon (12°06' E, 00°20' N).

These are very accurate data, are they not? An exact description of the finding place is necessary, in order to establish what species the fish belongs to, and also in order to be able to find the location again.

In addition it also permits inferences to be made on the presence of a species in a hydrographic system, if one has detailed maps at one's disposal.

The 'Loboou' stream near the village of Ebé in north Gabon, location of *Aphyosemion maculatum*. The locality code is "LEC 93/4"

Type locality, terra typica. When an animal species is discovered for the first time or is recognised as a new species, it can be scientifically described and provided with its own name. For this to happen, precise conditions must be fulfilled for this scientific publication to be valid. One very important aspect of a first description is the origin of the animals (or plants). The reason for this is that it might be necessary to be able to collect and research the species again at a later date.

The author of a first description therefore chooses the finding place as the type locality, where the new species was found for the first time, or else specimens bred from them which he thinks most suitable. The Latin word "terra typica" refers in its anglicised form to the place of origin of the type specimens of a new species.

Hydrographic system. As the reader will find out in the chapter **The Habitat in the Wild: the Biotopes**, the killies of the "*cameronense*"-group live in very small bodies of water, in which they prefer to stay in the shallow areas by the banks. *Aphyosemion* species are very poor swimmers and like to stay in one place. Each little stream flows into the next larger one, which then with other streams joins the rivers. The clear tendency to form populations in a specific stream, combined with the distinct lack of "wanderlust" have led to many species and phenotypes of the "*cameronense*"-group to be restricted to certain river systems.

It can be said, for example, that in the drainage area of the Sanaga different killie species occur than in the hydrographic system of the Ivindo. Especially in the area of watersheds this fact is of considerable significance.

A sub-division of an area into hydrographic systems often provides an understanding of the killifish present there. When it comes to the group discussed in this book, it can be said that it occurs only in the river systems of the Sanaga, Dja, Nyong, Kellé, Ntem, Rio Ecucu, Woleu, Mvoung and Ivindo. In the adjoining systems other species from other species groups or subgenera take over the ecological role of the representatives of the "*Aphyosemion cameronense*"-group.

The Nyong in the south of Cameroon in the dry season! How much water must flow in it in the rainy season?

The following map is intended to give a general view of the hydrographic systems in the countries of Cameroon, Gabon, Equatorial Guinea and the Republic of the Congo. Only the largest rivers of these countries have been shown. More detailed information on the situation in the distribution area of a species or an undescribed phenotype will be found in the more detailed discussion in the chapters **The Species of the "*camero-nense*"-group** and **The Various Phenotypes of the "*cameronense*"-group**.

Water hardness. In aquarium literature a great deal has been written on the basic chemistry involved with the maintaining of ornamental fish. Despite this fact we will at this point discuss it, especially with relation to *Aphyosemion* species.

"Hardness" refers to the content of chemically dissolved substances in the water. In particular the calcium, magnesium, hydrogen carbonate and hydrogen sulphate ions have a certain significance. The higher the hardness reading of a sample of water, the higher the content of dissolved material. In Central Europe, depending on the area, hardness can measure from 2 to over 30° German total hardness (dGH). The carbonate hardness can range between 1 and 25° carbonate hardness.

The waters of the rainforests of West and Central Africa are poor in minerals, so the readings there are of 0 to 1°dGH. The usual test kits detect virtually no carbonate hardness.

In the chapter **Maintenance and Breeding** we show that it is by no means necessary to copy these extreme water conditions in the aquarium. In this respect the killies from the "*cameronense*"-group are much more adapatable than is generally supposed.

pH. The low carbonate hardness of the waters makes no effective buffering of the ph. The lower the pH reading, the higher the content of free acid in the water. The constant leaf-fall in the dense rainforests causes a heavy build-up of tannic acid, when leaves that have fallen in the water decompose. Acid pH readings of 4.8 (14 January 1993, sluggish stream 16km from Libreville Airport on the road to Cap Estérias) to 6.9 (10 January 1993, stream about 60km west of Makokou on the "N 4") are possible. But these are extreme readings; the average lies between 6.5 and 6.7.

There has already been much detailed discussion on the effect of the pH on the health and fertility of *Aphyosemion*. It is conceivable that the water's acid content affects the sex ratio of the following generations. Unfortunately, as far as we know, there are no documented reports of experiments to find this out. A lot of useful information would result from such experiments.

Conductivity. Water hardness and pH relate to the content of certain chemical substances in the water, providing information of both quantitative and qualitative nature. The conductivity, on the other hand, indicates only how many electrically conducted materials are dissolved in the water. It does not tell us what materials are involved (so is purely quantitative).

The electrical conductivity of the water increases with the content of ions which conduct the current. The extremely low content of mineral salts in the waters of the rainforest produces readings of 12 microSiemens (12 January 1993, about 16km from Médouneu on the "N 5" in a westerly direction towards the coast, water temperature at 17.00 27.2°C!) to 40 microSiemens (7 January, stream near Laboka II, near the Ndjolé-Makokou-Mitzic crossroads, water temperature 25°C).

Tap water in South Germany can give readings of up to several hundred microSiemens, as the high hardness levels raise the conductivity considerably.

Dorsal, caudal, anal, ventral and pectoral fins. The following drawing shows the scientific names for the fins of our fish.

Aphyosemion spec. aff. cameronense Phenotype 4 from Bélinga in north Gabon

Aphyosemion mimbon "LEC 93/19"

Marginal, submarginal, basal, distal. These terms indicate the positions of the markings in the fins. Here too a drawing is used to explain these concepts.

Radial, inter-radial. These terms describe the extent and position of the pattern along and between the fin rays.

Margin, band. These very similar markings are hopefully clarified by the following drawing. It is often not easy to say whether the outer area of a fin bears a margin or a band. The deciding factor is the fact that a band is always clearly defined, whereas a margin merges into the basic colouration of the fin.

By ***Aphyosemion spec. aff. cameronense*** we mean a form related to *Aphyosemion cameronense*, which, in our opinion, could be described as a subspecies or even a separate species.

The term ***Aphyosemion cameronense halleri*** **sensu RADDA & PÜRZL** actually includes the definition of the subspecies, as is understood by the two authors.

The name ***Aphyosemion cameronense*** **sensu stricto** is used by many authors to refer to this species in a narrower sense, i.e. the true *Aphyosemion cameronense*. The corresponding suffix "**sensu largo**" refers to a species in the broader meaning, the various phenotypes included.

What is a Killifish of the "*Aphyosemion cameronense*"-group?

The reader has already seen some basic terms that are commonly used in relation to killifish. The expression "*cameronense*"-group has been used repeatedly, and is also the title of this book. We consider it important to state precisely, right at the beginning, what is meant by a fish from the "*Aphyosemion cameronense*"-group.

First we define *Aphyosemion cameronense* itself, followed by the other species, subspecies and undescribed phenotypes of the group in the second part of the chapter.

What do we mean by *Aphyosemion cameronense*?

As far back as the 19th century preserved fresh-water fish arrived from West Africa into Europe, where they were studied by ichthyologists. These zoologists specialising in fish very soon realised that the fish involved were hitherto unknown forms. They consequently described many new species. That mistakes were made is understandable, looking back: several scientists of different generations and institutes were working with the preserved specimens to methods which to some extent were quite different. Their basic approaches were not the same either.

At the turn of the century BOULENGER, the ichthyologist working in London, received material from the river system of the Dja in south Cameroon. After examining it, he decided to describe the new species as *Haplochilus cameronensis*. He named the species after the country of origin, i.e. Cameroon (today we know that *Aphyosemion cameronense* in the form he had is found in the north of Gabon and possibly also in the north of Equatorial Guinea).

At the time the generic name *Haplochilus* was used for these species. In the course of time the scientific names have changed repeatedly. Many authors even used the generic name *Fundulus*, which was later replaced by *Panchax*. It was not until MYERS proposed the genus *Aphyosemion* in 1924 that the name *Aphyosemion cameronense* was used.

Subsequently numerous other species from Cameroon and the bordering countries were described. Some of these later turned out to be synonyms of *Aphyosemion cameronense*. SEEGERS (1988) stated the names *Panchax obscurus* (*Aphyosemion obscurum*), *Panchax microstomus* (*Aphyosemion microstomum*), *Panchax bellicauda* (*Aphyosemion bellicauda*) and *Fundulus beauforti* (*Aphyosemion beauforti*) to be synonyms of *Aphyosemion cameronense*.

Since the end of the sixties all authors have agreed as to what species is meant by *Aphyosemion cameronense* (SCHEEL, RADDA & PÜRZL, SEEGERS, WILDEKAMP, HUBER, AMIET, see also in the chapter **Previous Publications on the "*cameronense*"-group**). The only wide divergence of opinion is on the validity of the different species and subspecies of this group.

In 1987 AMIET published his pioneering work "The Fauna of Cameroon, Vol 2: The genus *Aphyosemion* MYERS". In it he gives a definition of the species *Aphyosemion cameronense* in the narrower sense, which we would like to quote here:

> "Amongst the various phenotypes of this group, those that are united under the name of *Aphyosemion cameronense* are some of the largest, the males reaching or slightly exceeding 50mm in overall length.
> The ground colour, on the flanks, including at the level of the caudal peduncle, is a very shiny metallic blue or green.
> The development of the pattern of spots varies according to the population but, on the whole, the spots are not very numerous and form, at the most, a dorsal line in the shape of a zigzag at the level of the caudal peduncle; the remainder of the pattern of spots is constituted of dots which are disseminated or joined in small longitudinal series.
> The red medio-ventral line, which is always well developed, stretches from the end of the caudal peduncle to the start of the anal or the pelvics, even the pectorals.
> The dorsal, which is quite uniform in appearance throughout the distribution area, is golden green passing to copper distally with red dots and/or flames.
> The anal is very variable. Generally, it is decorated with a red submarginal band and a white (exceptionally yellow) marginal band but in some populations (middle basin of the Ntem), the pattern can be different: red inter-radial stripes and narrow white edging, or markings reduced or even absent.
> The caudal is less densely pigmented with red than in *Aphyosemion obscurum*; except for the darkened posterior edge, the golden green or blue background colour generally predominates over the markings which are made up especially of flames and large dots: the submarginal bands are roughly in the shape of a lyre which marks the limits of the central part: the margins are very variable."

This extract shows clearly how AMIET concentrates on the colouring of the males for finding rules to classify the fish.

It must not be thought that the present book consists only of such descriptions. In the following pages we shall try to explain AMIET's opinions and amplify them with drawings and colour pictures.

We hope that the reader will then learn step by step how to identify a member of the "*cameronense*"-group.

A word of advice. Should you ever have difficulty in following our argument, refer directly to the descriptions of the species and phenotypes shown in the book. During the course of the work these will be carefully described in words and pictures and differentiated from each other. With the help of the large number of colour pictures you will with time recognise the characteristics mentioned and get a feeling for this way of looking at the fish.

Body size. AMIET's reference to the 50mm total length of adult males should only be used for purposes of identification. Body size is always determined individually and can be greatly influenced by the quality of food and the water conditions in the aquarium.

Moreover there are very many *Aphyosemion* species of similar size. Within the "*cameronense*"-group too, it is scarcely possible to make distinctions between the species based on body size.

The basic colour. It is crucial to stress the metallic blue-green colouration of the whole body.

Within the group there are recognised species whose basic body colour is yellow or orange in the hind part of the fish. Besides this, in Cameroon and Gabon phenotypes with this characteristic have been discovered, which do not belong to the species *Aphyosemion cameronense* (see also the sections "Phenotype 3 from Djoum-Mintom", "Phenotype 4 from Bélinga", "Phenotype 5 from Koumaméyong" and "Phenotype 9 from Ngoyang" in the chapter **The Various Phenotypes in the "*cameronense*"-group**).

A basic blue colouration can be seen on most species of the genus *Aphyosemion*. In general the shade of colour changes with the mood of the fish and the angle of the light. Lovers of the "*cameronense*"-group tend to say that the brilliance of the colours in this group is particularly great.

One should not get drawn into a dispute on this point, as personal reactions are not measurable, and we are at liberty to decide what fish we find the most beautiful.

The red zig-zag band. This is a characteristic which is extremely helpful in the identification of the true *Aphyosemion cameronense* as well as some species and phenotypes of the group.

This band is found in the upper area of the caudal peduncle and begins right at the base of the caudal fin. It runs virtually horizontally and goes beneath the dorsal fin forwards into a linear arrangement of red spots of the same size. The band ends roughly in the middle, between the ventral and pectoral fins.

This characteristic is always present in *Aphyosemion cameronense*. It varies in breadth and length, depending on the individual fish and the population. As a general rule, the band in the fish from Gabon is much less clearly defined than in the populations from Cameroon.

The red spots on the sides of the body. A further significant characteristic of the genus *Aphyosemion* is the red spots, which in many species are arranged regularly ("*elegans*"-group, "*striatum*"-group) and in others can merge into vertical bands (subgenus *Kathetys*). In addition we also know species which show no red spots on the flanks: *Aphyosemion cinnamomeum*, the "*Aphyosemion coeleste*"-group and some species of the subgenus *Chromaphyosemion*.

In *Aphyosemion cameronense* we always find these spots arranged in the same way: immediately behind the eye there are three red lines parallel to each other. These lines turn upwards slightly towards the rear. The uppermost line is always shorter than the others. In many strains it is so poorly defined that one has the impression that there are only two. Closer examination will confirm the presence of the upper short band.

Below the eye runs a short red band that seems to follow the curve of the eye. The size of this band varies from strain to strain, but it is always visible.

Behind the pectoral fins follow three irregular horizontal rows of red spots. Sometimes several of these spots merge and give the impression of a continuous red line. From halfway down the body towards the end of it, the spots become smaller and the rows disappear.

Aphyosemion are not at all constant with regard to the shape, size and arrangement of these spots, which is why we discuss further the variability of the red spot pattern on the flanks of the body in the section ***Aphyosemion cameronense*** in the chapter **The Species of the "*cameronense*"-group**.

We have in fact devoted a whole chapter to this subject: **The Variability of Killies in the "*Aphyosemion cameronense*"-group**.

The term **medio-ventral band** refers to a characteristic that has always been used for the definition of this species. Like the zig-zag band in the upper area of the caudal peduncle, it is particularly clear on the rear part of the body to the caudal fin. It also begins at the base of this fin and stretches from the lower edge of the caudal peduncle to the base of the anal fin. Strains are even known in which this red "*cameronense*" band reaches as far as the pectoral fins.

This characteristic too is very variable and yet it is present on all strains known to date. It is shown most effectively by the different pictures of male*Aphyosemion cameronense* as well as of most other species and phenotypes in this book.

The dorsal fin has a very uniform colour pattern. The ground colour is metallic blue-green similar to the ground colour of the body. On the margin (distally), this colour assumes an increasingly golden sheen.

At the base there are almost circular spots, which merge as they go outwards and join to become inter-radial streaks and "flames". Only the outer margin of the dorsal is without red markings. On many strains it is more lightly coloured than the ground colour, so that one gets the hint of a margin.

When fully stretched, this fin can be seen to have no extensions.

For the anal fin not much can be said covering clear characteristics, as this fin varies so much in its colouration as between the numerous strains. We know populations from Cameroon which have a pretty well uniformly blue anal fin, and at the same time there are populations in which it has a most beautiful colour pattern.

Aphyosemion cameronense "HJRK 92/11"

Aphyosemion cameronense "CGE 91/8"

The outer area of the fin consists of a white to light blue marginal border, whose width can amount to from one to roughly four tenths of the whole fin.

To the interior follows a dark red submarginal band, whose width can also be very variable. In many strains it consists merely of a row of red spots, which form a broken red band.

In the basal area there are red spots which vary both in number and size. In many strains they can form an irregular and in places broken red band. In addition, in the central area of the fin, there is a good scattering of red spots, which form an irregular pattern.

The following drawing shows how variable this species is with regard to the colouring of the anal fin. A comparison should also be made with the pictures of the various strains of *Aphyosemion cameronense*.

It is above all when the males open the fins fully that the shape of the anal fin can be seen, like a parallelogram. The posterior end of the fin is slightly extended, but it never reaches the length that can be observed, for example, in males of the subgenus *Chromaphyosemion*.

The caudal fin shows a very characteristic colour pattern, which cannot be found outside the "*cameronense*"-group.

In the upper and lower region we can see a broad marginal band, which is always light in colour.

The colour can have the most varied gradations from white to light blue and a metallic gold-green to light yellow. However, the typical form of this margin always remains the same.

We know strains in which many males have a yellow and white margin. Either the upper or the lower margin may be yellow. On occasions males appear with two yellow marginal borders in the caudal fin.

Inside the fin both margins are bordered by a red submarginal band. These can be seen as continuations of the zig-zag band and the medio-ventral band. They separate the marginal borders from the central area of the fin.

This area displays, over a metallic blue-green ground colour to the base of the fin, isolated almost circular red spots and dots, which to the rear join to become inter-radial flames.

With this pattern too astonishing variability is apparent, as is shown on the following drawing.

On the previous pages we have seen how *Aphyosemion cameronense* can be recognised from the pattern of markings on the fins and body. This list will become easier to understand, when the colour pictures of the populations of *Aphyosemion* *cameronense* are examined carefully. Try to recognise the characteristics mentioned. You will find that even though they are more or less pronounced, they will always be present.

Aphyosemion cameronense "Madang I"

Aphyosemion cameronense "Mélén"

What Fish belong to the "*Aphyosemion cameronense*"-group?

According to the definition of the species that has given its name to this group, we now want to try to describe the other species and phenotypes that can be placed within this group. This task is aggravated by several factors:

- Species already described, such as *Aphyosemion amoenum*, *Aphyosemion halleri*, *Aphyosemion haasi* and *Aphyosemion obscurum*, are so obviously related to *Aphyosemion cameronense* that they are considered by many authors to be synonyms (lumping or sampling).
- This is also true for some phenotypes of the "*cameronense*"-group, which are discussed in the chapter **The Various Phenotypes in the "*cameronense*"-group**. Of course these phenotypes have distinguishing features, by which they can be separated from the species *Aphyosemion cameronense*.
- There are species which by reason of their meristic features clearly belong to the "*cameronense*"-group, but which lack some of the characteristics mentioned above: e.g. *Aphyosemion maculatum* and *Aphyosemion mimbon*.
- HUBER and other collectors discovered phenotypes in the north of Gabon, which many other authors placed with *Aphyosemion cameronense*, even though on the one hand characteristics of this species are absent, but on the other hand characteristics are present that are typical for the recognised species of this group, that is they are not found in *Aphyosemion cameronense* itself.

In fact it can be said that there are considerable differences of opinion regarding the species and their validity. This book may be able contribute a few arguments to the discussion. These will be found in the chapter **Summing-up**.

We will now list the characteristics which in our opinion are appropriate for considering the various species and phenotypes as members of the "*cameronense*"-group. As we are not in a position to count the ray fins and scales or even work on chromosome counts and forms, we rely exclusively on the colouration characteristics of adult fish and the "general impression" one gets from observing a fish.

The body size. In our experience the total length of adult fish of this group varies from 45 to 55mm, but in this the individual measurement plays a considerable part.

In addition there seem to be species and phenotypes which grow to a larger or smaller size.

AMIET discovered west of Lolodorf in Cameroon a phenotype related to *Aphyosemion cameronense*, which exhibits some important characteristics of this species and whose maximum total length seems to lie around 45mm (Phenotype 1).

The first description in 1976 of *Aphyosemion amoenum* and *Aphyosemion halleri* (*Aphyosemion cameronense halleri* sensu RADDA & PÜRZL), by RADDA & PÜRZL gives the total lengths of the preserved specimens, as up to 52mm for *Aphyosemion amoenum* and 43.5mm for *Aphyosemion halleri*.

Aphyosemion spec. aff cameronense Phenotype 6 "LEC 93/22"

Aphyosemion amoenum "CGE 91/13" from the only known strain of the "*cameronense*"-group caught north of the river Sanaga!

Fish bred from the wild caught specimens of 1990 of the last mentioned species reached in the aquarium total lengths typical of the "*cameronense*"-group.

In 1976 the first description was published of *Aphyosemion haasi* (*Aphyosemion cameronense haasi* sensu RADDA & PÜRZL). The total lengths of two specimens were given as 39.0 and 42.5mm.

On page 141 of this work the authors give the following measurements: "The new subspecies grows large and fish of 60 to 70mm total length were collected". As no progeny were secured from this strain, and as nobody has been able to collect fish from the terra typica or surrounding area, we must accept these as the maximum measurements for a member of the "*cameronense*"-group.

One observation can be made about the "*cameronense*"-group, which is not normal for the genus *Aphyosemion*. Very often the females reach a greater total length than the males. As a rule it will be found that the *Aphyosemion* females are always a few millimetres smaller than the males.

In the chapter **Behaviour: Aggressive and Peaceful Disposition**, we discuss amongst other things the problems that occur when pairs are placed together for spawning, if the females are larger than the males.

The basic body colouring of the males was shown to be a dubious recognition feature for *Aphyosemion cameronense.* This is also true for the other representatives of this group.

In the anterior area of the flanks of the body there is always a blue-green shade in evidence, which changes with the angle of light and also the type of lighting.

The "Yellow Blotch". There are within this group species and phenotypes, which in the posterior part of the body exhibit a feature which is otherwise only found in *Aphyosemion amieti* (this species belongs to the group around *Aphyosemion ndianum* and *Aphyosemion puerzli*, which are close to the large *Aphyosemion* species; there are no connections with the "*cameronense*"-group). From the base of the caudal to about the beginning of the dorsal fin the caudal peduncle is coloured yellow to orange-red across its total height.

This particular characteristic was used by RADDA & PÜRZL as one of the arguments for the specific status of *Aphyosemion amoenum* and the subspecific status of *Aphyosemion cameronense halleri* (*Aphyosemion halleri* sensu AMIET). However it is also present in AMIET's Phenotype 3 from the south-west of Cameroon as well as in two further phenotypes from Gabon ("Bélinga" and "Koumaméyong"). Phenotype 9 from Ngoyang in Cameroon also has a yellow blotch in this area, even if it is considerably smaller.

This peculiarity is discussed fully under Phenotypes 3, 4, 5 and 9 in the chapter **The Various Phenotypes in the "*cameronense*"-group**.

The red zig-zag band is present on some of the species and phenotypes: *Aphyosemion amoenum*, *Aphyosemion halleri*, *Aphyosemion haasi*, *Aphyosemion obscurum* and Phenotypes 1, 2, 3, 4 and 9 show this feature in all males, whether found in the wild or tank-bred.

It is absent on *Aphyosemion maculatum* and *Aphyosemion mimbon*. The authors of the first descriptions of both species (RADDA & PÜRZL and HUBER respectively) unhesitatingly place these species in the "*cameronense*"-group, even though the zig-zag band is not present. These species have other characteristics which suggest convincingly that they belong to this group.

In 1978 HUBER discovered in the "Monts de Cristal" in Gabon a phenotype related to *Aphyosemion cameronense*, which he called *Aphyosemion spec. aff. obscurum*. In 1993 a male of this phenotype was caught and brought back to Europe. We call this form Phenotype 6 and deal with it in the chapter **The Various Phenotypes in the "*cameronense*"-group**. It too lacks the red zig-zag band.

In addition there occurs in the region of the southern distribution area of the "*cameronense*"-group near Koumaméyong in Gabon a phenotype with a yellow caudal peduncle, which has only a suggestion of this red zig-zag band in the form of a few red spots in front of the base of the caudal fin. Here we call this fish *Aphyosemion spec. aff. cameronense* "Phenotype 5". The following drawing shows a male of the strain "LEC 93/2":

The red spot pattern on the sides of the body is in most members of the "*cameronense*"-group similar to that of the nominate species. This can be seen in *Aphyosemion halleri* and *Aphyosemion amoenum*.

In *Aphyosemion obscurum* the spots are considerably greater in number, so that the impression is given of a regular horizontal striped pattern. This is also the case in Amiet's Phenotype 1, even if this phenotype has similarities with the geographically separated *Aphyosemion obscurum* only with regard to the body markings.

The few available colour pictures of *Aphyosemion haasi* (*Aphyosemion cameronense haasi* sensu Radda & Pürzl) also show on the anterior part of the body the irregular spots of *Aphyosemion cameronense*. *Aphyosemion maculatum* and *Aphyosemion mimbon* also have the typical markings on the anterior part of the body. But on the rear part of the body they have numerous extremely large spots. This colour pattern is restricted to these two species.

There are many phenotypes in the "*cameronense*"-group that show the spotted markings on the side of the body. We know this in Phenotypes 2, 3, 5 and 7.

The geographically separated Phenotypes 4 and 9 have a more regular spotted pattern reminiscent of *Aphyosemion obscurum* and Phenotype 1. At the same time, however, they have the "Yellow Blotch", which is absent from the two forms last mentioned.

The body markings on Phenotypes 6 and 8 are especially well developed. The zig-zag band and the lower red band are missing, and irregularly scattered red spots lie on the whole side of the body. The two phenotypes are also geographically separated and differ in the colouration of the unpaired fins. This can be seen from the colour pictures on pages 29 and 145. The red spots mentioned on page 22 can be seen on all members of this group, but they are also present on many other *Aphyosemion* species. This is why in our opinion they are not features that can be used for identification.

Aphyosemion spec. aff. cameronense Phenotype 7 "LEC 93/7"

The medio-ventral band runs from the lower third of the caudal in the bottom part of the caudal peduncle to about the ventral fins. It is found on *Aphyosemion amoenum*, *Aphyosemion obscurum*, *Aphyosemion halleri*, *Aphyosemion haasi* as well as on all the other undescribed forms of this group apart from Phenotypes 6 and 8. Although the length of this band can vary considerably within the group, it does represent the best recognition feature. The only other species with a similar band is *Aphyosemion ndianum* from the coastal plain in the border region between Cameroon and Nigeria. *Aphyosemion ndianum* clearly belongs to the group of large *Aphyosemion* species. As mentioned on page 30, this species is therefore not related to the "*cameronense*"-group. The band is absent on the two recognised species *Aphyosemion maculatum* and *Aphyosemion mimbon*, so it cannot be used as an infallible identification feature for all species and phenotypes of the "*cameronense*"-group.

The dorsal fin of species in this group can be considered as conforming roughly to two differing colour patterns. In *Aphyosemion obscurum*, *Aphyosemion halleri*, *Aphyosemion haasi* and *Aphyosemion maculatum*, together with the Phenotypes 1, 2, 3, 4, 5, 6 and 7 it corresponds to that of *Aphyosemion cameronense*. The variability in the outer margin is also a feature of *Aphyosemion cameronense*.

Aphyosemion halleri "EMS 90/7"

Aphyosemion amoenum, *Aphyosemion mimbon* and Phenotype 6 have a yellow dorsal fin. The other colouration features are however so divergent that these three species definitely have to be separated from each other.

- *Aphyosemion amoenum* is one of the species with the "Yellow Blotch".
- *Aphyosemion mimbon* shares with *Aphyosemion maculatum* the extremely large spots on the sides of the body. In addition both species lack the "Yellow Blotch".
- Phenotype 6 again has a unique arrangement of red spots on the flanks. Here too there is no "Yellow Blotch".

The anal fin, on the other hand, differs considerably in colouration as between the various species and phenotypes. Only in *Aphyosemion obscurum* and Phenotypes 1, 3, 4, 5, and 8 does it correspond largely to the pattern we know from *Aphyosemion cameronense*. The anal fin of *Aphyosemion cameronense* has a red border, which spreads into the dense red markings of the inner part of the fin. The white marginal border on *Aphyosemion halleri* is scarcely visible. *Aphyosemion maculatum* has large irregular red spots on the anal fin. The anal fin of *Aphyosemion mimbon* has a marginal border, but the general markings of the fin differ greatly from *Aphyosemion cameronense*. Only Phenotype 6 has an anal fin which is coloured yellow on the inside area. On Phenotype 7 one can see a red submarginal band, whose width comes to five to six times that of the submarginal white band.

Nor is **the colouration of the caudal fin** suitable for using as a universal recognition feature for a representative of this group. Admittedly all the species and phenotypes apart from Phenotypes 5 and 8 have the two marginal borders. However, the upper border on *Aphyosemion halleri* and *Aphyosemion maculatum* is not clearly visible. Sometimes it does not differ from the ground colour of this fin. Neither is the pattern in the central areas of the fin uniform in the species and phenotypes.

So when the colouration of the males is looked at, there is no characteristic that can be used for all the members of the group. When representatives of the "*cameronense*"-group are kept in aquarium conditions, it can in fact be seen that all the males have strikingly yellow lips at times of particular excitement. This can be seen especially when equally strong males threaten each other or when a male mates with a female that is ready to spawn. This phenomenon can be seen on some of the colour pictures in this book. In actual fact this can only be observed outside the group on a few strains of the "*Aphyosemion elegans*"-group, which is not particularly closely related. Nevertheless the yellow colouration of the lips can only with reservation be used when placing an *Aphyosemion* into the "*cameronense*"-group, since it is visible for just a short period.

We know of no simple way of identifying an *Aphyosemion* as a member of the "*cameronense*"-group except by combining the characteristics mentioned with the "General Impression" gained from observing the males.

It will be found, however, that a wide variety of combinations of these characteristics occurs. One gets the impression that many species and phenotypes are more closely related to each other than to other representatives of the "*cameronense*"-group.

It seems obvious that the "*Aphyosemion cameronense*"-group as a whole can be split into smaller groups of species and phenotypes that share one of the important characteristics. In the following list we place such groups together and at the same time mention the characteristics which we can use to distinguish the species and phenotypes from each other.

The basic body colour is, depending on the angle of the light and the mood of the fish, a uniform metallic blue-green:

-*Aphyosemion cameronense*
-*Aphyosemion obscurum*
-*Aphyosemion haasi*
-*Aphyosemion maculatum*
-*Aphyosemion mimbon*
-*Aphyosemion spec. aff. cameronense* Phenotype 1
-*Aphyosemion spec. aff. cameronense* Phenotype 2
-*Aphyosemion spec. aff. cameronense* Phenotype 6
-*Aphyosemion spec. aff. cameronense* Phenotype 7
-*Aphyosemion spec. aff. cameronense* Phenotype 8

Only *Aphyosemion cameronense* and Phenotype 2 have the typical body markings of the first named species, but they differ in the markings of the anal fin.

Aphyosemion obscurum and Phenotype 1 have in common the regular arrangement of red lines, but these become "fused" and then change back to individual red spots. In addition there is the geographical separation of the two forms.

Aphyosemion haasi does have the colouration pattern of *Aphyosemion cameronense*, but the upper and lower band on the flanks are extremely broad, unknown to date in any strain of the latter species.

Aphyosemion maculatum and *Aphyosemion mimbon* have neither of the red bands but large irregular spots on the flanks. But they too are geographically separated. Moreover the colour pattern of the unpaired fins differs substantially.

Phenotypes 1, 2, 6, 7, and 8 can be separated from each other by their differing body colouration. The red spots on the flanks of Phenotype 1 are arranged regularly, giving the impression of parallel lines. As mentioned above, Phenotype 2 has the typical *Aphyosemion cameronense* markings on the body, which are not to be found on any other of the phenotypes here. The arrangement of the red markings of Phenotype 6 is unique for the "*cameronense*"-group. Besides, the red band is not present. The lower red band of Phenotype 7 is considerably broader than usual, but it is not as broad as in *Aphyosemion haasi*. The upper band is only slightly defined. The body markings of Phenotype 8 are more reminiscent of the irregular spots of representatives of the "*Aphyosemion gardneri*"-group. One thinks especially of *Aphyosemion scheeli*, which too has irregular red spots over the whole of the side of the body.

All the phenotypes mentioned here are also geographically separated from each other.

The Yellow Blotch on the caudal peduncle is present on the following species and phenotypes:

-*Aphyosemion halleri*

-*Aphyosemion amoenum*

-*Aphyosemion spec. aff. cameronense* Phenotype 3

-*Aphyosemion spec. aff. cameronense* Phenotype 4

-*Aphyosemion spec. aff. cameronense* Phenotype 5

-*Aphyosemion spec. aff. cameronense* Phenotype 9

The two species first mentioned can be separated from each other and from *Aphyosemion cameronense* by using the colour pattern of the anal and caudal fins.

Phenotype 3, which AMIET first recognised as divergent, has the red spots on the sides of the body and the colouration of the unpaired fins like *Aphyosemion cameronense*. This way it can be separated from all other species and phenotypes with the "Yellow Blotch".

Phenotype 4 has a regular pattern of spots on the sides of the body, which otherwise is not found on species and phenotypes with the "Yellow Blotch". This pattern of markings was mentioned with *Aphyosemion obscurum* and Phenotype 1, but these fish lack the "Yellow Blotch".

On Phenotype 5 there are very few red spots on the sides of the body, and the upper red band is only slightly developed. This last characteristic is present on all the other forms with the "Yellow Blotch". In the caudal fin there are no white or yellow marginal bands. Instead there are numerous round spots, and there are no other representatives of the "*cameronense*"-group which have them in the same number and arrangement.

The "Yellow Blotch" on Phenotype 9 is very small compared to the other species and phenotypes. Moreover here too is the regular spot pattern as in *Aphyosemion obscurum*, which separates it from Phenotype 4.

It is worth noting that the following species and phenotypes have the regular pattern of spots already mentioned:

-*Aphyosemion obscurum*

-*Aphyosemion spec. aff. cameronense* Phenotype 1

-*Aphyosemion spec. aff. cameronense* Phenotype 4

-*Aphyosemion spec. aff. cameronense* Phenotype 9

On *Aphyosemion obscurum* and Phenotype 9 the red spots join to give the impression of an almost continuous line. However, the "Yellow Blotch" and the geographical distance make it possible for the two forms to be separated.

Phenotypes 1 and 4 have on the sides of the body a large number of individual red spots, which because of their regular arrangement also appear to join to form lines. But it can be said that the individual dots are always separated from each other. Both phenotypes are easily distinguished by means of the "Yellow Blotch" on the caudal peduncle on Phenotype 4 from Bélinga, which is not present on Phenotype 1 from Mvilé.

The upper zig-zag band is the second most frequent shared characteristic:
- -*Aphyosemion cameronense*
- -*Aphyosemion obscurum*
- -*Aphyosemion halleri*
- -*Aphyosemion haasi*
- -*Aphyosemion amoenum*
- -*Aphyosemion spec. aff. cameronense* Phenotype 1, Phenotype 2, Phenotype 3, Phenotype 4 and Phenotype 9.

This grouping contains species and phenotypes which have already been placed together on the grounds of other characteristics. It has also been explained, why these species within these groupings can be separated from each other.

Aphyosemion cameronense, *Aphyosemion obscurum*, *Aphyosemion haasi* and Phenotypes 1, 2 and 9 have a similar basic body colour.

They therefore cannot be placed together with the species *Aphyosemion halleri* and *Aphyosemion amoenum*, nor with Phenotypes 3, 4 and 9, as these have the "Yellow Blotch".

Besides we have here forms, which on the one hand have the upper red zig-zag band, but have either a regular spot pattern (*Aphyosemion obscurum*, Phenotypes 1 and 9) or the arrangement of spots typical of *Aphyosemion cameronense*.

A further characteristic used in placing together representatives of the "*cameronense*"-group might be the medio-ventral band, which is present on the following forms:
- -*Aphyosemion cameronense*
- -*Aphyosemion obscurum*
- -*Aphyosemion halleri*
- -*Aphyosemion haasi*
- -*Aphyosemion amoenum*
- -*Aphyosemion spec. aff. cameronense* Phenotype 1
- -*Aphyosemion spec. aff. cameronense* Phenotype 2
- -*Aphyosemion spec. aff. cameronense* Phenotype 3
- -*Aphyosemion spec. aff. cameronense* Phenotype 4
- -*Aphyosemion spec. aff. cameronense* Phenotype 5
- -*Aphyosemion spec. aff. cameronense* Phenotype 7
- -*Aphyosemion spec. aff. cameronense* Phenotype 9

Even when we try to characterise representatives of the "*cameronense*"-group with this feature, it has to be recognised that some forms, such as *Aphyosemion maculatum*, *Aphyosemion mimbon* and Phenotypes 5 and 8 are not included.

If one refers to other striking features like the yellow dorsal fin (see page 34 above) or the spot markings, it will still not be possible to find a clear distinguishing feature for a representative of the "*cameronense*"-group.

The numerous ways in which the colouration characteristics within the "*cameronense*"-group can be combined present contradictions, which together with the geographical distribution would justify a comprehensive revision of the species complex. We will discuss this further in the chapter **Summing-up**.

The following table gives a final overview of the characteristics mentioned and shows again the irregularity of the way they can be found within the "*cameronense*"-group:

Species or Phenoptype	Yellow Blotch	Upper Red Band	Lower Red Band	Spots on the Body	White Band on the Anal
Aphyosemion cameronense	absent	clear	clear	typical	narrow to broad
Aphyosemion obscurum	absent	clear	clear	regular, linear	narrow
Aphyosemion halleri	clear	faint	clear	irregular, almost typical	absent, red margin
Aphyosemion haasi	absent	very broad	very broad	fainter than the bands	narrow
Aphyosemion amoenum	clear	clear	clear	typical	absent, red margin
Aphyosemion maculatum	absent	absent	absent	big spots	narrow to broad
Aphyosemion mimbon	absent	absent	absent	big spots	very narrow
Phenotype 1	absent	narrow	narrow	regular, linear	narrow
Phenotype 2	absent	faint	clear	irregular, almost typical	narrow
Phenotype 3	clear	clear	clear	typical	narrow to broad
Phenotype 4	clear	faint	faint	regular, linear	clear
Phenotype 5	clear	absent	faint	sparse	narrow
Phenotype 6	absent	absent	absent	irregular, dense	absent
Phenotype 7	absent	clear	clear	typical	absent
Phenotype 8	absent	absent	absent	irregular, not dense	absent
Phenotype 9	small	clear	clear	regular, linear	clear

The Geographical Distribution of the "*Aphyosemion cameronense*"-group

In this chapter we will first describe roughly where these fish occur in the wild, then show the precise frontiers as they are known to us at the present time.

The distribution areas of the species and unnamed phenotypes will be dealt with in detail in the relevant parts of the chapters **The Species of the "*cameronense*"-group** and **The Various Phenotypes in the "*cameronense*"-group**.

The genus *Aphyosemion* is the one with probably the largest number of species of killifish in Africa. These fish are found to the east of the Dahomey Gap to as far as Angola in the south. Not very much is known as yet of the southern distribution frontier of this genus.

Aphyosemion is therefore found in the following countries of West and Central Africa: Togo, Benin, Nigeria, Cameroon, Equatorial Guinea, Central African Republic, Gabon, Republic of the Congo, Zaïre, Cabinda and probably Angola.

Inside this enormous area the fish discussed in this book inhabit the countries of Cameroon, Equatorial Guinea, Gabon and the Republic of the Congo (see the following map No 2). For reasons of clarity, in the following four sections we intend to deal with each of these countries individually and show the distribution frontiers.

Cameroon

The climatological and geographical conditions of this 475,442 sq km sized country are the reason for a killifish fauna extremely rich in species. About 60% of this area is forested, of which a quarter at the most consists of primary rainforest.

Towards the coast and the south distinctly higher rainfall is recorded than in the dry north and north-east of Cameroon.

The Geographical Distribution of the "*Aphyosemion cameronense*"-group

Aphyosemion cameronense and the related species and phenotypes occur in an area, which is bounded by the following points: Pouma, Yaoundé, Diang by Bertoua, Mintom, the border with Gabon and finally Nyabessan in the southwest.

For a long time it was believed that *Aphyosemion amoenum*, the most northwesterly representative of this group, did not cross the Sanaga. In 1991, however, GRELL and EBERL were able to find a location north of this river ("CGE 91/13": Ngong Mkak). Nevertheless it appears that the members of the "*cameronense*"-group do not occur more than a few kilometres north of the Sanaga.

According to AMIET (1987) no representative of this group could be found north of the capital Yaoundé. At Ntui, 60 km north of Yaoundé, *Aphyosemion bualanum* was found. This species inhabits the small waters of the savannas of north Cameroon and presumably takes over the ecological role of the "*cameronense*"-group.

Only from Diang, about 38 km west of Bértoua, is a strain known, that is placed within *Aphyosemion cameronense*. AMIET (1987) published a colour picture of a male of this strain.

Within the normal variability it is obviously *Aphyosemion cameronense*, although this finding-place is an extreme north-easterly point. Intensive collections in this area might well provide more useful information.

The eastern distribution frontier of the group cannot be stated precisely, and moreover no thorough collecting trips have been undertaken. AMIET (1987) mentions a locality for *Aphyosemion wildekampi* 50 kilometres east of Lomié. This species clearly belongs to another species group, either the "*elegans*"-group of the Congo Basin or else another group of its own (AMIET: "*Aphyosemion wildekampi*"-group with *Aphyosemion wildekampi* and *Aphyosemion punctatum*).

In the south-east of Cameroon the road from Djoum to the east is passable for motor traffic only as far as Mintom (as experienced by GRELL & EBERL, 1991). This is why the border area Cameroon-Congo Republic between Alati and Souanké cannot be investigated. At the moment the most south-easterly location is Mintom itself (AMIET, 1987).

About 100 kilometres south-east of Mintom, still in the Congo Republic, HUBER (1982) was able to discover *Aphyosemion cameronense* or a phenotype of this group in several localities.

Along the Cameroon-Gabon border there are also representatives of this group, as the distribution area stretches far into Gabon. From Djoum a road leads to the south, where it runs from the village of Yen to the west as far as Oveng, parallel to the border. Between the last mentioned places GRELL and EBERL were able to find *Aphyosemion cameronense* in 1991.

The Geographical Distribution of the "*Aphyosemion cameronense*"-group

In the west towards the coast of south Cameroon, this group is found as far as the edge of the inland plateau. On the coastal plain itself the ecological role of the "*cameronense*"-group is taken over by representatives of the "*calliurum*/*ahli*"-group. AMIET gives locations for *Aphyosemion cameronense* along the Ma'an-Nyabessan road, which runs along the Mvila and not via Nyabessan to the west in the direction of Campo, and then to the coast. The locality "Asseng" 20 kilometres west of Ma'an is the most south-westerly known location for a representative of the *Aphyosemion cameronense*-group in Cameroon.

The westerly distribution frontier is formed by a line drawn through Asseng, Méfou, Ngovayang and Pouma. In this area several roads run in an east-west direction, and *Aphyosemion cameronense* or related phenotypes have been found there.

RADDA & PÜRZL (1976) show on a black and white picture a male, which we would clearly have to place in the present definition of *Aphyosemion cameronense*. This fish comes "from a small stream in the rainforest near Mefou on the road from Ebolowa to Kribi". Investigation is needed to find out how far west the species extends.

To the north of this road runs the road from Lolodorf via Bipindi to Kribi. 15 kilometres west of Lolodorf, AMIET (1980) found a divergent form of *Aphyosemion cameronense*, which in 1987 he called "Phenotype 1". Even today there is no further location for a representative of the "*cameronense*"-group west of this place. But further collecting trips might result in shifting the distribution area further in the direction of Bipindi.

To the north of the Ngovayang range runs the road joining Fifinda, Song Mbong and Eséka. It is here that lies the terra typica of *Aphyosemion heinemanni*, a representative of the "*calliurum*/*ahli*"-group. This too should form a frontier between the two species groups. Unfortunately this ichthyologically interesting area has not been investigated adequately.

Aphyosemion halleri "PEG 94/31" from Billy in Northern Gabon

On the main road between Yaoundé, Edéa and Douala, there is the town of Pouma north of Song Mbong. This is at present the most north-westerly locality of *Aphyosemion amoenum*.

With a little imagination the distribution area of the "*cameronense*"-group in Cameroon can be thought of as a rectangle with the four corners represented by Pouma, Diang, Mintom and Asseng. The following map No 4 shows this area.

Equatorial Guinea

With the islands of Bioko (Santa Isabel or Fernando Póo) and Pagalu (Annabón) stretched out along the coast, this country has a total area of 28,059 sq km and is therefore by far the smallest of the four countries involved.

We know very little about the killifish in this country. Only SCHEEL (1986) and Dr Benigno ROMAN (1971) were able to investigate the fish there.

In his book "Peces de Rio Muni", which appeared in 1971, ROMAN writes among other things about a fish, which he identified as *Aphyosemion cameronense*. He gives the following localities: Rio Kie, 5 April 1966, six specimens. Rio Mami, 13 August 1967, 45 specimens. Same locality, 5 September 1967, 42 specimens. Senye, near Izaguirre, 18 July, 1968, twelve specimens.

Neither the maps available to us nor the map in ROMAN's book give us any clear indication of where these localities are exactly. The name "Rio Kie" is very vague. It covers the whole of the border river between Cameroon and Gabon where the three countries meet at Ebebiyin. The Kie (Kye) flows from Mongomo (Mongono) along the border between Gabon and Equatorial Guinea to the north, where it reaches Cameroon near Ebebiyin and after a few kilometres flows into the Ntem.

The colour description of the males in ROMAN (1971) indicates that this is an *Aphyosemion cameronense* of the "Gabon phenotype", which occurs in the whole of north Gabon. The copy of the book we have does not make any comparison of the colour pattern possible, which is why we are unable to classify these fish precisely.

RADDA & PÜRZL (1976) published on page 131 a black and white picture of a fish with the following designation: "*Aphyosemion aff. cameronense*, male from the Rio Ecucu system near Bata, Equatorial Guinea. (Photo: J.J. SCHEEL)".

There is no doubt that this specimen belongs to the "*cameronense*"-group, even if the location "near Bata" suggests that it is a finding-place very close to the coast. The Rio Ecucu itself is about 40 to 50 kilometres long and originates to the west of Niefang. It then flows due west and reaches the sea at Bata.

As we have no information on the geology of this country, we cannot say whether this locality is on the inland plateau or on the coastal plain. Knowledge on this point would tell us if another phenotype as well as *Aphyosemion amoenum* might have left the inland plateau in a westerly direction towards the coast. More of this when we deal with *Aphyosemion amoenum*.

In Cameroon and Gabon, the countries which surround Equatorial Guinea, killifish of the "*cameronense*"-group have been found right up to the international borders. We can therefore be certain that there are representatives of this group in this country too. Presumably there is in the north-east *Aphyosemion halleri*, to the south and west of this area *Aphyosemion cameronense* "Gabon phenotype", and in the area north of Médouneu *Aphyosemion mimbon*.

The distribution frontier towards the coastal plain should, with more knowledge, stretch into Cameroon and Gabon along the transition area from the inland plateau to the coastal lowlands. As stated above, this could contradict the designation "near Bata".

Intensive efforts by collectors might eventually produce new divergent phenotypes, which could correspond on the one hand to SCHEEL's males, or on the other hand might result in the definition of further phenotypes. As far as we know no work has been done in this area in recent years.

Inquiries made by EBERL in January and July 1993 proved that it is not possible to find a suitable vehicle for hire for our purpose in Equatorial Guinea, because of the roads and logistical problems.

It may be possible in a few years time to go to there and successfully collect fish.

Gabon

This country is 267,667 sq km in area and only half as large as Cameroon and at the same time considerably less densely populated. Estimates range from a population of one to two million. In the north Gabon is covered with rainforest and only in the south are there scattered areas of savanna. Although the border with Cameroon coincides partly with the Ntem, the killifish on both sides of this river appear to have identical colour patterns. This is true of *Aphyosemion halleri* and *Aphyosemion cameronense*.

The Geographical Distribution of the "*Aphyosemion cameronense*"-group

Representatives of the "*cameronense*"-group occur in the north-west of the country in the "Monts de Cristal", which belong to the inland plateau. In January 1993 Legros, Cerfontaine & eberl discovered on the Kougouleu-Médouneu road in the village of Song a single male, that clearly belongs to the "*cameronense*"-group (Phenotype 6). In the village of Méla that lies six kilometres to the south-west, Passaro & Eberl found in July of the same year *Aphyosemion microphtalmum*. This fish is a representative of the coastal plain, and it occurs right on Cap Estérias, that is to say, a few kilometres from the coast north of Libreville.

Numerous localities of representatives of the "*cameronense*"-group have been found along the border with Equatorial Guinea from Médouneu eastwards to Sam as well as along the Sam-Bibassé(Bibas)-Oyém road and north to as far as Bitam. These fish have also been found along the border with Cameroon in the north to as far as Minvoul.

The enormous area of the Monts Kokaméguél and the region of Minkébé have not been opened up by roads, which is why it has not been possible for people to go collecting there. It can be assumed, however, that the "*cameronense*"-group is represented here.

In February 1987, Numrich found between Bélinga and Mayibout a phenotype of the "*cameronense*"-group, which he calls *Aphyosemion cameronense* (DKG-Journal, January 1989).

South of Bélinga, on the Makokou-Mékambo road, there are only a few locations of *Aphyosemion cameronense* of the "Gabon Phenotype", which is why it is not possible to state precisely the distribution area of the group. Closer to Mékambo *Aphyosemion punctatum* was found progressively more. West of Mékambo this species occurs together with *Aphyosemion cameronense* "Gabon Phenotype", but to the east towards the Congo Republic it seems more and more to replace it. In 1986, only 17 km east of Makokou airport Wagner & Wendel discovered a locality of *Aphyosemion cameronense* "Gabon Phenotype", which as far as we know seems to be at its most easterly point along this road ("GWW 86/2"). In this area too, intensive collecting efforts would be worthwhile.

South of Makokou on the road to Okondja *Aphyosemion punctatum* has also been found: Heinemann & Lenz 1979 and Grell (1992).

The Ovan-Makokou road runs east west and has been frequently fished in the past. As there are no roads off to the south, the distribution frontier in this area cannot be stated precisely.

The most southerly verified locality for a representative of the "*cameronense*"-group is a "stream south of Koumaméyong on the road to Booué" (pers. comm. Herzog, 1992). The collector was not able to give further details on the location of the stream. But in 1972 he had identified the males at the locality as *Aphyosemion cameronense*. He called this phenotype "*Aphyosemion cameronense* 'yellow'". Today we consider this phenotype to be *Aphyosemion spec. aff. cameronense* "Phenotype 5".

In August 1992 Grell tried to find a stream with killifish between Booué and Koumaméyong, but his attempts were as vain as those of Legros, Cerfontaine & Eberl in January 1993 (heavy rainfall!).

Neither were Passaro & Eberl (July 1993) able to find any suitable streams along this road.

Booué itself lies on the northern bank of the Ogooué, which is an important frontier for killifish. At Achouka south of Booué, on the opposite bank of the Ogooué, *Aphyosemion lamberti* has been found. This species is a member of the "*Aphyosemion elegans*"-group and seems to replace the "*cameronense*"-group south of the Ogooué.

So the southern distribution frontier of the "*cameronense*"-group must lie between Booué and Koumaméyong.

Huber (1977) mentions locality 48 of the 24 August 1976 on the Lalara crossroads, where he found *Aphyosemion cameronense* (pers. comm. Sept. 1993).

Along the road to the west of Lalara no representatives of the "*cameronense*"-group have as yet been found, even though there are no geological or hydrographic obstacles. It is conceivable that fish of the "*cameronense*"-group might be found along the Lalara-Ebel Alémbé road, if they were looked for diligently.

The roads joining Kougouleu, Médouneu, Sam, Mitzic, Lalara, Ndjolé and Bifoun form a circle which surrounds the "Monts de Cristal", which belong to the inland plateau of north Gabon and is thus inhabited by members of the "*cameronense*"-group. Within this circle and west of Lalara the distribution frontiers still remain unknown. Admittedly there are private roads that lead into the enclosed area, but these can only be used by vehicles of the timber companies. In the south-west of the "Monts de Cristal" in particular, it might be possible to find new phenotypes with divergent body markings.

Aphyosemion spec. aff. cameronense "CGE 91/6": Phenotype 3 may theoretically also occur in the extreme north-west of the Congo Republic

This picture shows a female of *Aphyosemion spec. aff. cameronense* Phenotype 9 of the strain "EMS 90/2"

The Republic of the Congo

With its 342,000 sq km the Congo Republic (formerly the People's Republic of the Congo) is the second largest of the four countries we are dealing with. About 65% of it is forested, the remainder consisting of forest fringes and savanna areas. Killies of the "*cameronense*"-group occur only in the extreme north-west of the country in an area belonging to the drainage area of the Ivindo.

To the present day HUBER has been the only person to visit the extreme north-west of the country, where he caught killifish in July 1978. In a detailed description of this trip published in May 1982 he gives four localities of *Aphyosemion cameronense*, without going into the colouration of the males. We are therefore not in a position either to place these fish in a specific species of the "*cameronense*"-group or with HUBER's information define a further undetermined phenotype.

The four localities lie 3 and 18 kilometres east and 26 and 58 kilometres west of Souanké in the border region between Cameroon and Gabon. HUBER's locality "RPC 150" 18 kilometres east of Souanké is at present the most easterly locality for a member of the "*cameronense*"-group.

Between Souanké and Sembé is the watershed that separates the Ivindo basin from the river area of the Sangha, which itself belongs to the Congo Basin, where the numerous representatives of the "*Aphyosemion elegans*"-group occur. Possibly this is the most eastern frontier of the distribution area of the "*cameronense*"-group in the Congo Republic.

The present knowledge about the "*cameronense*"-group in the area Mékambo-Madjingo-Gouanéboum is so slight that we cannot give positive data on the distribution.

The bad roads make fish collecting difficult in this area, where further divergent phenotypes may live. The only way to return to HUBER's localities seems to be a journey from Brazzaville. The capital of this country lies in the extreme south, which is why at a guess one would have to travel 1,000 km to Sembé.

The Habitat in the Wild: the Biotopes

For a better understanding of the requirements of fish in the aquarium, we want in this chapter to try to describe the rainforest streams, in which killifish of the "*Aphyosemion cameronense*"-group can be found. First we will describe the climatological conditions and then the appearance of the streams. On the one hand we will use colour pictures, and on the other hand drawings are intended to show the precise division of the various fish species in these biotopes.

The height above sea-level. The distribution area described in the previous chapter lies on the inland plateau of the countries involved. This is why the rise in the terrain can vary from 154 to about 750 m above sea-level. The following list of some localities of species and phenotypes of the "*cameronense*"-group shows that most localities lie about 400 to 600 m above sea-level:

Diang	*A. cameronense*	704 m
Mebande	*A. cameronense*	591 m
Asseng	*A. cameronense*	465 m
Djoum	*A. cameronense*	661 m
Nguém	*A. cameronense*	649 m
Meuban I	*A. cameronense*	629 m
Matomb	*A. obscurum*	593 m
Bikok	*A. obscurum*	731 m
Ototomo	*A. obscurum*	728 m
Ambam	*A. halleri*	570 m
Biyi (Billy)	*A. halleri*	600 m
Zomoko	*A. haasi*	600 m
Pouma	*A. amoenum*	154 m
Ndoupé	*A. amoenum*	185 m
Dibang	*A. amoenum*	280 m
Ebé	*A. maculatum*	445 m
Matora	*A. maculatum*	560 m
Médouneu	*A. mimbon*	630 m
Akoga	*A. mimbon*	540 m
Mvilé	*A. spec. aff. cameronense* Phenotype 1	410 m
Nsessoum	*A. spec. aff. cameronense* Phenotype 2	595 m
Efoulan	*A. spec. aff. cameronense* Phenotype 3	626 m
Avobengon	*A. spec. aff. cameronense* Phenotype 3	610 m
Alop	*A. spec. aff. cameronense* Phenotype 3	647 m
Bélinga	*A. spec. aff. cameronense* Phenotype 4	500 m
Koumaméyong	*A. spec. aff. cameronense* Phenotype 5	485 m
Souganlam	*A. spec. aff. cameronense* Phenotype 5	462 m
Song	*A. spec. aff. cameronense* Phenotype 6	500 m
Minkouala	*A. spec. aff. cameronense* Phenotype 7	520 m
14 km West Sam	*A. spec. aff. cameronense* Phenotype 8	505 m
Mentanyé	*A. spec. aff. cameronense* Phenotype 9	422 m
Ngoyang	*A. spec. aff. cameronense* Phenotype 9	460 m

One striking fact is that the localities of one species, *Aphyosemion amoenum*, are at a much lower altitude than those of all the other species and phenotypes. In fact this species lives on the north-western edge of the inland plateau of south Cameroon and has even spread from there onto the coastal plain. We will discuss this unique fact further when we deal with this species in the chapter **The Species of the "*cameronense*"-group**.

In all the other localities on the previous page one can see a relatively uniform distribution of altitudes between 400 and 600 m. The example of *Aphyosemion obscurum* south-west of Yaoundé, the capital of Cameroon, shows that there are possibly members of the "*Aphyosemion cameronense*"-group in even higher waters as well.

Further investigation in the future might result in such localities being found, even though at the highest elevations of the inland plateau there could only be extremely few streams with suitable conditions. Besides, the roads in the rainforest do not go to such elevations (up to 1001 m: Mont Sassamongo near Batouala/north Gabon), so that they are in any case inaccessible.

The rainfall. The killifish of the "*Aphyosemion cameronense*"-group live on the western edge of the inland plateau, and so the average rainfall is high, like that of the nearby coast. The equatorial winds carry warm and moist air from the Atlantic Ocean eastwards. This results in regular rainfall patterns on the coastal plains of Cameroon, Equatorial Guinea and Gabon. The beginning of the inland plateau, with the rise in the land, encourages this process, so that to the east in the interior the rainfall gets less. This can be seen in the examples of the following few towns:

Town	Distance from Coast	Altitude	Rainfall
Douala	on the coast	0-10 m	4150 mm/p.a.
Kribi	on the coast	0-10 m	3017 mm/p.a.
Bata	on the coast	0-10 m	2170 mm/p.a.
Cocobeach	on the coast	0-10 m	3900 mm/p.a.
Libreville	on the coast	0-10 m	3200 mm/p.a.
Edéa	60 km	17 m	2710 mm/p.a.
Yaoundé	220 km	769 m	1550 mm/p.a.
Lambaréné	110 km	13 m	2000 mm/p.a.
Bitam	190 km	608 m	1650 mm/p.a.
Mitzic	215 km	568 m	1650 mm/p.a.
Makokou	390 km	473 m	1650 mm/p.a.
Mékambo	490 km	503 m	1700 mm/p.a.

These figures come partly from Legros (1990) or were calculated from the maps available to us. Although Mékambo in the interior has only roughly 400 mm/p.a. less rainfall than the capital of Equatorial Guinea on the coast, the general tendency is for the rainfall to decrease as one gets further away from the coast. The irregularities seen result from local and regional peculiarities, which we cannot go into here.

Although the average rainfall in the distribution area of the "*cameronense*"-group is significantly less than on the coastal plain, there is still sufficient precipitation to allow the tropical rainforest to flourish with its wealth of species. The varied composition of the flora of the coastal lowland and the inland plateau cannot be described here, as our knowledge of botany is too limited.

The Succession of Rainy and Dry Seasons. The climate in these countries is by no means the same throughout the year. Rather it is subject to regular variations. The following table illustrates in the case of Gabon how the average rainfall (given in mm/ month) varies throughout the year.

Town	**Jan.**	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Bitam	0-50	100	100	200	200	100	0-50	0-50	200	450	200	100
Mékambo	100	100	200	200	200	100	0-50	100	200	200	200	100
Mitzic	100	100	200	200	200	0-50	0-50	0-50	100	450	200	100
Makokou	100	100	200	200	200	0-50	0-50	0-50	100	450	200	100
Libreville	200	200	450	450	200	0-50	0-50	0-50	100	200	600	450
Cocobeach	200	200	450	450	450	100	0-50	0-50	200	600	600	450
Lambaréné	250	100	250	250	250	0-50	0-50	0-50	100	450	450	100
Port-Gentil	200	200	450	450	200	0-50	0-50	0-50	0-50	200	450	200

The first four towns lie in the distribution area of the "*cameronense*"-group (Mékambo at the most south-easterly edge). The four towns mentioned last represent the amount of rainfall on the coastal plain. It will be clearly seen once again how the rainfall drops as one moves eastwards away from the coast into the interior. In general less rain falls in the months of December to February and June to September than from March to May and October and November. It is therefore possible to think of two rainy and two dry seasons.

Compared with other regions of Africa, the variations in rainfall are much less and the length of the dry seasons shorter. As a result there is always sufficient moisture available for the vegetation. Although during the dry seasons virtually no rain falls, the plants stay green and continue to grow constantly.

The bodies of water therefore only dry out completely in very rare instances. Consequently in this region there occur no purely annual fish as for example the species of the genus *Nothobranchius* in East Africa (Kenya, Tanzania, Zaïre, Uganda, Mozambique etc). Only the three semi-annual species *Aphyosemion splendidum*, *Aphyosemion batesii* and *Aphyosemion kunzi* live in the rainforests of the distribution area of the "*Aphyosemion cameronense*"-group.

However, for the small streams in the forest the variations in rainfall mean drastic changes.

With the onset of rain the water level rises by 50 to 100 cm, and in exceptional cases even to 200 cm. The stream may become two to three times wider. The rain-water causes the current to flow faster, and the water temperature drops a few degrees Celsius. These changes will be discussed more fully in the following sections of this chapter.

The water and air temperatures. Together with the different amounts of rainfall, variations in temperature are apparent too. Generally, on the coastal plains in the countries under discussion, the temperatures are higher than on the inland plateau. Again here is a comparison of four towns in both regions of Gabon, with the average air temperatures (given in °C):

Town	**Jan.**	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Bitam	25	25	25	25	25	25	23	23	25	25	25	25
Mékambo	23	25	25	25	25	23	21	21	23	25	23	25
Mitzic	25	25	25	25	25	23	23	23	23	23	23	25
Makokou	25	25	25	25	23	23	21	23	23	23	23	23
Libreville	26	26	26	26	26	26	23	23	23	23	23	25
Cocobeach	25	25	25	25	25	23	23	23	23	23	23	25
Lambaréné	26	27	27	27	27	25	23	25	25	26	26	26
Port-Gentil	26	27	27	27	26	25	23	23	23	25	25	26

It is worth noting that it is actually in the rainy seasons that the monthly average temperatures are at their maximum. The abundant rain causes gaps in the cloud cover to occur more often and the sun's warmth comes through more. The air temperatures are higher than in the dry seasons, when the cloud is also dense. But it remains unbroken longer, and so the air does not get heated so much by the sun.

Since only average temperatures are given in the table, we provide here two recorded air temperatures at localities in the distribution area of *Aphyosemion amoenum.* The readings were taken by Olivier LEGROS:

Place	**Date**	**Time**	**Air Temperature**
Song Bibaï, 3 km north Pouma	12.07.1989	10.30 (a.m.)	27°C
Nkonga, 6 km north Pouma	12.07.1989	12.00 (noon)	25°C

It must be stressed that these localities lie in the transitional area between the coastal plain and the inland plateau. So the altitudes are not representative for the "*Aphyosemion cameronense*"-group.

Just a few days later Bas VLIJM took the following readings in the distribution area of *Aphyosemion cameronense*, *Aphyosemion obscurum* and *Aphyosemion amoenum*:

Place	**Date**	**Time**	**Air Temperature**
Houga, between Eséka and Lolodorf	12.07.1989	10.30 (a.m.)	27°C
Efoulan, between Lolodorf and Ebolowa	12.07.1989	12.00 (noon)	25°C
Matomb II, 53 km west Yaoundé	26.07.1989	10.30 (a.m.)	24°C
Biang (Bihiang), 9.2 km north Pouma	26.07.1989	14.30 (2.30 p.m.)	25°C

In August 1990 Eberl and others succeeded in finding various species and phenotypes of the "*cameronense*"-group in the south of Cameroon. Here follow readings they took at that time:

Place	**Date**	**Time**	**Air temperature**
Ngoyang, between Eséka and Lolodorf	16.08.1990	11.30 (a.m.)	25°C
Mebandé, 25 km south-east Lolodorf	16.08.1990	15.00	25°C
Nsessoum, 66 km south Ebolowa	17.08.1990	10.00 (a.m.)	24°C
Ambam, on the border with Gabon	17.08.1990	12.00 (noon)	24°C
Ndoupé, 6 km east Pouma	19.08.1990	13.00	25°C

In January 1993 Legros, Cerfontaine and Eberl travelled in the north of Gabon and recorded similar measurements at the localities of *Aphyosemion cameronense*, *Aphyosemion maculatum*, *Aphyosemion mimbon* and some phenotypes of the "*cameronense*"-group:

Place	**Date**	**Time**	**Air temperature**
Laboka II, 12 km east Lalara	07.01.1993	13.15	25°C
Ebé, 11 km est Makokou	08.01.1993	13.00	26°C
E'béssi, 14 km west Makokou	09.01.1993	10.30 (a.m.)	27°C
Oveng, 36 km north-west Zomoko	11.01.1993	11.00 (a.m.)	24°C
Essong, 14 km west Mitzic	12.01.1993	09.00 (a.m.)	22°C
Sam, border with Equatorial Guinea	12.01.1993	12.30	28°C
Avang, 36 km west Médouneu	13.01.1993	07.00 (a.m.)	18°C
Song, 100 km south-west Médouneu	13.01.1993	13.30	23°C

As can be seen there is a temperature difference of 9°C. The air temperature of 27°C in E'béssi was measured after a period of sunshine, so that the air was warmer. The 18°C in Avang was recorded on a grey morning. Early in the morning, after a cloudy night, the air temperature in the rainforest might go down to 16 or 18°C. Even on a clear night the dense vegetation prevents the air temperature from dropping to below 15°C. During a total of six trips to Cameroon and Gabon, one of the authors had to leave the tent on occasions during the night, when he found the temperature very pleasant.

One can deduce from the high reading of 27°C that in the rainy season the air temperatures might easily reach 30°C during a sunny spell. What is certainly true is the fact that when you enter the dense forest from the open road, the air temperature is considerably lower in the leafy shade. The water evaporating from the trees also contributes to the cooling.

The cooling of the very moist air can lead to the formation of high mist, as can be seen on the colour picture on pages 52 and 53. It was taken on 16.8.1990 at about 17.30 from the back of "Le Ranch" hotel in Ebolowa.

The Geology of the Soils. As very few roads in the rainforest of these countries are asphalted, the nature of the subsoil can be seen very easily.One is first struck by the brownish red colouring, which is caused by the high iron content in the laterite.

Laterite has very little or no effect on the mineral content of running water. This explains the extremely low readings in the native water of these killifish.

Over the mineral subsoil there is a very thin layer of humus and fallen leaves.

The contrast between the fresh green of the vegetation and the pleasant red of the soil is shown particularly on the colour picture on pages 56 and 57.

The Vegetation. The climatic conditions portrayed above can be called "mild". As a result an immense number of plant species are to be found in the rainforest of Equatorial Africa. The ground is covered with small plants, especially ferns and mosses. On the trunks of the trees that grow up to 50 metres climbing plants grow and the crowns of the trees are the homes of numerous epiphytes.

In places where tree clearance and road-building have destroyed the plant cover, fast growing plants soon cover the ground and win back this territory. The upper picture on page 64 shows the asphalted road from Douala to Yaoundé via Edéa. This road was not finished until the end of the eighties. As a result of the road building operations, the forest on both sides of the road was cut down but with the years the vegetation is spreading back to the edge of the road. Hence it is necessary to use machines to cut back the vegetation by the roadside at regular intervals to stop the plants encroaching onto the road.

In contrast the upper picture on page 65 shows a narrow virgin forest road in the south of Cameroon. As you drive on it, you get the impression of green walls rising vertically on either side. Roads of this category are not asphalted and are therefore directly exposed to the influences of the violent rainfall in the rainy seasons. The subsoil composed of laterite can then be transformed into a slippery mass which can only be driven over by four-wheel drive vehicles.

In the drier months on the other hand, cars without four-wheel drive can be used on these roads without any problem.

As already stated, the luxuriant vegetation prevents the sun's rays from penetrating to the forest floor and also the small streams. Consequently the temperature does not rise during the day as much as is the case out in the open. By the same token cooling during the night is delayed, so that in general the forest exerts a levelling effect on both the air and water temperature.

The temperatures that remain so constant throughout the year cause the plants to grow constantly. There is no seasonal leaf-fall as occurs in Europe in autumn. So old leaves fall continuously onto the forest floor, where they decompose. The leaves of many plant species release tannic acid, which results in the low pH and the brown colouring of the water. Examples of readings from different bodies of water will be found in the section **The water chemistry** in this chapter.

The asphalted main road from Douala to Yaoundé via Edéa is the most important road in Cameroon. It was built in the late 80ies

The abundant sunlight on the roadside encourages the formation of fresh plant growth, which is then strongly coloured red

Less comfortable but much more interesting is driving on unmade up roads!

In north Gabon this colourful spider was photographed on red laterite

The leaf-cover in untouched forest is so dense that for photographs without flash maximum aperture and an exposure of 1/30 or 1/15 second are necessary. This weak light is adequate for the numerous ground plants. But these conditions are not good enough for aquatic plants, as the light is further reduced as it passes through the water. Only on roads or places where people have altered the forest does enough light fall into the streams, to allow aquatic plants to thrive.

Frequently used washing and bathing areas of small streams and pools are good places to look for a strictly limited presence of aquatic plants. If they are found to be there, they will not extend into the poorly lit part of the enclosed forest. Only when the water is four to five metres wide or more are the gaps between the trees wide enough to allow adequate light to fall into the water and permit thick stands of aquatic plants to develop.

The plant cover of the forest presumably provides the killies' food supply from insects that fall and fly into the water. This will be dealt with in the section **Food in the wild**.

The water chemistry. When RADDA & PÜRZL first collected killifish in their native waters, the chemical composition of the water was measured. The aim was to obtain information on the best conditions for keeping killies in the aquarium.

There are indeed conditions which one should "fulfil" as well as possible, whilst it is not advisable, for example, to copy the pH or hardness of the natural waters in the aquarium. We describe here the conditions in which the killifish in question are found in the wild, but in the chapter **Maintenance and Breeding**, we will show how these fish can be successfully kept and bred in the aquarium.

RADDA (1971) gives temperature differences of 2 to 4°C in the waters of the coastal lowland. But he also states that the readings for pH, total hardness and electrical conductivity scarcely vary.

In that publication a table contains the readings of seven localities of the southern interior plateau of Cameroon. pH readings of 5.6 (four times), 5.7, and 5.8 to 5.9 (once each) are quoted. The electrical conductivity is given with readings of 11, 16, 17, 18, 30 and 36 µS. The total hardness amounts to between 0.56 and 1.01° dGH. We recommend to the interested reader this publication which contains very accurate water analyses from different locations.

RADDA & PÜRZL (1977) published an equally detailed table with readings from four streams in north Gabon, including one inhabited by *Aphyosemion maculatum*. Here the pH ranges from 6.3,.6.4 and 6.5 to 6.7. These readings are appreciably higher than those mentioned above and correspond rather to those taken by LEGROS 1989 in Cameroon and LEGROS, CERFONTAINE and EBERL 1993 in Gabon. The readings for the electrical conductivity are also higher: 20, 25, 40 and even 112 µS. This too agrees with the findings of LEGROS, CERFONTAINE and EBERL. Finally, according to RADDA & PÜRZL in this publication, the total hardness varies from 0.1 to 2.1° dGH.

The recommendation made in the previous paragraph is also valid for this excellent work.

In January 1993 LEGROS, CERFONTAINE and EBERL used the test kits normally used in the hobby to determine the pH, German total hardness and carbonate hardness. As indicated above, the level of hardness is between 0 and 2° dGH and below 1° carbonate hardness. This was confirmed in a total of 25 localities. The following table gives the data of some streams in the north of Gabon, where readings were taken from 7th to 13th January, 1993:

Place	pH	Total Hardness in ° dGH	Conductivity in µS
Laboka II, 12 km east Lalara	6.0	0-1°	40
Ebé, 48 km east Koumaméyong	6.3	0,5°	20
Ebé, 800 m west of the village	6.7	0°	40
E'béssi, 14 km west Makokou	6.3	0°	n/a
Adoué, 39 km west Makokou	6.5	0°	30
48.5 km west Makokou	6.3	<1°	30
Bissobilam, 54 km west Makokou	6.3	0°	30
60 km west Makokou	6.9	0-1°	40
64 km west Makokou	6.9	0°	40
Ayol, 5 km west Ovan	6.3	0°	30
Souganlam, 30 km west Ovan	6.4	0°	20
Oveng, 36 km north-west Zomoko	6.3	0°	30
Essong, 14 km west Mitzic	5.7	0°	14
48 km west Mitzic (PK 50?)	6.3	0°	18
Sam, 56 km west Mitzic	6.3	0°	18
51 km west Sam	6.3	0°	20
16.5 km west Médouneu	5.7	0°	12
Avang, 35 km west Médouneu	6.3	0°	18
near Assok, 79 km west Médouneu	6.9	0°	20
Assok, 79 km west Médouneu	8.0	0°	20
Song, 99 km west Médouneu	6.7	0°	20

Of note here are two locations:

- 16.5 km west of Médouneu, readings of pH 5.7 and conductivity 12 µS from a stream containing *Aphyosemion mimbon* and various other fish. These readings are surprisingly low; nevertheless fish were plentiful and in the best of health.
- On the outskirts of Assok in the "Monts de Cristal" a pH of 8.0 was recorded in the three metre wide stream. The drop indicator used can cause errors which can give a deceptively high reading, but the water was distinctly alkaline. At this locality the only fish caught were young specimens of *Aphyosemion spec. aff. cameronense* Phenotype 6. There were no suggestions of altered geological conditions nor of human interference, which might have been responsible for this high pH.

Fish from both localities were successfully transported without losses during the rest of the trip and subsequently brought back to Europe.Water changes were always made with fresh water of the normal composition from other streams, without the fish showing any signs of discomfort.

Olivier LEGROS taking water readings near Sam on the Gabon/Equatorial Guinea border, at a locality of *Aphyosemion cameronense*

Other properties of the water. The modest measuring methods used on location allowed only the readings mentioned to be taken.

Inspection of the photographs of the localities will show the reader that the water is always clear and slightly brownish. In addition it is without exception running water, so the oxygen content should always lie at around 100%. In many locations, however, isolated specimens were often found in small pools near the banks of the streams. The picture on page 69 shows a small pool near Matora in north Gabon, where *Aphyosemion maculatum* was found in large numbers in the stream and in the pools.

A slightly brown colouring of the water can be seen in all the streams of the rainforest. This presumably changes during the course of the rainy and dry seasons. It is probable that with the downpours of the rainy periods a "thinning" of the water occurs, so that the brown colour becomes weaker. The degree of brown colouring is not measurable and so we are unable to give precise records of it.

Moreover the intensity of this shade of colour does not appear to be the same at the various localities, but we have no explanation for this.

The size of this pool can be estimated from the legs of the boy, who is about 10 years old. In the pool about a dozen adult *Aphyosemion maculatum* were found

The width and depth of the streams. The streams in which representatives of the "*cameronense*"-group are found can be characterised by the maximum parameters pertaining to width and depth. These are streams that are too small for larger fish such as catfish and cichlids. These habitats have been taken over by genera and families of fish that stay small: characins, barbs and killies.

When looking for killifish it is best to concentrate on slow flowing streams with a width of 100 to 250 cm. The width does not remain constant along the stream. On the one hand there are narrower sections, where the current is correspondingly faster, and on the other hand the width may extend to several metres. In these cases the water is 10 to 20 cm deep and the current considerably slower. Frequently one comes across sections a good 100 m long, which are several metres wide and only ankle deep.

While catching members of the "*cameronense*"-group in Cameroon and Gabon in both the months July/August and January/February, one of the authors often observed that the relatively small bodies of water flow in a stream-bed which is much wider and deeper than would actually be needed by the amount of water in it.

According to the villagers who live close to the forest streams and use them as a source of drinking water, the water level of many streams may rise by up to two metres, with the result that they overflow their banks and flood the surrounding parts of the forest. It is conceivable that, being poor swimmers, the killifish will prefer the quieter parts close to the water's edge to avoid being chased by larger fish that have moved in. If then the water level drops, there frequently remain larger or smaller pools or even puddles. This will explain the occurrence mentioned on page 68 of *Aphyosemion maculatum* in the pools. On several occasions one of the authors learnt from the villagers at various locations (Avobengon, Efoulan, Méla), that during the rainy season the water becomes cloudy and brownish in colour. This can be explained by the heavy falls of rain which wash out particles from the forest floor which are left in suspension and cause the cloudiness. In 1989 Legros, Vlijm and Eberl were able to catch *Aphyosemion spec. aff. mirabile* at Takwaï II in west Cameroon. It was pouring with rain, and the fish were in a fast flowing stream with slightly cloudy water, which would seem to confirm the assumption just mentioned. Where there are bends in the streams the current very often gouges into the stream-bed, creating areas of particularly deep water. These places are occupied mainly by larger fish species and lamp-eyes. Killifish of the genera *Aphyosemion* and *Epiplatys* always prefer the shallow bank areas where the water has a maximum depth of 30 to 40 cm. The following drawings illustrate schematically the appearance of streams typical of *Aphyosemion* and especially members of the "*cameronense*"-group.

The depth of the small pools and ponds can vary from 5 to 30 centimeters. It seems as if exclusively Killifish of the genus *Aphyosemion* can be found there; other species seem to avoid limited places like these.

The speed of the current. This feature of the biotope is also difficult to measure and describe. In south Cameroon and north Gabon it was possible to find members of the "*cameronense*"-group in streams with either relatively fast or slow flowing currents. Factors that play a decisive point here include showers, the incline of the land as well as the width and depth of the stream.

As a general rule the water flows fastest in the middle of the stream or where the main current is. The absolute maximum can be observed at narrow and shallow points. Nearer the bank and where the depth increases, the water becomes calmer. Right by the bank itself the water is almost completely still.

As a general observation, it can be said that the killifish do not spread themselves equally throughout the whole stream. Rather do they occur only in certain places. Their choice is affected largely by both the water level and the speed of the current. The killies discussed in the book prefer decidedly shallow and very slow flowing to still water. As described above, they find these conditions right by the bank and in the pools and puddles alongside the stream.

Apart from the size of the stream and the speed of the current, these fish seek out places that are especially suited to their basic requirements. Consequently, the killies occur in quite specific parts of the stream, where they may be found in quite large numbers.

The stream bed. The nature of the bottom of the streams can be of very many kinds. Depending on local factors, smaller or larger stones up to 30 cm in diameter may be spread throughout the stream. In this case the current will be fast. Representatives of the "*cameronense*"-group are unlikely to be present, or else they stay in particularly protected spots where the current is slow.

Streams whose beds are covered with gravel may also provide suitable living quarters for these fish. In such cases the diameter would be from 3 to 15 cm.

Finally there are streams with sand at the bottom, as can be seen on pages 60 and 61. Often these streams are slow flowing, and it is here that *Aphyosemion* appear to prefer to live.

In all these cases decaying leaves, branches and mud are deposited near the banks. The fish obviously prefer this bottom. The picture on page 69 shows that, as the current decreases, so the mud that collects increases. The layer of mud ranges from a few centimetres to almost 30 centimetres.

Frequently the killifish hide in this layer of mud when you approach the stream. They stay there even when you get right up to them. They often use also the leaves and small branches which in places cover the stream bed in large numbers.

If you step into the stream, the mud causes the water to become very cloudy, but this disappears very quickly.

Where the current is slow, near the bank there collects fine brown mud, into which scattered leaves and small twigs sink

Since the oxygen always remains at 100%, at no locality with flowing water was any smell of decay detected. Nor does the mud appear to dirty the water very much. The fish found here were in the best of health.

The overhanging vegetation. On the different locality photographs it can be seen that non-aquatic and amphibious plants always reach right up the water's edge. These are moisture loving ferns and mosses which in the rainy season can survive being flooded for a period. In addition, on the slopes of the banks plants could be found that can be kept in the aquarium: *Anubias* and *Bolbitis* species. These plants appear to be particularly well suited to places with little light and considerable changes in living conditions.

Plants growing on the bank often hang into the water of the stream and provide protection for the killifish. Here they are safe from larger fish that might chase them. This explains why *Aphyosemion* - including members of the "*cameronense*"-group - occasionally occur in streams inhabited by larger species such as cichlids, catfish and bush-fish. At least an adequate supply of hiding places by the bank is one of the necessary conditions for their safety.

The territorial way of life. Even by just observing *Aphyosemion* species in the aquarium one will soon see that these fish like to occupy territories and have little interest in leaving them.

In the wild it can be seen time and again that individual groups are attached to specific parts of the stream. If you wade into an obviously suitable stream, the first place to search is near the banks where the water is shallow and there is overhanging vegetation. Then it is possible to find a good number of killifish in restricted areas a few metres in extent, whilst a few metres up and downstream only isolated specimens occur. To describe this situation we use here the term "microbiotope".

It is not simple to find an explanation for this, but possible reasons are:

- In these restricted "microbiotopes" there is a rich supply of food, so the fish prefer to stay there.
- Close to the bank the adult fish can find optimum conditions for spawning. Killifish of the "*Aphyosemion cameronense*"-group are bottom spawners (see chapter **Maintenance and Breeding**) and require certain conditions to be met if they are to spawn.
- The special environmental conditions with their hiding places protect the fish from being chased by predators.
- Although shoaling in *Aphyosemion* species cannot be proved, they may prefer to stay in groups, to increase their chances of survival in the event of attacks by predatory fish.
- In the "microbiotopes" the current is ideal for killies, in that the water flows only very slowly and yet is always of the required quality.
- Dominant males occupy the best spawning and feeding sites, and they attract those females ready to spawn. The females for their part draw the attention of subservient males to the "microbiotopes" and in their turn attract these males.

We assume that the factors mentioned are not single explanations of the sometimes numerous presence of members of the "*cameronense*"-group at specific points, but rather that these factors influence each other. Intensive observations in the field could produce interesting results.

The diet in the wild. One question that interests many lovers of killifish particularly is this: "What do killies eat in the wild?" Many people on collecting trips have tried to find an answer to this.

Mention should first be made of the Frenchman Brosset, who stayed for months in the north of Gabon, primarily to study the species of the genus *Diapteron*. These fish are close to *Aphyosemion*, which is why it was not until 1978 that Huber & Seegers separated them into a new genus. Brosset, with the help of Prof Y. Coineau of the French National Museum, managed to study the stomach contents of 66 specimens of the genus *Diapteron*. They identified *Crustacea*, various *Copepodae*, *Ostracodae*, aquatic larvae of insects, *Chironomidae* (similar to our "bloodworms"), *Ephemeropterae*, some terrestrial insects and oligochaete worms.

These are creatures that occur in the native waters of *Diapteron* in the area of the Ivindo Basin in north Gabon. Since *Aphyosemion cameronense*, *Aphyosemion maculatum* and some phenotypes of the "*cameronense*"-group have been found in these biotopes, it can be assumed that these fish too eat at least some of the creatures mentioned.

The gathering of useful findings from the rainforest streams can be said to be a difficult exercise.

In July 1989, LEGROS (1990) at location "C 89/22" at Nkonga, 6 km north of Pouma in Cameroon, searched intensively but was unable to discover any creatures living in the water that could possibly be prey for the *Aphyosemion* (*Chromaphyosemion*) *loennbergii* and *Aphyosemion amoenum* that lived there. He assumes that they feed mainly on black ants that fall from the leaves of the bushes and trees onto the surface of the water. The water-bugs and freshwater shrimps that can be observed there appear to be predators rather than prey in this context.

In 1990, 1991, 1993 and 1994, in south Cameroon, and also in north and south Gabon, one of the authors tried to get information on the natural foods of the killifish of the "*cameronense*"-group and of other species groups of the genus *Aphyosemion*. These efforts were just as fruitless as LEGROS's attempts we have just mentioned.

Usually large numbers of other creatures living in the water are found, for example stick bugs, water-beetles, water-bugs, shrimps of different species and tadpoles. Most of these creatures are too big to be considered as prey for killifish. Could it be possible that *Aphyosemion* feed on freshly hatched shrimps that have not had time to develop a hard shell?

In January 1993 EBERL brought back some adult shrimps from the north of Gabon and kept them together with various *Aphyosemion* species, including wild fish from the same trip and the same biotope. There was no hint of any aggression.

As the attempts to breed the shrimp failed, it was not possible to carry out any experiments on the possibilities of feeding *Aphyosemion* with young shrimps.

One can be fairly certain that for killifish of the genus *Aphyosemion*, including members of the "*cameronense*"-group living in the waters of Cameroon and Gabon, terrestrial insects that fall into the water form an important part of their diet. This is suggested by the information - albeit limited - so far gathered in the wild, together with BROSSET's findings and a consideration of the conditions prevalent in the localities.

As indicated earlier, the rainforest streams are covered with thick vegetation. At times of strong winds and heavy rainfall, ants, caterpillars, beetles and other insects must fall off this vegetation and land on the surface of the water. This is where the fish will wait to catch and eat their prey.

We have no information as to whether there is a connection between the rainy and dry seasons and this presumption. Nor can we say what proportion of the fishes' diet is composed of terrestrial insects, and what proportion the water creatures mentioned by BROSSET. It is a fact, however, that the *Aphyosemion* upward facing mouth is particularly specialised at catching food from the surface of the water.

The mud stirred up when someone steps into the water settles quickly or else is washed away by the clear water flowing by

Brown leaves, under which *Aphyosemion* can hide very well; as the leaves decay, so the brown colouring of the water arises

The Accompanying Fauna in the Biotopes

In this chapter we want to consider more closely the fish species that occur in the same streams as the representatives of the "*cameronense*"-group. It is difficult to describe the numerous other organisms mentioned in the previous chapter when the foods in the wild were dealt with, since we do not have the relevant specialist knowledge. Hence we are unable to discuss more fully the numerous aquatic organisms in these biotopes.

In the first section we deal with the killifish which according to our present knowledge occur in the wild alongside the species and phenotypes related to *Aphyosemion cameronense*. Included are various species of the genera *Aphyosemion*, *Aplocheilichthys*, *Epiplatys*, *Episemion*, *Hylopanchax* and *Plataplochilus*.

In the second section we deal with the fish species that have been found in these waters and which are not killifish. As these fish are large in number and only rarely kept in the aquarium, and as we specialise in the genus *Aphyosemion* (and especially in the "*cameronense*"-group), the discussion of these species is merely superficial. In part we had to use the available literature to help us identify the fish species. Where species cannot be determined accurately, approximate data on the identification of the species are given.

Syntopic Killifish

The term "syntopic" is used to describe the fish that occur in the same body of water: the first syllable "syn", derived from the Greek, means "with..." or "together...", and the ending "...top" refers to the biotope.

It must be said that the conditions in the streams change constantly and therefore often two syntopic killifish species have been found in different places. For example the small *Diapteron* species prefer to live near the banks over a muddy base, whereas *Epiplatys* and *Episemion* are always to be observed at the water surface and on occasions in open water. Lampeyes of the genera *Aplocheilichthys*, *Plataplochilus* and *Hylopanchax* in their turn live in groups in the open water, where they look for the current.

***Aphyosemion batesii*, *Aphyosemion kunzi* and *Aphyosemion splendidum*.** These three species together form the subgenus *Raddaella*; they differ from the other *Aphyosemion* species in the region under discussion in body shape, colouration, fin shape and way of life.

The fish are strong, stocky and with a maximum total length of 70 mm can be larger than the members of the "*cameronense*"-group. Experience of them in the aquarium has shown that they grow very fast, have a healthy appetite and that their eggs undergo one or several diapauses during their development. In addition their life expectancy is shorter than with the small *Aphyosemion* species. This means that the eggs must be stored in peat or peat fibre, as is necessary with the species *Aphyosemion sjoestedti*, *Aphyosemion fallax*, *Aphyosemion kribianum*, *Aphyosemion rubrolabiale*, *Aphyosemion deltaense*, *Aphyosemion gulare*, *Aphyosemion filamentosum* and *Aphyosemion robertsoni* from the coastal plains of Cameroon and Nigeria.

Since the killifish in the rainforests of the countries under discussion can be caught virtually only during the dry seasons, we do not have information on the life cycle of these three species. The fact that they have sometimes been found together with *Aphyosemion cameronense* and the related species, but in smaller numbers and in far fewer localities, points to a semi-annual way of life. It is probable that *Aphyosemion batesii*, *Aphyosemion kunzi* and *Aphyosemion splendidum* spawn predominantly in the rainy season in places near the bank which then become dry as the water level drops. The eggs develop during the following three to four months and then hatch with the onset of rain and the rising water level. The fry have to grow quickly, which is why they eat a lot. They have to become sexually mature before the rains ease off and lay as many eggs as possible to ensure the next generation.

In its basic aspects this method of reproduction is also known from the purely annual species of the genus *Nothobranchius* from East Africa. A feature of the breeding of *Nothobranchius* and *Raddaella* is the fact that not all fry hatch at the same time. A certain percentage always remain in the eggs, so that they do not hatch until the second wetting. In this way the species survive rainy periods that are too short. This may also be the case with *Raddaella,* which would explain the small number of specimens present in the streams in the dry season.

WENDEL (pers. comm. 1988) says this is why these semi-annual species are found together with non-annual species such as *Aphyosemion cameronense*, *Aphyosemion punctatum*, *Aphyosemion bochtleri* and the *Diapteron* species.

It is not easy to separate the three species, and moreover there are differing opinions as to their validity. So we give here a short description of the colour pattern of adult males:

- *Aphyosemion batesii* from Cameroon has two broad marginal bands on the caudal fin. They are separated from the central part of the fin by a narrow red band. In addition the anal fin has a very broad yellow band, which is separated from the middle of the fin by a considerably narrower red band. Individual specimens may have a very weakly developed yellow marginal band on the upper edge of the fin. The anal fin has a regular red pattern and the yellow band is absent.
- *Aphyosemion splendidum* from Zaïre and the northwest of the Republic of Congo has a more slender body and fins with longer extensions. As with *Aphyosemion kunzi* the caudal fin has only a lower marginal yellow band. The anal fin is bordered yellow in the outer area.

RADDA & PÜRZL (1977) give a locality for *Aphyosemion batesii* in a marsh south of Mbalmayo in Cameroon and for *Aphyosemion kunzi* in a marshy stream on the western outskirts of Koumaméyong in Gabon.

In 1991 GRELL and EBERL discovered *Aphyosemion kunzi* and *Aphyosemion exiguum* in the village of Ayén, south of Djoum on the border with Gabon. On the following day, between Ménguém, and Mvengué, they once again found *Aphyosemion exiguum*, but this time with *Aphyosemion batesii*.

WAGNER and WENDEL found in the village of Latta about 17 km east of Makokou *Aphyosemion kunzi* together with *Aphyosemion cameronense*, *Diapteron georgiae*, *Epiplatys neumanni* and *Hylopanchax silvestris*. In 1993 LEGROS, CERFONTAINE and EBERL found *Aphyosemion spec. aff. cameronense* Phenotype 7 and a male *Aphyosemion kunzi* in a stream 48.5 km west of Makokou.

***Aphyosemion exiguum*.** This species, together with *Aphyosemion bualanum* and *Aphyosemion dargei*, forms the subgenus *Kathetys*. We agree with AMIET (1987) who does not place *Aphyosemion bamilekorum* in this subgenus, as this species differs too much from the others. Whilst *Aphyosemion bualanum* and *Aphyosemion dargei* inhabit the savannas of Cameroon, *Aphyosemion exiguum* is the corresponding rainforest species in the south of Cameroon, the extreme north of Gabon (one locality!) and in the Congo (one locality by HUBER!). This is a small species which can occur in great numbers in many streams.

Aphyosemion exiguum is notable for the numerous red diagonal stripes on the sides of the body of the males. This feature is not found on any representatives of the "*cameronense*"-group, nor on any other species dealt with in this section. It is possible that this characteristic which is peculiar to *Aphyosemion exiguum* makes it possible for the various species to live together, by preventing any aggression between males of different species. Nevertheless the males of two or even three syntopic *Aphyosemion* species do compete with each other to a certain extent, when they display to a female that is ready to spawn. The characteristics that separate the females are - compared with the males - only poorly developed. Purely theoretically, this could lead to "mix-ups", if it came to mating of fish of different species. It is interesting to note that the females of *Aphyosemion exiguum* have in less distinct form the vertical striped markings of the males. This may make them recognisable to males of their species as well as of other species. How far nature has set up natural barriers based on the colour markings of males and also possibly of females, it is impossible to say, owing to a lack of observations in the wild and in the aquarium (the latter possibly of dubious validity?). Nevertheless it would be worth carrying out series of experiments to find out more about the intraspecific behaviour of *Aphyosemion*. *Aphyosemion exiguum* occurs in the whole of south Cameroon as far as the border with Gabon, together with *Aphyosemion cameronense* and some related phenotypes. However it has as yet not been found syntopic with *Aphyosemion obscurum*. RADDA (1971) mentions a stream 8 km south of Sangmélima containing *Aplocheilichthys camerunensis*, *Aphyosemion exiguum* and *Aphyosemion cameronense* as well as another stream near Nsomi on the Sangmélima-Yaoundé road. In this latter stream were *Aphyosemion batesii*, *Aphyosemion exiguum* and *Aphyosemion cameronense*. During their Cameroon trip from 31.12.1978 to 12.1.1979 HEINEMANN and LENZ found *Aphyosemion exiguum* together with *Aphyosemion cameronense* in a stream 33 km west of Sangmélima on the Ebolowa road between Zoébefam and Meyos. In the literature there are numerous examples of *Aphyosemion exiguum* and *Aphyosemion cameronense* being found together.

Male *Aphyosemion kunzi* "GBG 92/13"

Female *Aphyosemion kunzi* "GBG 92/13"

Male *Aphyosemion exiguum*

Female *Aphyosemion exiguum*

Aphyosemion bochtleri and Aphyosemion herzogi. Originally both forms were described as separate species in one publication. For a long time these were considered as such, but in recent years different authors have begun to consider *Aphyosemion bochtleri* as a subspecies of *Aphyosemion herzogi* (i.e. *Aphyosemion herzogi herzogi* and *Aphyosemion herzogi bochtleri*) or even only a colour form. In this latter case, the name *Aphyosemion bochtleri* would have to be dropped for reasons of priority - *Aphyosemion herzogi* being described earlier in the publication.

This point of view is supported by a form caught on 10th January 1986 by Wagner and Wendel in north Gabon in the village of Bindzima (Bidzima) about 13 km south-west of Bibassé (Bibas) on the road to Sam (GWW 86/18). The collectors call them a transitional form between *Aphyosemion herzogi* and *Aphyosemion bochtleri*. Unfortunately the fish from this location did not survive the journey back to Europe, so nothing can be said about their systematic position.

As long ago as 1977 Huber mentions the presence of a form related to *Aphyosemion herzogi*, which he calls *Aphyosemion spec. aff. herzogi*. The fish pictured in the first description of *Aphyosemion mimbon* show points of similarity with *Aphyosemion bochtleri*, but at the same time differs from it quite considerably.

In January 1993 Legros, Cerfontaine and Eberl managed to find localities of this form on the western edge of the 'Monts de Cristal' in north Gabon. Some specimens were brought back to Europe (*Aphyosemion spec. aff. herzogi* "LEC 93/22" and "LEC 93/23"). It may be possible in due course to study this form scientifically and carry out crossing experiments, in order to clarify its relationships.

Grell (1993a) describes where and how he caught various forms in the north of Gabon. He shows their variability in some colour photographs. This article can be warmly recommended to the interested reader.

Amiet (1987) shows a colour picture of an *Aphyosemion* male that he had found with *Aphyosemion cameronense* in Asseng between Nyabessan and Ma'an in south Cameroon, in December 1979. This form he called *Aphyosemion herzogi*, but there are distinct differences in colouration between it and the fish from the terra typica of this species near Zomoko in Gabon. This makes the situation appear more complicated.

To clarify this situation fish need to be collected and more detailed research carried out. Without wishing to commit ourselves, we tend to follow RADDA, who described *Aphyosemion herzogi* and *Aphyosemion bochtleri* as separate species. At the same time we accept the form first discovered by HUBER as *Aphyosemion spec. aff. herzogi*, in view of the peculiarities of its colouration. We agree with AMIET (1987) in including all the species and forms related to *Aphyosemion herzogi* in the "*Aphyosemion herzogi*"-group.

The representatives of this group are distinguished by a slim and slender body shape. In addition the caudal fin is almost always evenly rounded. Individual males appear to have a slightly divergent form of the caudal fin, in that only slight differences from the rounded shape can be observed. When one considers the females of this group, it is not just the body shape which distinguishes them from other *Aphyosemion*. In addition the females have - compared with other females of the genus - a surprisingly intense body colouration. The unpaired fins and pectorals have irregular red spots and on the flanks there is a pattern of irregular dark spots, giving the impression of marbling.

As mentioned with *Aphyosemion exiguum*, this divergent colouration of the females might facilitate the co-existence with the species of other subgenera and species groups in the biotopes.

Aphyosemion herzogi and *Aphyosemion bochtleri* were discovered towards the end of the very successful collecting trip in north Gabon made by Wolfgang HERZOG and Franz BOCHTLER, and it was after them that the fish were named.

Aphyosemion herzogi was first discovered near Zomoko, which lies to the north of the Lalara crossroads. This strain is still today distributed in the hobby under the name "Zomoko". This speaks for the use of precise locality naming for the maintenance of pure strains (see page 11!). Its distribution area stretches from Lalara via Mitzic to Sam, where it occurs together with *Aphyosemion cameronense* with the usual colouration of this area. Leaving Sam, *Aphyosemion herzogi* might also occur south of this road in the 'Monts de Cristal'. It is not until one goes further to the west that one finds HUBER's *Aphyosemion spec. aff. herzogi*. It represents an extreme "yellow" coloured species, which presumably helps separate it from the "blue" species *Aphyosemion cameronense*.

On 7th January 1993 LEGROS, CERFONTAINE and EBERL found numerous *Aphyosemion cameronense* and a single male *Aphyosemion herzogi* ("LEC 93/1") in a remote forest stream 2.8 km west of Laboka between Lalara and Koumaméyong. Despite intensive efforts no other specimens of *Aphyosemion herzogi* could be found. In July of the same year PASSARO and EBERL fished in a small tributary of the Amvéné on the private road from Zomoko to Oveng. They found a few specimens of *Aphyosemion herzogi* ("PEG 93/15"), but no *Aphyosemion cameronense*. This seems to show that it may well be possible to find the two species in the streams, but they appear to choose different biotopes. This would mean that one would have to look in longer stretches of the stream, if one has happened to find odd specimens of *Aphyosemion herzogi.*

Male *Aphyosemion herzogi* "Zomoko", raised by Karl-Heinz LÜKE

Male *Aphyosemion spec. aff. herzogi* "LEC 93/23"

Aphyosemion bochtleri "GWW 86/11"

Female *Aphyosemion bochtleri* "GWW 86/11"

The terra typica of *Aphyosemion bochtleri* is a small stream about 300 metres north of Mintoum on the road from Ovan to Makokou (in addition *Aphyosemion cameronense* and *Epiplatys neumanni* were also found here). For a long time no fish from this locality were available in the hobby, until WAGNER and WENDEL found this stream again in January 1986 and brought back the strain "GWW 86/11". The male of strain "GBG 92/19" illustrated in GRELL (1993a, page 68) bears a very close resemblance to the fish of the locality just mentioned.

According to GASPERS, the other known localities are:

- A stream near Essenkéllé, 52 km west of Makokou: *Aphyosemion bochtleri*, *Aphyosemion cameronense*, *Aphyosemion kunzi*, *Aphyosemion punctatum* and *Diapteron georgiae*.
- A stream 68.5 km west of the Makokou Catholic Mission on the road to Ovan: *Aphyosemion bochtleri*, *Aphyosemion cameronense* and *Diapteron fulgens*.

If the strains of both species distributed in the hobby are compared, it will be seen that with *Aphyosemion herzogi* basically yellow colours predominate, and the caudal fin is asymmetrically coloured. With *Aphyosemion bochtleri*, on the other hand, blue colours dominate, and the caudal fin is symmetrically coloured.

Within its distribution area between Makokou and Ovan, *Aphyosemion bochtleri* occurs together with *Aphyosemion cameronense*, *Aphyosemion punctatum*, *Aphyosemion kunzi*, *Epiplatys neumanni* and the *Diapteron* species *cyanostictum*, *fulgens* and *georgiae*.

The females of this species too have a "marbled" body colouration like *Aphyosemion herzogi* and *Aphyosemion spec. aff. herzogi* from the Monts de Cristal.

***Aphyosemion loennbergii*.** This is the only species of the subgenus *Chromaphyosemion* that has to date been found together with a representative of the "*cameronense*"-group. These are in general species that inhabit the coastal plains of the countries Togo, Bénin, Nigeria, Cameroon, Equatorial Guinea and Gabon. *Aphyosemion loennbergii* penetrates relatively far away from the coast to the rise of the inland plateau in Cameroon. Near Pouma it meets *Aphyosemion amoenum*, the only species of the "*cameronense*"-group to have left the inland plateau on the western side.

The male *Aphyosemion loennbergii*, as members of the subgenus *Chromaphyosemion*, have four significant characteristics, which separate them clearly from other subgenera and species groups:

- The dorsal fin is strikingly large and with an extension, the tip of which is a shiny orange-yellow.
- The caudal fin is bilobate, sometimes the central part is extended, the tips have the same colouration as the dorsal fin.
- On the sides of the body there are two dark longitudinal bars parallel to each other. Depending on the mood of the fish, they are black to grey or almost invisible.
- The dorsal begins almost above the base of the anal fin.

The last mentioned characteristic is also found on members of the subgenus *Raddaella*, but their flanks have red markings, and both sexes lack the two dark longitudinal bars.

The females have short, round and colourless fins, but the two longitudinal bars are much more conspicuous than are the males'. Moreover the intensity of these bars is less dependent on the mood of the fish. We have here a characteristic of the females' colouration, which enables them to be distinguished immediately from females of the "*cameronense*"-group. There are many examples of biotopes around Pouma, in which *Aphyosemion amoenum* and *Aphyosemion loennbergii* have been found together:

- "C 89/22": a stream, which crosses the Pouma-Sakbayémé road at Nkonga, about 6 km north of Pouma.
- "C 89/46": in the village of Biang (Bihiang) about 3 km north of Pouma.
- "EMS 90/8": the 'Lababaga' stream near Sonmayo, south-east of Sakbayémé.
- "EMS 90/9": a stream near Log Bako'o, about 5 km east of Pouma south of the 'Axe lourd'.
- "EMS 90/10": a stream about 100 metres south of Ndoupé on the 'route ancienne' east of Pouma.

We can therefore assume that in this region both species can be found in almost all bodies of water suitable for killifish. It has been established that there were large numbers of both species in all the streams just mentioned. This leads one to conclude that they have partly differing requirements and thus do not compete with each other to any extent.

***Aphyosemion punctatum*.** This species was discovered in 1971 by GASPERS and others (locality: marshy stream near the Makokou Catholic Mission). They called it *Aphyosemion striatum* or *Aphyosemion striatum ogoense*. Then in 1974 BOCHTLER and others brought back fish from the same location with the code "G 10/74" (i.e. the 10th finding-place of their trip). These fish were used by RADDA and PÜRZL for the first description of *Aphyosemion punctatum*.

In this publication the authors give another locality: "G 37/75", about 4 km east of the (then) ferry across the Mvoum near Ovan, 100 km west of Makokou. *Aphyosemion bochtleri* was also present, but there is no mention of any member of the "*cameronense*"-group. Besides the cases mentioned on the previous page of the three species *Aphyosemion bochtleri*, *Aphyosemion cameronense* and *Aphyosemion punctatum* occurring together, we know of more localities, in which a similar combination of species has been shown to occur:

- "GBG 92/16" with *Diapteron fulgens* and *Aphyosemion cameronense* (according to GRELL, 1993b).
- "LEC 93/6": 39 km west of Makokou, 'Otong Etougé' stream near Adoué, *Aphyosemion cameronense*, *Diapteron georgiae* and *Epiplatys neumanni*.
- "LEC 93/7": 48.5 km west of Makokou on the N4, *Aphyosemion kunzi* (just one male), *Aphyosemion spec. aff. cameronense* Phenotype 7, *Aphyosemion punctatum*, *Diapteron fulgens* and *Epiplatys neumanni*.

Male *Aphyosemion loennbergii* "C 89/21"

Female *Aphyosemion loennbergii* "C 89/21"

Aphyosemion punctatum "LEC 93/7"

Female *Aphyosemion punctatum* "LEC 93/7"

-"LEC 93/8": 55 km west of Makokou in the 'Mévomé' stream near Bissobilam, *Aphyosemion cameronense* and *Aphyosemion punctatum*.

This is a species with numerous more or less regular red spots on blue-green flanks (*punctatum* = spotted). Depending on the locality and individual fish, there are on the sides of the body two or three rows parallel to each other.

In the past this pattern feature led to the names mentioned above of "*Aphyosemion striatum*" (= striped *Aphyosemion*) and *Aphyosemion striatum ogoense.* To start with it was believed that the fish was the genuine *Aphyosemion striatum* of the coastal plain of Gabon. When differences with this species were proved, the name *Aphyosemion striatum ogoense* was used and the form considered as a subspecies of *Aphyosemion striatum*.

As a matter of fact the wild fish from locations "LEC 93/6", "LEC 93/7" and "LEC 93/8" were very regularly spotted, thus giving the impression of a horizontal striped pattern.

A photograph in RADDA & PÜRZL (1977, page 30) shows a wild pair from collecting place "G 37/75". The male has very few red spots on the flanks and they form a regular and unbroken row. Although the upper row gives the impression of a zig-zag band, the lower red band is missing. In addition the totally different fin markings as well as the syntopic occurrence clearly exclude the possibility of the species belonging to the "*cameronense*"-group.

It is a problem even for killi-experts to separate the females of *Aphyosemion punctatum* from the relevant representatives of the "*cameronense*"-group at a location. The experiences of LEGROS, CERFONTAINE and EBERL in January 1993 showed that there are no really obvious distinguishing features. Only when kept in the aquarium can females of *Aphyosemion punctatum* be separated from female *Aphyosemion cameronense* by making direct comparisons.

Between Ovan and Makokou a few locations were found in which the two species occur together, but there is a predominance of localities, where either only *Aphyosemion punctatum* or a representative of the "*cameronense*"-group occurs. East of Makokou in the direction of Mékambo, *Aphyosemion punctatum* appears to increasingly replace the members of the "*cameronense*"-group. This seems to indicate that both species have similar habitat requirements and only occur together where optimum conditions for reproduction obtain. As far as we know, the centre of distribution of *Aphyosemion punctatum* lies south-east of Makokou. This means that the locations between Makokou and Ovan can be thought of as a border area for this species.

In less suitable biotopes the better adapted form seems to succeed.

The close similarity of the females would support this hypothesis.

Aphyosemion raddai. Knowledgeable readers will wonder why this species is discussed here and not in the chapter **The Species of the "*cameronense*"-group**. In fact, after its discovery by SCHEEL and the subsequent first description in 1975, *Aphyosemion raddai* was stated to be a member of this group. The type locality lies at the junction of the Edéa-Yaoundé-Eséka roads. RADDA (1971, pages 164 and 166) uses the description "stream with a fast current in open land near the junction of the Yaoundé-Edéa-Eséka roads".

Since the end of the 1980s it has been impossible to find this collecting place again. At the time SCHEEL and RADDA still used the dirt road from Douala via Edéa to Yaoundé. With the construction of the new asphalted 'Axe lourd' in 1987 and 1988, the old road became increasingly difficult to negotiate. As a result it is today no longer possible to follow its route (as proved by EBERL and others in August 1990).

Subsequently some locations were discovered between Boumnyébél and Matomb along the 'route ancienne' and later the 'Axe lourd'. After it was originally thought they had caught *Aphyosemion obscurum*, SCHEEL recognised the differences from this species and described the new species in honour of Dr Alfred C. RADDA from Vienna.

Afterwards the specific name "*Aphyosemion raddai amoenum*" was used by many authors, to stress the similarity with *Aphyosemion amoenum*. On closer examination, however, it can be seen that *Aphyosemion raddai* has neither an upper nor a lower red band. These are very distinct features on *Aphyosemion amoenum* and on *Aphyosemion obscurum*, which is *Aphyosemion raddai*'s neighbour to the east. A much more obvious feature on the flanks of the males are four horizontal lines composed of closely spaced red spots. All the lines are equally clearly developed, which is not the case with *Aphyosemion obscurum* or Phenotypes 1, 4 and 9. The markings too of the unpaired fins suggest the separation of this species from the "*cameronense*"-group: the dorsal and anal fins have numerous longitudinal lines. AMIET (1987, pp 115-117 and 240-242) refers to these facts and deals with them in great detail. We agree with his arguments and consider *Aphyosemion raddai* to be an isolated species, which has connections with Gabonese species (*Aphyosemion microphtalmum* and perhaps even *Aphyosemion primigenium*?).

On 19.8.1990 EBERL and others found near Log Bako'o, about 6 km east of Pouma, in a stream south of the 'Axe lourd' *Aphyosemion amoenum* and *Aphyosemion raddai* together with *Aphyosemion loennbergii* and *Epiplatys sexfasciatus* ("EMS 90/9"). What was predicted by AMIET (1987) was seen in the wild for the first time. GRELL and EBERL succeeded in visiting this location a second time in August of the following year and making the same observations again. If *Aphyosemion raddai* were a representative of the "*cameronense*"-group, this would be the first case to date of two recognised species of this group being found in the same biotope. As in this case the requirements of both species would be virtually the same, the weaker form would be ousted by the stronger one. One can conclude from this that *Aphyosemion raddai* is not a member of the "*cameronense*"-group. So AMIET's view can be substantiated with arguments.

AMIET (1987) mentions too the stability of the colour pattern of *Aphyosemion raddai* in the various location variants. In fact one of the authors found this species in a total of three locations but was unable to detect the usual degree of variations found in the "*cameronense*"-group either between individual males or between the populations.

Male *Aphyosemion raddai* "C 89/28"; this strain was found in Modé

A female of the same strain

Male *Diapteron fulgens*

Male *Diapteron georgiae*

The males of locality "EMS 90/1", a stream called 'Mayongo' near Lepku'um south of Eséka, did not differ from the males of locality "C 89/28" near Modé north of Boumnyébél, nor from the males caught near Log Bako'o in 1990 and 1991. The distance from Modé to Lepku'um is 44 km as the crow flies.

Compared with strains from the "*cameronense*"-group separated by similar distances, the males of *Aphyosemion raddai* had practically identical colouration. Even though it is difficult to distinguish females of *Aphyosemion raddai* from females of the "*cameronense*"-group, this species should not be placed in this group, in view of the facts mentioned above. As has already been shown with *Aphyosemion punctatum*, it is possible - even if rarely - to find females of two syntopic *Aphyosemion* species to resemble each other closely, despite the difference in colouration of the respective males. At the present time only one stream is known in which *Aphyosemion raddai* and *Aphyosemion amoenum* occur together, but there is always the possibility that in future further such cases will be found. A wide range of killifish fauna (*Aphyosemion amoenum*, *Aphyosemion raddai*, *Aphyosemion obscurum* as well as *Aphyosemion cameronense* and *Aphyosemion bualanum* in the south and north respectively) is to be found between Pouma and Yaoundé, and therefore this area would benefit from further investigation carried out systematically.

The genus *Diapteron*. This comprises five species, which were earlier considered to be a species group of the genus *Aphyosemion*. Then HUBER & SEEGERS 1977 raised the four species then known to subgenus level and so separated them from *Aphyosemion*.

SEEGERS (1980, page 115) states that, in view of the present information on the distribution of these fish (Ivindo Basin in north Gabon) he supports their elevation to the rank of genus. We here follow this view, since some important facts and characteristics - clearly presented in SEEGERS just mentioned - justify the separation of *Diapteron* from *Aphyosemion*:

- The maximum body size is at roughly 35 to 40 mm much less than that of all currently known *Aphyosemion*.
- The very colourful males have a colour pattern that is in contrast to that of all the *Aphyosemion*: the basic colour of the flanks is red, over which there are blue spots that vary in size and number, depending on the species and strains.
- The caudal fin begins almost above the first ray of the anal fin. Admittedly this is known in *Fundulopanchax, Raddaella* and *Chromaphyosemion*, but all these three subgenera can be easily distinguished from *Diapteron* by features such as body size, colouration, longitudinal bands in the flanks, way of life and long fin extensions.
- SEEGERS (1980, page 115) cites the divergent surface structure of the *Diapteron* eggs as a further characteristic to distinguish the genus from all *Aphyosemion*.
- In addition he states that as at present there is no known connecting link to *Aphyosemion*, in other words there is no species midway between the two genera.
- In the 1970s, between Ovan and Makokou, two *Diapteron* species were discovered together in the same stream (BOCHTLER and GASPERS, according to RADDA & PÜRZL,

1977). This has so far not been observed with *Aphyosemion*, which, when found together, have always been members of different subgenera or species groups. In this case they never have exactly the same requirements, as would two species from one subgenus or species group.

Diapteron georgiae was described by LAMBERT & GÉRY in 1968. The type locality is situated near Bélinga north-east of Makokou, from where only *Aphyosemion spec. aff. cameronense* Phenotype 4 is known at present. However, *Diapteron georgiae* has also been caught at numerous locations along the Makokou-Lalara road together with various representatives of the "*cameronense*"-group.

The most westerly known locality is about 18 km west of Koumaméyong on the road to Lalara, near the village of Matora ("PEG 93/14"), where *Aphyosemion maculatum* was also found, in a form with striking yellow fin margins.

GASPERS and others give for their trip in 1974 the two following localities:

-160 km west of Makokou (about 7 km west of Koumaméyong) together with *Aphyosemion cameronense* "yellow" (= *Aphyosemion spec. aff. cameronense* Phenotype 5).

-Makokou Catholic Mission together with *Aphyosemion punctatum* and *Epiplatys neumanni*.

In December 1975 RADDA & PÜRZL (1977, page 25) then also found *Diapteron georgiae* at their locations 36 (terra typica of *Aphyosemion maculatum*), 38 and 41 .

HEINEMANN & LENZ discovered in December two further localities of this species:

-3 km west of Makokou together with *Aphyosemion cameronense*, *Diapteron cyanostictum*(!) and *Epiplatys neumanni*.

-55 km west of Makokou, behind Bissobilam, with no other killies.

Peter WAGNER and Roland WENDEL fished very intensively the Ivindo Basin during their extremely successful trip in January 1986 and found *Diapteron georgiae* in the following localities:

-"GWW 86/2", 17 km east of Makokou behind the village of Latta, with *Aphyosemion kunzi*, *Aphyosemion cameronense*, *Epiplatys neumanni* and *Hylopanchax silvestris*.

-"GWW 86/3", 12 km west of Makokou with *Aphyosemion cameronense*, *Aphyosemion punctatum* and *Epiplatys neumanni*.

-"GWW 86/9", 68 km west of Makokou, with only one other killie: *Epiplatys neumanni*.

-"GWW 86/10", 78 km west of Makokou with *Aphyosemion cameronense* and *Epiplatys neumanni*.

-"GWW 86/11", in the village of Mintoum, with *Aphyosemion cameronense*, *Aphyosemion bochtleri* (type locality) and *Epiplatys neumanni*.

- "GWW 86/12", 10 km east of Koumaméyong, one other killi-species, *Aphyosemion cameronense* (Phenotype 5? No further data available).

Diapteron cyanostictum has on the body and the fins numerous blue spots

Diapteron abacinum might be found with representatives of the "*cameronense*"-group

The females of the genus *Diapteron* are difficult to separate

Epiplatys neumanni inhabits the whole of the Ivindo Basin in north Gabon

Besides these locations there are many others (RADDA & PÜRZL; BROWN and others, 1990; GRELL (1993b); LEGROS, CERFONTAINE and EBERL, January 1993 and others), for reasons of space we cannot give them all here. It appears that this species generally occurs between Koumaméyong and Makokou.

Diapteron cyanostictum was also described from the area around Bélinga but from a different stream. This species has a similarly large distribution area between Ovan and Mékambo. We even know a locality in the extreme north-west of the Republic of Congo: "RPC 153", 58 km west of Souanké, just before the village of Bempoko: *Aphyosemion splendidum* (= *kunzi*?), and *Aphyosemion cameronense* as well as a very dark strain of *Diapteron cyanostictum* in HUBER, 1982, page 3.

In addition there is a strain with the code "GBN 88/29", whose location is given as Sam, which lies between Mitzic and Médouneu on the border with Equatorial Guinea. In contrast with all other *Diapteron* localities, this is far outside the Ivindo Basin. Despite the geographical distance from the nearest known locality of this species (about 130 km as the crow flies), this is clearly the same fish.

Here too we will give some localities with the names of other killies found in the same stream, for example by GASPERS and others in January 1974:

- -2 km east of the ferry over the Mvoum near Ovan with *Aphyosemion cameronense* and *Epiplatys neumanni*.
- -Approximately 20 km east of Makokou on the road to Mékambo behind a village of unknown name with *Aphyosemion punctatum*, *Aphyosemion kunzi* and *Epiplatys neumanni*.
- -13.5 km west of the Makokou Catholic Mission with *Aphyosemion cameronense*.

On the occasion of the trip mentioned on page 95, HEINEMANN and LENZ found this *Diapteron* at the following localities:

- -14 km east of Makokou with *Aphyosemion punctatum*, *Aphyosemion kunzi* and *Epiplatys neumanni*.
- -40 km south-east of Makokou behind the village of Mbandou with the same combination of species.
- -3 km west of Makokou with *Aphyosemion cameronense*.

BROWN and others in 1990 and GRELL (1993b, seven localities!) found this species. In addition LEGROS, CERFONTAINE and EBERL caught *Diapteron cyanostictum* at the two following locations in January 1993:

- -"LEC 93/5", 14 km west of Makokou with *Aphyosemion cameronense* and *Epiplatys neumanni*.
- -"LEC 93/11", 5 km west of Ovan with *Aphyosemion cameronense*.

The great distances between these localities show that this is the *Diapteron* species with the widest distribution area. At the majority of the locations *Aphyosemion cameronense* or another member of this group was found.

Diapteron cyanostictum has in the past been found with *Diapteron fulgens* as well as with *Diapteron georgiae*. Further collecting efforts east of Makokou might provide information about the relationship with *Diapteron abacinum*.

Diapteron fulgens closely resembles *Diapteron georgiae* in the colouration of the males, with only the caudal fin having two marginal yellow to orange marginal bands. In 1975 RADDA described this form as a subspecies of *Diapteron georgiae* (*Diapteron georgiae fulgens* sensu RADDA, 1975). The type locality is "A stream in the rainforest near Essenkéllé, 52 km west of Makokou". According to RADDA & PÜRZL, 1977, page 25, in 1976 BOCHTLER and GASPERS found *Diapteron georgiae* and *Diapteron fulgens* in one and the same stream, which is why these authors consider the two forms to be separate species. In January 1974 GASPERS and others found this species near Essenkéllé (later RADDA's type locality) with *Aphyosemion bochtleri*, *Aphyosemion punctatum*, *Aphyosemion kunzi*, *Aphyosemion cameronense* and *Epiplatys neumanni*. 68.5 km west of the Makokou Catholic Mission they found it on the road to Ovan with *Aphyosemion bochtleri* and *Aphyosemion cameronense*.

HEINEMANN and LENZ found two further localities of *Diapteron fulgens*:

- -15 km west of Makokou (with no other killies).
- -41 km west of Makokou with *Aphyosemion cameronense* and *Epiplatys neumanni*.

GRELL (1993b) reports a total of three localities of this species, where in addition the following occurred: *Aphyosemion punctatum*, *Aphyosemion kunzi*, *Aphyosemion bochtleri*, *Aphyosemion cameronense* and *Epiplatys neumanni* ("GBG 92/16", "GBG 92/18" and "GBG 92/19").

LEGROS, CERFONTAINE and EBERL found the two following streams with *Diapteron fulgens* in January 1993:

- -"LEC 93/7", 48.5 km west of Makokou with *Aphyosemion spec. aff. cameronense* Phenotype 7, *Aphyosemion punctatum*, *Aphyosemion kunzi* and *Epiplatys neumanni*.
- -"LEC 93/9", 60 km west of Makokou with *Aphyosemion cameronense* and *Epiplatys neumanni*.

Diapteron seegersi was not described until 1980 by HUBER. It thus represents the most recent species of this genus. As at present only one locality is known, and it was chosen as the type locality: "RPC 149: 35 km south of Sembé, on the way to Mékambo (Gabon) before the village of Gouanéboum, on a path to Gabon only passable by bicycle" in HUBER (1982). Actually the locality lies in the extreme north-west of the Republic of Congo in the border region with Gabon, which hydrographically belongs to the Ivindo Basin. HUBER (1982) describes the stream as very sluggish with leaves covering the bottom, and also with many arms leading off it. This stream therefore corresponds to the *Diapteron* biotopes of the neighbouring region of Mékambo.

Found with it were *Aphyosemion splendidum* (*Aphyosemion kunzi*?) and *Epiplatys neumanni*.

Epiplatys esekanus has a very limited distribution area near Eséka in Cameroon

A female *Epiplatys esekanus* of the same strain ("Kéllé River")

Episemion callipteron "GWW 86/20" from the type locality 6 km south of Bibassé

The females too differ considerably from those of the genus *Epiplatys*!

Although no representative of the "*cameronense*" was present, it is conceivable that in the event of future collecting trips, *Aphyosemion cameronense* or a related phenotype might be found with this *Diapteron*, as in the surrounding area HUBER discovered streams containing killifish, which he placed in *Aphyosemion cameronense*.

Epiplatys esekanus is a species which seems to have a very small distribution area north of Eséka in Cameroon. The type locality is the finding place for *Aphyosemion raddai* already described on page 90 (SCHEEL, 1968). On 14.7.1989, near Ndoupé, a few kilometres east of Pouma, LEGROS, VLIJM and EBERL found *Epiplatys esekanus* together with *Aphyosemion loennbergii* ("C89/29"). *Aphyosemion amoenum*, which is found in large numbers in this region, was not present.

While LEGROS and EBERL after two weeks unfortunately had to return to Europe, Bas VLIJM was able to stay for a third week and on 26.7.1989 he found *Epiplatys esekanus* near Mbanga on the 'route ancienne'. There were no other killies present.

At the moment this *Epiplatys* is not known from any locality in which a representative of the "*cameronense*"-group has been found (*Aphyosemion amoenum* would be a possibility), but we cannot exclude future findings in the event of intensive searches between Pouma, Eséka and Boumnyébél. This is a distinct possibility.

This is suggested by the large number of locations for *Aphyosemion amoenum* in this region, the syntopic presence of *Aphyosemion amoenum* with *Aphyosemion loennbergii*, or *Epiplatys esekanus* and *Aphyosemion loennbergii* or *Epiplatys esekanus* and *Aphyosemion raddai* in their common terra typica. The last mentioned fish was also found with *Aphyosemion amoenum*. It definitely seems that by these species similar biotopes are populated.

Epiplatys neumanni was found in the Ivindo basin of north Gabon during the earliest collecting trips and brought back to Europe (GÉRY, 1965; LAMBERT & GÉRY, 1969; GASPERS and others, 1974; HEINEMANN and BOCHTLER, 1977; HEINEMANN and LENZ, 1979; PAP, 1980; WAGNER and WENDEL, 1986; GRELL in 1993b). HUBER (1982) also mentions populations of *Epiplatys spec. aff. sangmelinensis* from the north-west of the Republic of Congo, which because of the hydrographic positions of the waters in the Ivindo basin might be placed with *Epiplatys neumanni.*

Numerous localities of this species have already been mentioned in connection with other killifish on the previous pages of this chapter, which is why we do not go into greater detail here.

Because of the relatively dull colouration of both sexes, these strains have never had a sufficient distribution in the hobby to ensure its permanent position in the tanks of killie keepers. Originally this fish was considered to be *Epiplatys sangmelinensis*, as no big differences from this species from Cameroon were detected. But with time various authors (SCHEEL (1974 and 1990), RADDA (1977), HUBER (1982), BERKENKAMP and others) began to doubt the identification of the Ivindo populations with *Epiplatys sangmelinensis*. This led to the use of the name *Epiplatys spec. aff. sangmelinensis*.

Finally in 1993 BERKENKAMP published the first description of this species, naming it in honour of Dr. Werner NEUMANN. As type specimens he chose fish caught by WAGNER and WENDEL at locality "GWW 86/2" (see page 95 under *Diapteron georgiae*) as well as paratype specimens from various locations of HEINEMANN and LENZ, PAP, HARZ and others.

This *Epiplatys* is distributed over the whole of the Ivindo basin from Lalara via Ovan, Makokou and Mékambo into the Republic of Congo, as well as south of Makokou. It occurs very commonly with *Aphyosemion cameronense*, Phenotypes 5 and 7 as well as *Aphyosemion maculatum*, as we know from locality "GBHL 96/18" (14 km west of Ovan with *Aphyosemion punctatum* and *Diapteron georgiae*).

Epiplatys sangmelinensis was already described by AHL in 1928 with the terra typica "Sangmélima". Today this locality can no longer be defined exactly because of the imprecise data. Nevertheless all the various authors agree what *Epiplatys* is now understood by this name.

This unfortunately rather plain species is found in the south of Cameroon from about Ebolowa via Sangmélima and Mbalmayo to as far as Yaoundé in the north, Akonolinga in the north-east and Mintom in the south-east.

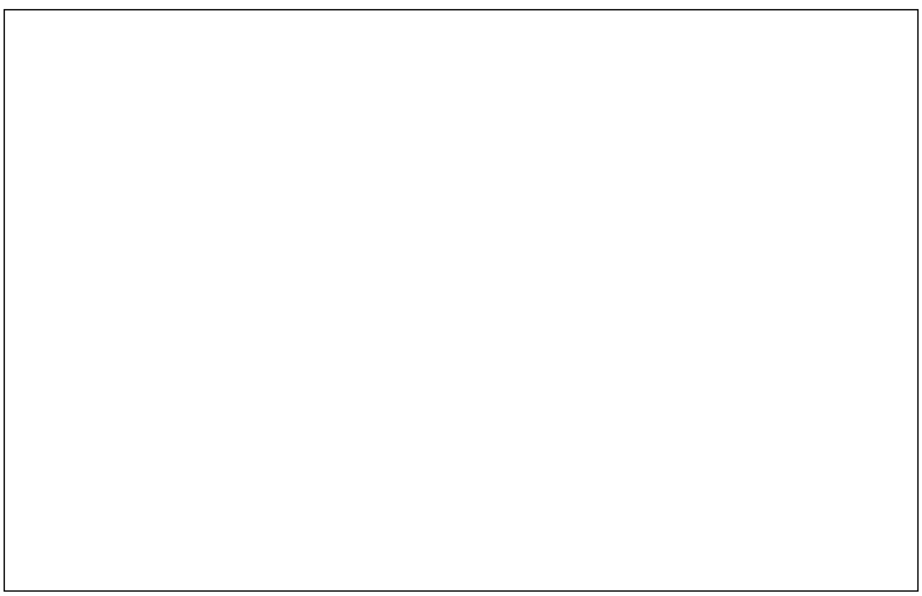
Many people who have travelled in Cameroon report on locations, of which we intend to give just a few here:

- RADDA (1971) 8 km east of Sangmélima with *Aphyosemion cameronense*, *Aphyosemion exiguum* and *Aplocheilichthys camerunensis* (terra typica of the last mentioned species) as well as from the eleventh finding place of this trip between Mefomo and Ngoulmékong on the Edéa-Yaoundé road.
- HEINEMANN, LENZ and others from the second finding place of their trip in late 1978 early 1979: Etondo, 34 km east of Ebolowa in the direction of Sangmélima; no other killies present.
- GRELL and EBERL found on 8.8.1991 in the 'Otongbibé' stream near Avonbengon (AMIET, 1987: Avonbengon) between Djoum and Mintom *Epiplatys sangmelinensis* together with *Aphyosemion spec. aff. cameronense* Phenotype 3 and thus confirmed AMIET's findings.

Episemion callipteron is also a species that has not been known for very long. Specimens of this species were first caught by the Frenchman Hervé GONIN in the 'Ottomitan' stream near Médouneu airport in north Gabon on 3.7.1983 (pers. comm. on 12.12.1993). However it was not subsequently described as a new species.

On 10th January 1986 WAGNER and WENDEL, at the twentieth locality of their trip ("GWW 86/20"), about 6 km south of Bibassé between Oyém and Mitzic, discovered *Aphyosemion cameronense* together with a hitherto unknown fish, which was later described by RADDA & PÜRZL as *Episemion callipteron*. The generic name was created from the terms "*Epiplatys*" and "*Aphyosemion*", to emphasise the position of this species between the two genera.

Here and there one comes across small waterfalls like this...



...or even rather larger!

In fact it is a species that cannot be placed in either the genus *Epiplatys* or the genus *Aphyosemion*. This is why we cannot follow the recent placing of the species into the genus first mentioned. In addition the females are very strongly coloured, resembling the males much more than is the case with *Epiplatys*.

The three killifish species with which we wish to end this section belong to the lamp-eyes. It has been the general experience that these fish transport very badly, so that they have only rarely been imported and consequently hardly ever kept in aquaria.

Their preferred habitats are flowing streams with clear water. Basically these fish keep to the open water, where they show a distinct tendency to shoal. In this way they present no direct competition to *Aphyosemion*, *Epiplatys* or *Diapteron*, as these species always keep to near the banks of the streams.

It is perfectly possible to observe lamp-eyes in the wild by standing on the bank of a stream. Only a short time after human disturbance these shoaling fish return to the open areas of the streams, to "stand" in the current and wait for food that has been deposited in the water. In 1989 observations of this kind were made by one of the authors between Edéa and Mouanko (*Aplocheilichthys macrophthalmus*), in 1990 east of Edéa (*Procatopus spec.* "EMS 90/19") as well as location "LEC 93/5" (*Hylopanchax silvestris*). It seems that these species avoid standing water and thus prefer streams rich in oxygen.

One gets the impression that in smaller streams these killifish occupy the ecological niches of other shoaling fish, in this case the larger growing characin species of West Africa.

Aplocheilichthys camerunensis was described in 1971 by Dr RADDA (1971, pp 163 to 166) using specimens from a stream 8 km south of Sangmélima on the road to Olounou. In addition *Aphyosemion cameronense*, *Aphyosemion exiguum* and *Epiplatys sangmelinensis* were also found there.

This small species (the total lengths of the type specimens came to 29 and 30 mm) seem to be very rare in the wild, as in the literature available to us only two further locations are named: localities 4 and 5 of HEINEMANN and LENZ's Cameroon trip in December 1978 and January 1979. These are in the village of Essangmvout, 35 km south-east of Sangmélima with *Aphyosemion exiguum* and two kilometres west of Emvieng (48 km south-east of Sangmélima), with no other killies present. It is distinctly possible that *Aphyosemion cameronense* will be found in other streams around Sangmélima, Djoum and Ebolowa, if the area is fished intensively.

Then we would find out more about whether this species prefers streams which are too wide or fast-flowing for *Aphyosemion* and *Epiplatys* (which is suggested by the three locations known at the present time).

Hylopanchax silvestris was described by POLL & LAMBERT in 1958. Since then it has been but rarely imported. The genus *Hylopanchax* was first created by the same authors in 1965, on the grounds of physical peculiarities. At the moment it does not seem to be kept in the hobby.

The following list of localities known today shows that this species is found together with *Aphyosemion cameronense* on only extremely rare occasions. The reason for this may be that the centre of distribution lies rather to the east of Makokou, where *Aphyosemion cameronense* is increasingly replaced by *Aphyosemion punctatum*.

In December 1979 HEINEMANN and LENZ found six localities in north Gabon:

- -11 km from the mission in Mékambo in the direction of Zoula with *Diapteron abacinum* and *Epiplatys neumanni*.
- -10 km south-west of Mékambo on the road to Makokou with *Diapteron abacinum* and *Aphyosemion kunzi*.
- -14 km east of Makokou with *Diapteron cyanostictum*, *Aphyosemion punctatum* and *Aphyosemion kunzi*.
- -40 km south-east of Makokou, behind the village of Mbandou with *Diapteron cyanostictum*, *Aphyosemion punctatum* and *Aphyosemion kunzi*.
- -3 km est of Makokou with *Aphyosemion cameronense*, *Diapteron cyanostictum*, *Diapteron georgiae* (!) and *Epiplatys neumanni*.
- -15 km west of Makokou with *Diapteron fulgens*.

WAGNER and WENDEL found near Latta on 6th January 1986 *Hylopanchax silvestris* with *Aphyosemion cameronense*, *Aphyosemion kunzi*, *Diapteron fulgens* and *Epiplatys neumanni*. At locality "LEC 93/5", mentioned on page 105, 14 km west of Makokou, *Aphyosemion cameronense*, *Epiplatys neumanni*, *Diapteron cyanostictum* and also *Hylopanchax silvestris* were identified.

GRELL (1993b) mentions three finding places for *Hylopanchax silvestris*:

- -"GBG 93/2": with *Diapteron cyanostictum*, *Aphyosemion punctatum* and *Epiplatys neumanni*.
- -"GBG 93/4": south-east of Makébé with *Aphyosemion punctatum*.
- -"GBG 93/20": with *Aphyosemion bochtleri*, *Diapteron cyanostictum* and *Epiplatys neumanni* (a few kilometres west of Ovan; western distribution frontier?).

Plataplochilus spec. is what we call a lamp-eye related to this genus which was caught by LEGROS, CERFONTAINE and EBERL in the village of Song in the 'Monts de Cristal' in north Gabon on 13th January 1993. In two small bodies of water close to this stream, which is about four metres wide, *Aphyosemion spec. aff. herzogi* and *Aphyosemion spec. aff. cameronense* Phenotype 6 were found (locality code "LEC 93/22"). There was no similarity between this lamp-eye and the strains kept under the name of *Plataplochilus ngaensis* "GWW 86/31" (13 km from Libreville towards Cap Estérias on the coastal plain). As it is not possible to place it more closely within any other lamp-eye species of the genera *Plataplochilus* or *Procatopus*, we call this form "*Plataplochilus spec.*"!

The killifish listed in this section probably do not represent all the species that can be found with members of the "*cameronense*"-group. For one thing there may be collecting trips whose results are unknown or too little known by us. Secondly, there may be differences in the naming of species when the collectors in question have different opinions on the validity of certain species.

We would not like to exclude the possibility of one or other species not mentioned being caught with a representative of the "*cameronense*"-group. It is also possible that species mentioned here may be reduced to synonym status.

Other Fish Species

When one is in south Cameroon and north Gabon looking expressly for killifish of the genus *Aphyosemion*, other fish species inevitably get caught. When people step into the streams, these other fish may hide near the banks between the plants hanging in the water from the vegetation on the bank and also in the leaves deposited in the stream bottom.

Other fish species, on the other hand, flee into open water, where they cannot be caught with the methods usually used for killifish. Collectively all these fish belong to the cichlids, characins, barbs, bush-fishes, *Mormyridae* and further families of the bone-fish. As mentioned on page 77, we lack detailed knowledge of these fish. So in this section we give a few localities of representatives of the "*cameronense*"-group with the fish species previously found there. We refer to the literature available to us and recommend the cited publications to the interested reader.

RADDA (1971, page 160) shows a picture of a rainforest stream eight kilometres south of Sangmélima (terra typica of *Aplocheilichthys camerunensis*), where, on 15th January 1971, he caught, besides the killifish already mentioned, *Barbus camptacanthus*, *Barbus jae*, *Barbus trispilominus*, *Neolebias unifasciatus* and also *Ctenopoma ansorgei*.

Near Nsomi on the Sangmélima-Yaoundé road he also found a similar combination of species together with *Aphyosemion cameronense*, *Aphyosemion batesii* and *Aphyosemion exiguum* (collecting place No 10).

In the same publication (page 162) RADDA mentions further species like *Hepsetus odoë*, *Barbus callipterus*, *Barbus guirali*, as well as representatives of the genera *Garra*, *Ctenopoma*, *Pelmatochromis* and *Eleotridae*, *Cottidae*, *Amphilidae*, *Clariidae* and *Mormyridae*. RADDA (1971) mentions in addition *Barbus aff. holotaenia*, *Auchenoglanis spec.* and *Clarias* for a few locations in north Gabon.

Other collectors such as HEINEMANN and LENZ (south Cameroon, north Gabon) as well as GASPERS and others (north Gabon) give reports of numerous barb and characin species and also catfish of the genus *Synodontis*, without going more closely into the individual species. Moreover *Ctenopoma* species seem to be found repeatedly. On one occasion GASPERS mentions a characin that resembles the Congo characin. This would suggest *Micralestes acutidens* PETERS, 1852.

HUBER (1982, page 3) mentions the fish species that he found with *Aphyosemion cameronense* in the north-west of the Republic of Congo ("RPC 150", "RPC 151", "RPC 152", "RPC 153"): *Barbus jae*, *Parauchenoglanis guttatus*, *Ctenopoma nanum*, *Ctenopoma spec.*, *Clarias spec.*, *Nannochromis dimidiatus*, *Mastacembelus batesii*, a *Mormyridae* species and a *Characoides*.

A comparison of the many non-killifish caught in south Cameroon and north Gabon with the illustrations in the Aquarium Atlas Vol I, pp 217 to 223, suggested to one of the authors that the fish might be the species *Arnoldichthys spilopterus* BOULENGER, 1909, *Brycinus imberi* PETERS, 1852, *Brycinus longipinnis* GÜNTHER, 1864 or the *Micralestes acutidens* already mentioned. But we cannot guarantee these are all correct.

The pictures there of *Barbus holotaenia* BOULENGER, 1904 and *Barbus callipterus* BOULENGER, 1907 seem to represent barb species that were present in abundance in the streams fished. They would confirm the data given by the authors mentioned above.

The photographs in the Aquarium Atlas Vol I suggest that *Chromidotilapia finleyi* TREWAVAS, 1974 might occur in south Cameroon at least in some biotopes, which could also be true of *Chromidotilapia guentheri*.

With the fish mentioned of the family *Mormyridae* it might be a question of the genus *Gnathonemus*, but we cannot give any data on this species.

Knife-fish too, possibly of the genus *Xenomystus* and above all close to the species *Xenostymus nigri*, as well as a specimen with a great resemblance to the genus *Mastacembelus* were found by one of the authors here and there in the streams with members of the "*cameronense*"-group.

Most of the species mentioned in this section are considerably larger than the *Aphyosemion* species, which is why it is more difficult to transport them. When they are caught with killies they are put back into the stream straight away. In any case they do not belong to the species actually being sought. That is why we had no opportunity to import and photograph any of these non-killies. Anyone interested in these fish should therefore refer to the literature quoted.

The always inquisitive and friendly children know many streams with a wide variety of fish. It is very sensible to let them take you to them.

Killifish that Replace the Representatives of the "*cameronense*"-group

In the previous chapter we talked about the killifish which have been found with representatives of the "*cameronense*"-group in the same stream. The fish discussed were of the genera *Epiplatys*, *Episemion*, *Diapteron* as well as the lamp-eyes. These include species with marked differences in body shape as well as dissimilar markings on the fins and flanks. Because of the different requirements for them to thrive, they do not compete directly with the species and phenotypes around *Aphyosemion cameronense*, but they do prefer the same or similar biotopes ("indirect competition").

A characteristic of all members of the "*cameronense*"-group is their occupation of identical or very similar ecological niches. These fish have therefore adapted to certain environmental conditions (temperature, depth of water, food, hiding places, enemy threats, spawning sites and so on), which are not so successfully used by other fish. This principle can be applied to the genera, subgenera and species groups mentioned.

Outside the distribution area of the "*cameronense*"-group, there are in the rainforests of Cameroon, Gabon, Equatorial Guinea and the Republic of Congo countless biotopes with environmental conditions, which would suit the representatives of the "*cameronense*"-group but which are occupied by other *Aphyosemion* species. In these places the corresponding ecological niches were taken by similar subgenera or species groups. This is when we speak of "direct competition". In this chapter we want to say what these killifish are and where as far as we know there are clear distribution frontiers.

The precise knowledge of the situation regarding the distribution frontiers makes possible the conclusion that a huge selection pressure is exerted on the "*cameronense*"-group from outside, which in the final analysis could be an explanation for the extreme variability of the species and phenotypes. Similar observations have also been made covering other subgenera and species groups of the genus *Aphyosemion*. In this chapter we will "circle" the "*cameronense*"-group from Pouma outwards in clockwise fashion and briefly mention the *Aphyosemion* species which in our opinion compete directly with the "*cameronense*"-group. Cases of "indirect competition", according to our definition, are *Aphyosemion loennbergii*, the genus *Diapteron*, the "*herzogi*"-group, the subgenus *Raddaella*, all the *Epiplatys*, *Episemion callipteron* and the lamp-eyes; that is to say, all the killifish dealt with in the previous chapter with the exception of *Aphyosemion punctatum*. This special case will be discussed again in this chapter.

Aphyosemion edeanum. This species was first described by AMIET. To begin with it had been considered by almost all authors to be *Aphyosemion ahli* (some still hold to this today!). In 1974 SCHEEL had established differences in the chromosome counts between the populations east of Edéa (now *Aphyosemion edeanum*) and *Aphyosemion ahli* to the north and west of this town. AMIET fished this area intensively and realised that between Edéa and Pouma as well as south of Edéa a form of the "*calliurum/ahli*"-group occurs with a marked difference in colouration. He then gave this fish the specific name "*edeanum*" (after the town of Edéa).

In the first description (AMIET, 1987, pp 98 to 101 and 223 to 226), the author gives several locations at which he found the type specimens. In 1989 LEGROS, VLIJM and EBERL, with the help of Guy CLAVEAU, managed to visit one of these locations 18 km east of Edéa on the 'Axe lourd' to Yaoundé. From there they brought back some specimens of *Aphyosemion edeanum* "C 89/31" to Europe. In 1991 too, GRELL & EBERL visited this place and brought back fish of both sexes.

A comparison of the females from this locality with females of *Aphyosemion ahli* "Cellucam" (about 30 km distant as the crow flies!) shows definitively that they are two different species, which was confirmed by GRELL's photographs. *Aphyosemion edeanum* is found from Edéa along the 'Axe lourd' to shortly before Pouma, where the most westerly locations of *Aphyosemion amoenum* lie. As a representative of the "*calliurum/ahli*"-group, *Aphyosemion edeanum* prefers the waters of the coastal lowland of Cameroon. *Aphyosemion amoenum*, on the other hand, should in fact, as a member of the "*cameronense*"-group, prefer the inland plateau. However this species managed to leave the plateau and settle in some streams below the "falaise" (French for land-drop). It is interesting that *Aphyosemion loennbergii* was found both with *Aphyosemion edeanum* (AMIET, 1987, several localities; confirmed by various collectors) and with *Aphyosemion amoenum* (page 87)! This is in our view a clear indication that both species replace each other, and are thus in direct competition with each other.

The climate east of the "falaise" gets harsher, and this, together with the rise in the terrain, probably prevents *Aphyosemion edeanum* from advancing eastwards. Thus *Aphyosemion amoenum* was able to leave the plateau. Might it be that *Aphyosemion amoenum* is extending westwards and displacing *Aphyosemion edeanum*?

In our view a deciding factor is the fact that *Aphyosemion edeanum* represents a "small" species. It obviously belongs to the "*calliurum/ahli*"-group, but it can be distinguished from the other species only on close examination (unique markings on the anal fin within the group). In addition the distribution area is very limited (maximum 60 km as the crow flies between the furthest localities, according to AMIET, 1987).

When *APHYOSEMION AMOENUM* is considered, parallels can be drawn: differences in colouration from *Aphyosemion cameronense* (yellow caudal peduncle) as well as a small distribution area (maximum 40 to 50 km diameter).

This similarity could be caused by the following effect: when the species of two species groups meet, the competition in the biotopes would be drastically increased by the distribution at the edge of the species group in question combined with the intensive contact with another species group. This would mean an automatic rise in the selection pressure and encourage the variability of the populations.

Another factor which should be considered is the influence exerted by geological factors such as hydrographic systems and watersheds.

In this connection it would be very interesting to carry out crossing experiments with different pure populations of both species, in order to get information about the variations in the chromosome counts in such small distribution areas.

Map of the Edéa-Pouma region, where *Aphyosemion edeanum* and *Aphyosemion amoenum* meet

***Aphyosemion spec. aff. bualanum* Phenotype G.** AMIET (1987) for the first time defines three phenotypes (1,2 and 3) for the "*cameronense*"-group, in order to point to differing characteristics in colouration. In the same work he also splits the very variable species *Aphyosemion bualanum* AHL, 1924 into phenotypes, which he labels with letters (A, B, C, D, E, F and G).

In January 1982 he found in Ibaïkak a population related to *Aphyosemion bualanum*, which on account of peculiarities in colouration he calls "Phenotype G". He gives the robust body build as well as the very broad red vertical bands on the flanks and the coarse patterning on the unpaired fins as features that distinguish it from all other phenotypes of *Aphyosemion bualanum*.

This village lies in the drainage of the Djouel, a northern tributary of the Sanaga. In this area one finds dense rainforest, which is not usual for *Aphyosemion bualanum* in the true sense (see under *Aphyosemion exiguum*, page 79).

Ibaïkak (Ibaykak) is situated on the road going east from Sakbyémé. Travelling from Edéa to Pouma on the 'Axe lourd', one then turns north in the direction of Ngambé. Immediately after Sakbayémé a bridge crosses the Sanaga. Directly after this bridge a road leads east towards Kahn (Kan). After about 26 kilometres one then reaches Ibaïkak, which lies about 7 kilometres as the crow flies from the northern bank of the Sanaga.

Male *Aphyosemion bualanum* "Ntui" with the distinct vertical markings

Here a female of this very attractively coloured strain

Wild male *Aphyosemion microphtalmum* "PEG 93/20" from Méla

This is a wild female from the same finding place

Although this largest river in Cameroon divides the distribution areas of *Aphyosemion bualanum* (for us in the broader sense, i.e. Amiet's Phenotypes A-G) from the "*cameronense*"-group, the two do come very close geographically. Until 1991 no locality for a member of the "*cameronense*"-group was known north of the Sanaga. Then Grell and Eberl crossed this river at Sakbayémé to get to Ibaïkak. Technical problems with the engine of the hired car forced their return (against their will!) at the village of Ngong Mkak. Only about 6 of the required 26 kilometres to the actual objective of the journey had been covered, but the collectors nevertheless wanted to fish a stream before the return journey to Edéa. The villagers of Ngong Mkak were very friendly and complied with a for them strange request to lead the Europeans to a stream, in which *Aphyosemion amoenum* were swimming ("CGE 91/13"). Thus a representative of the "*cameronense*"-group was found for the first time north of this river.

The short distance between Ngong Mkak (*Aphyosemion amoenum*) and Ibaïkak (*Aphyosemion spec. aff. bualanum* Phenotype G) suggests that at least the populations of the former species occurring north of the Sanaga are placed "under pressure" by those of the latter, as we have already assumed for *Aphyosemion edeanum.*

We can conclude from this that the form related to *Aphyosemion bualanum* discovered by Amiet in Ibaïkak takes over the ecological role of *Aphyosemion amoenum* to the north of where the two species meet.

Further searches along the Sakbayémé-Kahn-Ibaïkak road and northwards towards Ngambé would certainly produce interesting information on this hardly touched region.

The Sakbayémé-Ngambé-Ibaïkak region north of the Sanaga

***Aphyosemion spec. aff. bualanum* Phenotype E.** Under this name Amiet (1987) includes the populations of *Aphyosemion bualanum* which occur to the north and east of Yaoundé. The males have the typical vertical striped pattern on the flanks and have yellow and orange red marginal borders on the dorsal and anal fins (absent in Phenotype G). According to his definition the strains "Ntui" and "Diang" belong to this phenotype, plus all the populations in the vicinity of these towns.

Ntui lies 60 kilometrers north of Yaoundé. There the climate is significantly drier than in the area of the capital. As a result the rainforest is replaced by savanna or dry woods, the typical vegetation for *Aphyosemion bualanum* in the broader sense. The lack of rainforest no longer makes it possible for members of the "*cameronense*"-group to find suitable biotopes. This group is thus replaced by *Aphyosemion spec. aff. bualanum* Phenotype E.

Diang is a small place about 40 kilometres west of Bértoua on the road to Nanga Eboko. Amiet (1987) assumes that there are populations of this phenotype between Ntui and Diang, which link these two. Grell & Kohler (1992) report on two localities between the two places named. During their trip in January 1990 they did in fact find fish of this phenotype ("GKC 90/19" and "GKC 90/20": "large, blue-yellow; broad red stripes; yellow-orange fins"). Amiet's conjectures were confirmed.

Despite the quite different vegetation in the area compared with Yaoundé, it can be said that *Aphyosemion spec. aff. bualanum* Phenotype E takes over the ecological role of *Aphyosemion obscurum*, which occurs only to the west and south-west of Yaoundé. The higher terrain, the lower rainfall and the greater variation between day and night temperatures are probably all factors that prevent members of the "*cameronense*"-group from advancing into the distribution area of this phenotype of *Aphyosemion bualanum*.

As the map on page 115 shows, there are around the capital of Cameroon many good quality roads, so that it would be very easy, with planned fishing, to fill the gaps that still exist between Yaoundé and Ntui. Information is lacking on the *Aphyosemion* that directly adjoin *Aphyosemion obscurum* and on the pressure exerted on it by *Aphyosemion edeanum* and *Aphyosemion spec. aff. bualanum* Phenotype G acting on *Aphyosemion amoenum* in the west.

AMIET (1987) shows a male each of *Aphyosemion cameronense* and *Aphyosemion spec. aff. bualanum* Phenotype E, both of which he caught near Diang in March 1985. But he does not give the precise localities, so we cannot say at present whether these two populations are found sympatrically. The two forms come very close geographically here, which indicates that in the Bértoua and Diang area they mutually replace each other.

***Aphyosemion wildekampi*.** In 1973 this species was described by BERKENKAMP with the type locality "Diang". This seems to be the same Diang near which *Aphyosemion cameronense* and *Aphyosemion spec. aff. bualanum* Phenotype E were found. We have no information on the exact locality.

Further strains are known: the "Bértoua" populations and "GKCAR 90/6" and "GKCAR 90/7". The last two were imported from the rainforest of the Central African Republic by GRELL and KOHLER in 1990.

The basic body colour of the males is greenish with regular red spots, which appear to form three horizontal lines when they are very numerous. The ground colour of the unpaired fins is yellow, and they have marginal red bands.

The females on the other hand are scarcely distinguishable from those of the "*cameronense*"-group.

If one bears in mind that *Aphyosemion cameronense* and *Aphyosemion wildekampi* come very close to each other near Diang, one is struck by many shared features in the colouration of the male and female *Aphyosemion wildekampi* and *Aphyosemion punctatum*. This led AMIET 1987 to place the two species together in the "*wildekampi*"-group.

At locality "GKCAR 90/6" *Aphyosemion exiguum* was also to be found. Its appearance was described by the collectors (GRELL & KOHLER 1992, page 35) as "small, red-yellow; fins pointed, yellow-red". Thus this population of *Aphyosemion exiguum* cannot be separated from those that have been found on numerous collecting trips in the rainforests of south Cameroon together with *Aphyosemion cameronense* and the Phenotypes 3 and 9.

It appears that *Aphyosemion wildekampi* seems to prefer similar biotopes to *Aphyosemion exiguum* and so also to *Aphyosemion cameronense*. This would mean strong competition with the latter species.

All the factors mentioned lead one to believe that *Aphyosemion wildekampi* - very closely related to *Aphyosemion punctatum* - has its centre of distribution in the rainforests of the south-west of the Central African Republic and in the south-east of Cameroon and between Lomié, Ngoila and Yokadouma it replaces *Aphyosemion cameronense* and *Aphyosemion spec. aff. cameronense* Phenotype 3.

The huge area between these places named is not served with roads, so it has not yet been possible to carry out planned searches there. We will have to wait a long time for this to happen.

The results of HUBER's collecting work (1982, page 3) also show that *Aphyosemion wildekampi* replaces the *Aphyosemion cameronense* he found in the north-west of the Congo Republic towards the north-east and east. Localities "RPC 145" (37 km north of Sembé, *Aphyosemion wildekampi*) and "RPC 150" (18 km east of Souanké, *Aphyosemion cameronense*) are about 66 km as the crow flies from each other. This shows that the two species come very close to each other here too.

A comparison of the killies located in this region shows that *Epiplatys neumanni* (HUBER: *Epiplatys spec. aff. sangmelinensis*) has always been caught with *Aphyosemion cameronense*, whereas *Aphyosemion wildekampi* was always found to be the only killie species. This is in contrast to GRELL and KOHLER's experiences in the Central African Republic. Unfortunately it is not possible to compare the colourations of the "RPC" strains of *Aphyosemion wildekampi* with the "GKCAR" strains, as none of the former are kept in the hobby and so are not available.

***Aphyosemion punctatum*.** This species can - as shown earlier - only be distinguished from the "*cameronense*"-group by the colouration of the males, the females being very similar. On pp 87 and 88 we have given a few finding places at which both species occur. On the other hand there are between Ovan and Makokou streams in which only one of the species has been caught. To the east and south-east of Makokou *Aphyosemion cameronense* becomes rarer and rarer, and *Aphyosemion punctatum* seems to replace it completely.

We have already listed some of the localities of this species known at present (that is without *Aphyosemion cameronense*) to the east and south-east of Makokou, during the discussion of this species on pp 87 and 90, so we will not mention any more here.

It might be that both species occupy mainly the same ecological niches and occur together where the optimum conditions prevail. *Aphyosemion punctatum* may advance east and south-east into the distribution area of *Aphyosemion cameronense*, or the latter species may extend in the opposite direction at the expense of the former.

***Aphyosemion lamberti*.** Many locations in Gabon are known for this species of the "*elegans*"-group, especially between Makokou and Okondja. In addition *Aphyosemion lamberti* occurs in the "Région des Abeilles" on the Koulamoutou-Booué road (a strain with this name has been imported). The most northerly finding place seems to be near Achouka, a few kilometres south-west of Booué.

As Booué itself lies right on the northern bank of the Ogooué and Achouka on the southern bank, Gabon's largest river seems to form the frontier between the "*cameronense*"-group and *Aphyosemion lamberti*. But experiences north of the Sanaga in Cameroon teach us that such an obstacle need not be an insurmountable barrier.

HERZOG (pers. comm. 1992) found on the road from Booué to Koumaméyong a population of the "*cameronense*"-group which he called "*Aphyosemion cameronense* yellow". His descriptions of the body colouration as well as the stress made of the yellow colouring indicate that the fish is *Aphyosemion spec. aff. cameronense* Phenotype 5.

There are no precise data available on Herzog's exact finding place. And as fishing attempts between Booué and Koumaméyong by Grell (July 1992) as well as Legros, Cerfontaine & Eberl (July 1993) produced no finding places with killifish, we cannot determine the most southerly location of Phenotype 5 to the Ogooué and therefore to *Aphyosemion lamberti*.

The distance from Achouka to Koumaméyong (locality "LEC 93/2" of Phenotype 5) amounts to about 60 kilometres as the crow flies, but Herzog's locality definitely lies south of Koumaméyong, so that the smallest distance is certainly even smaller.

Near Booué Phenotype 5 and *Aphyosemion lamberti* come very close to each other but are probably separated by the Ogooué

The region west of Booué is not served with roads, so we do not know how far Phenotype 5 has been able to extend to the west or which species replace it.

The area south-west of Lalara (*Aphyosemion cameronense* according to Huber, pers. comm. December 1993) has not yet been very intensively searched. The only findings so far available to us indicate that where the coastal plains begin *Aphyosemion gabunense gabunense* and *Aphyosemion striatum* have been caught. Between the most extreme localities of these species and Lalara there are gaps which are still difficult to fill. On the journey from Ndjolé in the direction of Lalara one travels for a part of the way directly along the Ogooué, where very few streams are to be found in which killies could live. Intensive collecting efforts could produce further divergent phenotypes in the transitional area from the coastal plain to the inland plateau.

***Aphyosemion microphtalmum*.** This species has been known for some time (first description by Lambert & Géry 1967). It has been found in many locations near Libreville and at the transition from the coastal plain to the inland plateau.

Pürzl (1992, page 69) has a colour picture of an adult male which he found together with *Plataplochilus miltotaenia* south of Lambaréné. He calls this species *Aphyosemion escherichi*, thus agreeing with Seegers (1988, pp 17 to 21). In view of inadequate information on these fish, we are keeping the specific name *Aphyosemion microphtalmum* for the time being. But Seegers' arguments are strong, so we do not exclude the possibility of this name being invalid.

Along the light blue flanks there are horizontal rows of very close red spots reminiscent of the impression of parallel lines produced in *Aphyosemion raddai*. The unpaired fins have numerous red dots, which are regularly arranged in the central area of the caudal fin and in the basal regions of the dorsal and anal fins. What is astonishing to observe in this fish is the lack of variations in the body colouration of the males.

In January 1993, Legros, Cerfontaine & Eberl found this species on the road from Libreville airport to Cap Estérias, only about 4 kms from the coast as the crow flies ("LEC 93/28")! In July of the same year, one of the collectors, together with G. Passaro, again found *Aphyosemion microphtalmum* ("PEG 93/20") about 6 km south of Song ("LEC 93/22": Phenotype 6!). The males of both locations were indistinguishable from each other.

Coming across a member of the "*cameronense*"-group and a typical coastal plain species so close to each other shows that the frontier must lie between Méla and Song. Most probably *Aphyosemion microphtalmum* replaces Phenotype 6 on the coastal plain where it begins in the west.

The lack of roads east of Cocobeach means that as yet it has not been possible to investigate the killifish biotopes of this region or to acquire information about the species that occur there. It would certainly be interesting to investigate the relationship between *Aphyosemion striatum* and the representatives of the "*cameronense*"-group.

The little available data on the killies of Equatorial Guinea (Benigno ROMAN, 1971) do not make it possible for precise statements to be made on syntopic species occurring there, nor on the *Aphyosemion* that replace the members of the "*cameronense*"-group on the coastal plain of that country.

A continuation of the ichthyofauna of north-west Gabon and south-west Cameroon into Equatorial Guinea is conceivable. This would result in *Aphyosemion australe* and *Aphyosemion striatum* (*Aphyosemion striatum ogoense* in ROMAN, 1971) as well as *Aphyosemion ahli* and one or several *Chromaphyosemion* species (*Aphyosemion bivittatum* in ROMAN, 1971) occupying the ecological niches of the "*cameronense*"-group. In the future the possibility may arise for someone to visit this country and fill the existing gaps in our knowledge.

***Aphyosemion pascheni pascheni* and *Aphyosemion pascheni festivum*.** AMIET (1987) shows on plate 48 two males of both subspecies and gives a locality of RADDA's 20 km north-east of Kribi in the direction of Bipindi (*Aphyosemion pascheni pascheni*) and one of his own near Nyété, 10 km south-east of Kribi (terra typica of the newly described subspecies). Although both subspecies are close to the "*calliurum/ahli*"-group and occur not far from the coast, they may well have advanced along the Kribi-Bipindi road. East of Bipindi must lie the western distribution frontier of the "*cameronense*"-group. It is therefore conceivable that *Aphyosemion pascheni* and its subspecies occupy the ecological niche of the group mentioned. To clarify this question further collecting work around Bipindi would be required.

***Aphyosemion heinemanni*.** This species was first described by BERKENKAMP in 1983. Subsequently various authors deemed it to be "normal *ahli*", until AMIET (1987, colour plate 53), using colour pictures of specimens he had caught himself at Song Mahi, BERKENKAMP's type locality (!), pointed out distinct differences from other representatives of the "*calliurum/ahli*"-group and stressed the validity of this species.

It seems to be another "small" species of this group. Like *Aphyosemion edeanum* further north, *Aphyosemion heinemanni* occurs at the frontier of this group and is in direct competition with members of the "*cameronense*"-group. Unfortunately there are no live specimens in Europe at the present time. It is simple to separate it from *Aphyosemion ahli*: the caudal is rounded, as has been described under the "*herzogi*"-group as "racket-shaped". The other unpaired fins are strongly rounded and differ in markings from *Aphyosemion ahli*. It is also easily distinguishable from *Aphyosemion edeanum*: the anal fin has a yellow-white marginal and a red sub-marginal band and is unspotted. In the former species this fin has no margin, but on the other hand is heavily spotted red, while the caudal has slight extensions above and below.

Further information on the killifish between Song Mahi (*Aphyosemion heinemanni*) and Eséka (*Aphyosemion cameronense* or even *Aphyosemion amoenum*) is lacking, so a collecting trip in this region would be worth-while. There are a few small roads, but in the past these have not been really passable.

The localities of *Aphyosemion pascheni* and *Aphyosemion heinemanni* in Cameroon, as known at the present time

Within the framework of future collecting trips more information will be acquired on the *Aphyosemion* mentioned in this chapter as well as on their distribution. The list of species that replace the representatives of the "*cameronense*"-group is neither complete nor flawless. It would certainly be worth-while investigating the areas on the distribution frontiers we have described as of particular interest, and above all Equatorial Guinea and the north-west of the Republic of Congo.

Maintenance and Breeding

In the previous chapters we have tried to describe the conditions in the wild in which the representatives of the "*cameronense*"-group can be found. This is essential if one wants to understand how to successfully maintain and then breed these fish in the aquarium. Admittedly many of the environmental conditions are so extreme, that it would be neither desirable nor possible to imitate them. An aquarium with the water readings described in the previous chapters would be very unstable because of the low pH and the lack of buffering effect from the absent carbonate hardness. Moreover it would be impossible to give killifish kept in the aquarium the food they would have in the wild. Even collected ants would only provide sufficient food continuously for six out of twelve months. In this chapter we want to show that experience over recent decades with killies of the most different genera has resulted in our now having at our disposal very good methods of successfully maintaining and breeding these fish. We acknowledge the work done by the many killi-enthusiasts who successfully kept and bred *Aphyosemion* in the sixties and seventies, without knowing, as we do today, the exact circumstances in the countries of origin.

In our opinion it is important to realise that killies can be satisfied with conditions that correspond only partly to those prevailing in the wild.

Among the various factors mentioned in this chapter there are some which are of fundamental importance and really must be provided for the fish. If these factors are provided, the killifish of the "*cameronense*"-group are considerably more hardy and long-lived than widespread prejudice would have us believe.

This chapter is divided into two parts. The first deals just with maintenance and the second - following the first - aims to show different ways of successfully breeding killies.

We would like to stress right at the beginning, that the conditions and methods described in the follwoing pages are based essentially on our own observations. As the subject is living creatures (albeit extremely attractive ones!), they do not function like machines, automatically or to order. Time and again the following situation has been experienced: breeding pairs are passed on from one aquarist to another, with a full description of the successful breeding method; the new owner of the fish tries to copy this method and has only limited success or even none at all. In breeding killifish it is important to realise that, in order to achieve success, one must repeatedly "experiment" within the framework of the given possibilities. It is advisable to first accumulate experience with so-called easier species before trying the species classified as more difficult. Over the years we have obtained young fish and breeding stock from different friends. On almost every occasion we have tried to keep the fish according to the current methods and get them to breed. Sometimes success has come relatively quickly, but on occassions some changes in conditions had to be tried before success was achieved.

Often a change in one factor was sufficient: the water temperature, the pH, the water level, the depth of the tank, the spawning medium, the food or - as already mentioned, we are dealing with living animals - it was just that the two fish were not compatible.

Never give up! Be patient and keep experimenting!

Maintenance in the Aquarium

The tank size. With a maximum size of 55 mm, and with their unique and beautiful colouring, the killies of the "*cameronense*"-group are ideal fish for smaller fresh-water aquaria. Single fish can be kept temporarily in five litre tanks, which are the smallest we use. At the other end of the scale there are obviously no limits. *Aphyosemion* can be kept in tanks of several hundred litres capacity.

But it should be borne in mind that by nature these fish are not keen swimmers. In over large tanks they can easily be overlooked, or at least they do not do themselves justice, as they do in smaller aquaria.

We find it impossible to give a rule of thumb in the form "x fish at y cm long to z litres of water". The aggressiveness, which is an important factor when calculating the number of fish per tank, depends on several factors, whose interrelationship is not known to us: the water quality, the species, adequate food, the age, the individual's disposition, the tank size, the set-up, and, of course, all these factors together.

Our advice for the optimum number of fish in an aquarium is to have as few *Aphyosemion* swimming in a tank as is possible.

The large number of photographs of killifish set-ups in the following pages show that in principle several aquaria of smaller size are necessary, in order to separate the various species and strains, as well as the sexes (prior to breeding).

Should anyone wish to just maintain killifish of the "*cameronense*"-group or just *Aphyosemion* in general, a start can be made with a 50 to 100 litre tank and about 10 pairs. Then if breeding is undertaken, additional small rearing tanks of 10 to 20 or 30 litres will be needed.

The number of fish. Basically, the larger the tank, the greater the number of fish that can be kept in it. As male *Aphyosemion*, including those of the "*cameronense*"-group, are naturally inclined to form territories, aggression can take place between the larger males and also the subordinate males. In tanks of about 30 litres a maximum of three males should be kept with five or six females. There are exceptions to this rule, so that in favourable conditions rather more fish can be kept together.

As soon as males or females are found to have torn fins or bites on the body, these subordinate specimens should be taken out. In some circumstances a reduction of the tank population is required, until no further aggression occurs.

Sometimes it is enough to remove particularly aggressive fish, for peace in the aquarium to be restored.

Experienced killifish breeders regularly check the conditions of their fish. Then if problems occur, they can deal with them accordingly. These regular checks should become a habit. In this way losses will be prevented.

Above: A medium-sized planted aquarium for adult *Aphyosemion* and over it several small tanks for fry, in Maurice CHAUCHE's flat. Below: Some more tanks of the same breeder

This is the main part of Maurice CHAUCHE's killifish set-up in his flat. The tanks are lit and planted. Above the set-up is a shelf where he keeps aquarium aids etc.

The escape-proof cover on the aquarium. Probably everyone who has started keeping killies has sooner or later suffered losses from fish jumping out of their tank. This phenomenon is rarely seen in other aquarium fishes such as live-bearing toothcarps, characins, cichlids and labyrinth fish. But all the killifish of the genera *Aphyosemion*, *Diapteron*, *Epiplatys* and *Rivulus* are liable to jump out of their tanks. For reasons not properly understood, these killies find those gaps in the cover, through which they can squeeze themselves.

The likelihood is that the killifish try to escape by jumping, when they are threatened by dominant members of the same species or chased by predators. In the special conditions in the aquarium this fleeing reaction could be more necessary than in their native streams. In most cases they jump against the sides of the aquarium and fall back into the water. It may be that only those fish end up outside the tank that by chance jump through a small gap. It may also be that they deliberately try to jump out of the tank by aiming for any gap present.

To prevent unpleasant losses of this kind, we recommend that the tank-cover fit the aquarium, and that the larger gaps be filled with nylon wool or small pieces of glass. A gap in the tank-cover is useful when feeding fish that are not prone to jump, but with the killifish mentioned, such a gap can lead to insidious losses.

"Thermetically sealed" covers are found on the tanks of most killie enthusiasts, and these have been shown to prevent losses of fishes caused by jumping out. It is simply a prerequisite for the successful (and above all long-term) maintenance of these fish.

Plants. As we have already shown, the representatives of the "*cameronense*"-group live in small streams in the rainforest of Central Africa. Only in rare cases have aquatic plants been found in them. So it can be inferred that a planted tank is of minor importance for our killies.

There are some killifish breeders who keep their fish in tanks with no plants at all, whereas others have lighting and keep a wide variety of aquatic plants. Both groups of aquarists enjoy success with their methods, so it is purely a matter of choice, and can be decided according to one's preferences, possibilities and aesthetic viewpoint.

So if aquarium lighting is not possible, or if there is a problem with the expense, plants can be omitted altogether. Other forms of hiding places will have to be provided, though.

On the other hand there is nothing against furnishing a killifish tank with aquatic plants which will thrive in the conditions provided (amount of light, water readings, temperature). Geographical criteria might be applied and only plants from Africa used.

Most killie keepers use plants that do not demand excessive lighting. Especially suitable in this context are Java moss *Vesicularia dubyiana*, Java fern *Microsorium pteropus* and small forms of *Anubias.* These plants also grow well when lit by a simple fluorescent tube, as can be seen from the pictures on pp 124 and 125. If the choice of plants is to be geographically correct, just *Anubias* would be used. But tanks can be made very attractive with the other plants mentioned.

Tanks with more powerful lighting can be planted with the hornwort *Ceratophyllum demersum*, ferns of the genus *Ceratopteris* as well as other floating plants such as *Pistia stratiotes*. These and other available species provide a wide selection.

Some people have tanks with a layer of floating plants, below which the plants requiring less light do particularly well. In aquaria furnished in this way the fish can hide and spawn in the Java moss, making it possible for individual fry to appear in the tank.

Lighting. It must be said that in principle killifish can be kept in very poorly lit tanks, if plants are to be left out. As already mentioned, though, killifish tanks are often lit with one or two fluorescent tubes. This method has become popular with many aquarists, as these tubes provide a good quality of light with a relatively small output of heat. Moreover, tubes are better for lighting shallow tanks than the spot-lights supplied by the trade, which are meant principally for taller tanks.

The fish are not affected by the colour of the tubes used, so a choice of tube can be made on purely aesthetic grounds.

Aphyosemion come from tropical countries near the Equator, where the length of day hardly varies during the course of the year. The ideal lighting time ought therefore to be 12 hours a day. We have not been made aware of any experimental evidence that shows that longer or varying lighting times affect the well-being of *Aphyosemion.* On the whole one would not expect any problems with 10 to 14 hours of lighting a day.

The tank-bottom. The pictures of the biotopes in the earlier chapters have shown that the composition of the stream-bottom can be very varied. Accordingly one cannot say that there is any one ideal material for the bottom of aquaria.

One regularly comes across aquaria provided with the traditional aquarium gravel and aquatic plants. The *Aphyosemion* feel perfectly at home here. Many killie enthusiasts provide the tanks with a layer of strained and boiled peat. Of course the peat must have no added fertilisers.

To make the appearance of the tank more attractive, peat fibre or brown leaves can be used at the same time. Brown leaves come probably closest to the stream-bottoms in the wild. If, for example, beech or oak leaves are used, an eye has to be kept on the pH. In addition, nitrites can be produced in the aquarium as the leaves decompose.

In larger set-ups, aquaria are to be found with nothing on the tank-bottoms. This means that uneaten food and the fishes' waste products can be simply and effectively syphoned out. If the aim is to breed a larger number of progeny, this "bare" tank set-up is the most effective, even if it is not aesthetically the most pleasing. It is for every hobbyist to decide how best to furnish his tanks.

Hiding-places. We have referred several times to the territorial and aggressive nature of *Aphyosemion*. This makes the provision of hiding-places essential, so that females not ready to spawn and weaker males can seek refuge from the pursuing males.

To this end aquatic plants, leaves, bog-wood, peat fibre and nylon mops can of course be used. The two last mentioned materials are also popular with the fish for spawning in, and this will be dealt with in the second part of this chapter.

Very often killifish tanks have a two to three centimetre layer of peat or peat fibre on the bottom. The advantage of this is that the fish can follow their natural instincts and hide in the material at the bottom of the tank. In addition the dark brown colouring of the bottom gives the fish a feeling of security; they are less timid and can be observed more easily. And finally, the wonderful colours of the males stand out more brightly than with a pale tank bottom. A distinct disadvantage of this kind of tank-bottom is that uneaten food can sink into it, decompose and then release nitrites.

The use of sand or aquarium gravel has the advantage that the bottom of the tank can be easily syphoned and the uneaten food removed. In this case, as mentioned earlier, an adequate supply of hiding places should be provided.

Hervé GONIN from Paris lights his tanks with a neutral white tube and gets superb plant growth

Jean-Paul Cicéron uses tubes with a blue or red cast, which also produce good plant growth

The water temperature. The numerous readings reported by various collectors from the forest streams in Cameroon and Gabon lie between 19 and 24°C. So these temperatures can be considered to be appropriate for keeping the killifish of the "*cameronense*"-group.

Basically metabolism is accelerated with a rise in water temperature (and with it the body temperature of the fish). This means that with sufficient feeding the fish will grow faster. At the same time the average life expectancy will be reduced. This can be shown especially with the annual fish of the genus *Nothobranchius* and with the semi-annual killifish of the genus *Aphyosemion*, which are listed at the bottom of page 77.

We can also apply this principle fo the members of the "*cameronense*"-group, but the different way of life means that less extreme lengthening and shortening of life expectancy can be shown.

If the young *Aphyosemion* are to grow quickly, they should be kept at temperatures around 23 to 24°C. Later such high temperatures are no longer necessary. A range of 19 to 21°C increases life expectancy and also appears to encourage a willingness to spawn.

Often aquaria are kept within a small and constant temperature range. This does not correspond to the conditions in the wild, as during the course of a day and with the change between rainy and dry seasons, the water temperatures are subject to not inconsiderable variations. Healthy killifish do not suffer at all, if a water change causes the temperature to drop two or three degrees. Many killifish breeders deliberately lower the water temperature in order to encourage breeding pairs to spawn. This effect is very easy to arrive at, as is shown in the following section.

Regular water changes. The representatives of the "*cameronense*"-group live in small flowing bodies of water, so they are constantly surrounded by fresh water. This means that for the correct maintenance in the aquarium we must ensure that the waste products are removed regularly. The simplest method is obviously a water change, in which a part of the contents of the tank is replaced with fresh water.

There is no hard and fast rule for the frequency and proportion of the water to be replaced. To obtain the right figures, the following factors must be borne in mind:

- What is the actual volume of the tank?
- How many fish are in it?
- Are they young fish, which have a higher metabolic rate (they are growing!) than adult fish?
- Are the fish fed often and heavily?
- Does the tank have aquatic plants, which will remove a part of the harmful materials from the tank?
- Are dead pieces of plant left in the tank to contribute to the organic load of the water?
- Are particles of food left after feeding, to further burden the water?
- How high is the nitrate content of the water supply? Is pure tap water used or is it passed through an ion exchanger or a reverse osmosis unit?

When and how much of the contents of the tank should be replaced depends on the total amount of waste products and the extent to which they are broken down by bacteria and plants. It is advisable to choose a specific day of the week for water changes and to ascertain the proportion over a period of time (e.g. a quarter of the contents of a tank once a week). If fish stop growing or show signs of ill health, water changes should be intensified. In this event it is more sensible to increase the frequency and to leave the proportion the same or even reduce it.

Let us compare in an abstract way of thinking the maintenance of *Aphyosemion* in the aquarium with the conditions in the wild. The presence of individual fish or small groups in pools on the bank of a stream should be disregarded as being isolated occurrences in the native waters. In the aquarium the fish swim in a tank with a constant volume of water. The fishes' poisonous waste products are converted and broken down by various bacteria in a series of processes, so that less poisonous substances are produced. These "end products" of the food chain may be absorbed by aquatic plants.

As a rule there are not enough plants to break down all the waste products. Or, as often happens, there are no plants in the aquarium. As a result, the concentration of waste products grows constantly. The rate of the rise in concentration increases with the number of fish, their size and conversion of food. On the other hand, this rate becomes less if a large number of plants are growing in the tank, taking up the waste products of a few fish.

Killifish tolerate certain concentrations of broken down substances without suffering any harm. This is a result of their natural adaptability to changing environmental conditions. However, when a higher concentration is reached, there is an effect on the fishes' willingness to take food and also on their fertility. Moreover the fish become more susceptible to diseases and parasites.

Depending on how polluted the water used is, sooner or later the danger limit will be reached. But in every case it is just a question of time.

One solution to the problem would be a densely planted aquarium together with a reduction in the number of fish (a reduction in food and thus the fishes' waste products would hardly meet with the fishes' approval!). This situation is very difficult to achieve. Moreover it would probably not be a very satisfying way of keeping killies for the hobbyist. There has to be another way out of the situation described.

In the wild the rainforest streams have very few aquatic plants, so they are of little help in breaking down the waste products, which are, in fact, simply washed away by the constantly flowing water. In addition, the proportion of the bio-mass of the fish to the surrounding body of water is much smaller than in the aquarium.

On the one hand the water in the streams is subject to continual variations in temperature and chemical composition, even if the latter can hardly be measured satisfactorily by the methods used in the hobby. On the other hand, the water contains only low concentrations of waste products, as the streams are very sparsely populated with fish.

So the most effective way of carrying out water changes would be to constantly allow a small part of the water to flow away and at the same time to replace it with fresh clean water. An aquarium with an overflow system could be used, so that the water level was always kept the same.

However this would involve high energy and water costs. So it is for the hobbyist to find the water change system most appropriate for his situation. "Often and little" is better than "rarely and a lot": a frequent exchange of small quantities of water suits the fish better and corresponds more to the conditions in nature than does an almost complete water change at infrequent intervals.

If for example tap water is used, it can never be guaranteed that over the weeks and months the water will always be of the same chemical compositions and constantly low (or high?) organic content. In the case of significant variations the fish would suffer more stress from a change of a high proportion of the water than from a change of a small proportion.

Moreover with a water change of say only 10 percent, we can happily do without prewarming the fresh water, if it is introduced into the tank at a slow and even rate.

The resulting water temperatures can be calculated as follows:

$$T_3 = \frac{V_1 \text{ x } T_1 + V_2 \text{ x } T_2}{V_1 + V_2}$$

When

- V_1 is the contents of the tank in litres after water has been taken out, in other words the amount remaining in the tank.
- T_1 is the temperature of the water in Celsius, taken in the aquarium before the water change.
- V_2 is the volume of water in litres which was removed from the aquarium and is to be replaced by fresh water (both quantities of water are the same, as normally the new water level should be the same as the old one).
- T_2 is the temperature of the fresh water.
- T_3 is the resulting temperature in the aquarium after the addition of the cold water.

The drop in temperature to be expected with a 10 percent water change using water at 15°C (T_2) in a tank of 100 litre capacity (V_1 = 90 ltr, hence V_2 = 10 ltr) and water at 24°C will amount to 0.9°C. The water will therefore be cooled to 23.1°C (= T_3). Even with a change of 20 litres (= 20 percent of the tank contents), again using water at 15°C the temperature in the tank drops only to 22.2°C

If the fresh water is introduced into the aquarium with a little care, this minimal drop in temperature will only take place slowly and should not harm the fish.

We can point out that similar or even greater changes in temperature occur very often in the biotopes of *Aphyosemion*.

View from the only hotel in Booué over the Ogooué to the south. On the other side of Gabon's largest river begins the distribution area of the fish shown below, which is a representative of the "*Aphyosemion elegans*" group (see pp 117 and 118)

Adult male *Aphyosemion lamberti*

Water chemistry in the aquarium. The comprehensive water readings made by many collectors in different areas of south Cameroon and north Gabon have shown that the streams always contain water whose composition remains constant within a certain parameter (pp 66 and 67). In general we can talk of "slightly acid water with scarcely any measurable hardness".

If one were to set up an aquarium with water having the same chemical composition as in the native biotopes of *Aphyosemion*, the resulting system would be very unstable. The carbonate (temporary) hardness of below 1° does not allow adequate buffering of the water. If acidity was produced (from peat, leaves, decomposition processes), the already sligthly acid pH value (6.5 to 6.9) would quickly drop to 6.0 or even to as low as 5.5.

Admittedly some water readings from the north of Gabon ("Essong" and 16.5 km west Médouneu) show that *Aphyosemion* of the "*cameronense*"-group can live at pH readings of around 5.7, but these isolated cases are exceptions. Probably this low pH arose through particular local or temporary conditions over a length of time, so that the fish were able to get used to it. But we cannot say if the *Aphyosemion* in these biotopes can keep going over a long period of time or if they are then able or willing to breed.

The same is also true for the streams with an alkaline pH (outskirts of Assok, pH 8.0).

Of basic importance for fish-keeping is the fact that, in the aquarium, variations in pH can occur much faster and more drastically than in the wild. This is due to the small quantity of water in the tanks and the comparativly large number of fish. Following the observations in the wild, it should be possible to acclimatise *Aphyosemion* to water of low or high pH. But we should certainly avoid a dramatic drop in pH caused by an extremely low carbonate hardness (1 to 3°).

In practice this means that it is possible to keep representatives of the "*cameronense*"-group in water with a carbonate hardness of 10 to 15° without any problems. The resulting hydrogen carbonates (HCO_3^-) present in the aquarium water produce an adequate buffering of the pH, since acidity formed in or added to the tank is removed through the formation of carbonic acid (and consequent release of the gas carbon dioxide).

As for the rise in carbonate hardness, it becomes increasingly difficult to influence the pH, but for the aquarist slightly acid water is good enough. This can be achieved by the addition of peat or peat fibres. For many years one of the authors has kept numerous strains of the "*cameronense*"-group at pH 6.5. This pH together with a carbonate hardness of about 10° has proved to be pretty well "ideal" both for wild caught fish and for subsequent tank bred generations.

Of course the carbonate hardness and also the pH affect the conductivity of the water, which we saw on page 57 has very low readings in the biotopes. Nevertheless wild caught fish of representatives of the "*cameronense*"-group show no visible negative reaction to higher conductivity readings, as occur in the use of tap water of medium hardness.

The total hardness - a measurement of the amount of calcium and magnesium ions in the water - is of less importance for the keeping of members of the "*cameronense*"-group in the aquarium. Admittedly it causes a rise in the electrical conductivity of the aquarium water, but to our knowledge a high dGH reading of a maximum 24 to 30° (measured with the commercially available test kits) has not had any harmful effects on the well-being of *Aphyosemion*.

With the decomposition of organic material, such as uneaten food or dead parts of plants, nitrogen compounds are released when the different bacteria break down this material. Oxygen is used to produce nitrite (NO_2^-), which is poisonous for fish, and also the less poisonous nitrate (NO_3^-).

For the nitrite to break down there must be a minimum quantity of oxygen in the water. This can be guaranteed by adequate water movement (aeration or filtration). With efficient filtration (see the following section), nitrite will very rarely cause serious problems.

In certain circumstances the nitrates created are broken down by a few species of bacteria and absorbed by aquatic plants, but only to a limited extent. As a rule these conditions occur only seldom in the aquarium, so that with time the nitrate accumulates in the water. This rise in the nitrate content follows slowly and steadily, so that the fish can adapt to it. But a fatally high level can be reached. Also, our own experience in keeping killies tells us that a consistently high nitrate content decreases fertility as well as the growth rate of fishes.

In addition a high nitrate content can check plant growth and lead to the spread of ugly algae.

The best way to remove this end-product of the fishes' metabolism - as already mentioned - is to carry out regular water changes (pp 130 to 133).

One of the products of the fishes' metabolism released into the water is a substance which in acid water (pH below 7.0) is present as ammonium ions (NH_4^+). Ammonium itself is, relatively speaking, only mildly toxic to fish, but in alkaline water (pH above 7.0) it risks turning into the very poisonous gas ammonia (NH_3). This process takes place very quickly and only needs the prerequisite of alkaline water, as mentioned above. Ammonia is very soluble in water, which is why even with heavy aeration it remains in sufficient concentration to cause the death of fish.

Here too we can see the reason for buffering the aquarium water with a carbonate hardness of about 10°. If the pH threatens to go above the neutral value of 7.0, the carbon dioxide (CO_2) released in the water reacts with the alkali (opposite of acid, so raising the pH) which has arisen or been added. Hydrogen carbonates (HCO_3^-) are formed, and the conversion of the ammonium into poisonous ammonia is prevented.

A high ammonium content can be obviated by a reasonably small number of fish in the tank, moderate or rather correct feeding, a good filtration system and also regular water changes.

There is more than enough literature that explains how ion exchangers or reverse osmosis can be used to reduce carbonate hardness, total hardness, the nitrate content or the total salt content. The interested reader is recommended to consult these sources and find out in detail about the best method in use at the time.

We here intend to describe briefly how tap water and treated water can be mixed to arrive at determined water values. For this we can refer back to the equation on page 132 and simply replace the water temperatures by degrees of hardness. We can create a total hardness required as well as a carbonate hardness. Here are the relevant definitions:

- V_1 is the amount of water in litres, for example the available water from the mains.
- H_1 is the total hardness (or carbonate hardness) of this water in degrees, which we have earlier found using a test kit.
- V_2 is the volume of the treated water in litres, which we have brought down to a total hardness (or carbonate hardness) of 0° dGH (0° KH) or down to any other value.
- H_2 is the hardness of the treated water, provided it has not dropped quite to 0°.
- H_3 is the resulting hardness of the mixed water after the mixing together of both masses of water.
- V_3 is the sum of both masses of water in litres ($V_3 = V_1 + V_2$).

We then get the following equation:

$$H_3 = \frac{V_1 \text{ x } H_1 + V_2 \text{ x } H_2}{V_1 + V_2}$$

By conversion we get equations for the values V_1, V_2, H_1 or H_2:

$$V_1 = \frac{V_3 \text{ x } H_3 - V_2 \text{ x } H_2}{H_1} \qquad V_2 = \frac{V_3 \text{ x } H_3 - V_1 \text{ x } H_1}{H_2}$$

$$H_1 = \frac{V_3 \text{ x } H_3 - V_2 \text{ x } H_2}{V_1} \qquad H_2 = \frac{V_3 \text{ x } H_3 - V_1 \text{ x } H_1}{H_2}$$

Such equations cannot be used for calculating the pH and electrical conductivity, as these are produced by the interplay of many factors. Moreover only a few of the relevant water qualities are measurable using the methods normally found in the hobby.

It is advisable, after mixing the supply water with the treated water, to aerate well and wait for at least a day for the final pH value to settle. If the mixed water is added too quickly, losses of sensitive fish through pH variations cannot be ruled out. Caution is of the essence.

Epiphytic ferns are often found in the rainforest. Some grow at head height, others higher up in the trees,...

...but sometimes immediately above the water surfacce on old branches. Might this fern be flooded by rising water in the rainy season?

Filtration. As was shown during the discussion of the ammonium, nitrite and nitrate content of aquaria, the good working order of an efficient biological filter is at least as important (if not more so) than the adherence to certain water values. This is why we have devoted a whole section to the subject of "filtration".

Filtration of a fresh-water aquarium can be divided into three types. For us aquarists the most easily recognisable form of filtration can be called "mechanical filtration". In this, water is passed through a filter material, so that for the human onlooker visible particles of dirt and matter which encourages cloudiness are held back. The particles found in the water should adhere to the filter material. The water stays clear and the aquarium looks visually very attractive. The individual aquarist will decide how much importance he or she places on the effect produced on the viewer. For the fish, however, it is - up to a certain limit - of little importance whether the water is clear or cloudy. This is demonstrated by the many fish which in Europe and also in all other parts of the world live in waters that are cloudy at times. Finally we must not foget that the *Aphyosemion* of the "*cameronense*"-group live in small forest streams, whose water can become very cloudy as a result of the heavy downpours in the rainy seasons. The degree of efficiency of a mechanical filter depends on the amount of water flowing through it, the actual mass of the filter, how fine it is and the nature of the surface.

The second way a filter works can be described as chemical filtration. The important feature of this method is that dissolved materials are removed from the water and bound to the filter material. In the fish-keeping hobby activated charcoal is often used, as it has a particularly large active surface. It is especially suitable for binding poisonous substances and medicaments. This material is to be recommended above all when substances need removing after treatment with medicaments or in the event of poisoning. But being responsible killifish lovers we carry out regular water changes, so these substances are automatically removed from the aquarium water. Thus the use of an expensive filter material like activated charcoal is unnecessary.

The third type of filter is probably the one of greatest importance: biological filtration. This work is actually taken over by bacteria, which must, however, be provided with a suitable habitat in the aquarium. In the wild the bacteria most probably live in the stream bottom, where they extract from the passing water certain substances for nourishment (nitrite) and subsequently release other substances (nitrate). These creatures are so useful to us (and the fish!). They need a firm substrate on which they can settle and over which the water flows. Of use here are in general all aquarium objects such the aquarium glass, stones, bog-wood roots, tank bottom and equipment in the tank. But the large number of fish in an aquarium calls for a filter in which many bacteria can settle in a small space and break down the harmful products of metabolism. That is why we must see to it that we choose a filter material that will allow the maximum number of bacteria to feed in the filter. For this purpose materials such as filter wool, clay pipes or gravel of different grades and surface structure can be used. All the same it is very difficult to assess the effectiveness of a filter material objectively and to compare it with others.

Over the years one filter material used for biological filtration has become especially popular, partly because of its low price: pumice stone. This is sold in aquarium shops in different quantities and sizes, so a wide selection is available. We can cater for large external filters for aquaria with several hundred litres (cichlid tanks) and also for internal filters in small aquaria for killies. Because of its porous structure, pumice stone offers optimum prerequisites for biological filtration. The bacteria can settle in it, where they find ideal conditions (speed of the water passing through, oxygen content etc). In additions this filter material can be cleaned easily and re-used many times - virtually indefinitely.

However we must see to it that if possible the pumice stone does not get dirty while the filter is in use, as the conditions for the bacteria will no longer be ideal. So it is advisable to use a fine filter material as a pre-filter. Filter wool, for example, holds back the dirt and shows the degree of dirtiness as a result of its more or less white colouring. The wool must therefore be regularly cleaned or, after being used several times, be replaced.

Even when the filter wool of the pre-filter is replaced by unused (and previously thoroughly rinsed) wool, thus removing completely the bacteria in this material, there are still enough bacteria in the pumice stone to break down the waste products and avoid instances of poisoning among the fish.

When the biologically active filter material is cleaned, one should never exchange or clean the whole filter mass. Filter material sterilised with hot water is biologically dead and is for the tank inhabitants a risk not to be taken lightly. A thoroughly cleaned filter lacks bacteria and cannot break down the constantly accumulating waste products.

The simplest solution to the problem is the use of a fragment of the old filter material. This will have on it countless bacteria. When the cleaned filter starts working again, the bacteria will multiply very fast and spread throughout the filter, when the "old" filter material containing bacteria is placed in the first part of the filter. The incoming water automatically distributes the bacteria to the still unoccupied material, where they cling and multiply rapidly thanks to the adequate supply of food (the fish are still being fed and producing excreta).

Another excellent material, especially for small and very small internal filters, is bacteria resistant sponge. This is supplied by the trade mostly in connection with air powered filters. For this purpose the trade supplies a large range of internal filters, from which one chooses the filter type best suited to one's own needs.

As internal filters for small aquaria can be made at home at low cost, the killifish keeper with an interest in D.I.Y. has virtually limitless possibilities.

The pictures on the following pages show some of the possible ways of filtering small aquaria, with many of the filters being made at home.

The parts of the filter mentioned on pp 142 and 143

This is how this filter looks when ready to use

An internal filter consisting of a triangular piece of sponge (Page 144 above)

This is how this filter looks when assembled

What kind of filter should be chosen for an aquarium depends on the following considerations:

- -Is the tank small enough for an air powered internal filter to be adequate, or does the tank need a motor powered filter?
- -How many fish are there in the tank? Are they adult or young fish (food conversion)?
- -Is a good proportion of the water often replaced with fresh water?
- -Can the necessary water changes be carried out regularly?
- -Does the tank contain flourishing plants which will break down a part of the waste products?
- -Does the aquarist aim to use home-made internal filters?
- -Are there in the foreground decorative features that require a more efficient filtering technique (hiding of "disturbing" features by such decorative material)?

Finally experience will show if a filter type suits a particular aquarium. So we recommend experimenting a bit with the filter technique, in order to test a certain principle over a period. Then, if need be, it can be improved or - in the case of failure - even thrown away. With a bit of imagination a few tricks can be tried to get a first rate filter which is of a form not available in the trade, but which is tailor made for the special needs of the killie keeper and his fish.

This is true for how the filter is powered, as well as its shape, size, construction, the set-up in the tank itself and the filter material used.

A very efficient and also convenient filter, which is easy to clean, can easily be made by the hobbyist. Holes are bored round the top of a plastic funnel, which is placed upside down in a plastic container. Then the filter material is added. The drawing below shows how the individual components of this filter work.

All the necessary parts consist of non-toxic plastic (suitable for use with foodstuffs) and can be bought from any hardware shop. When filled with pumice stone the filter becomes heavier and remains stable on the tank bottom. A pump is used to pump air into the funnel through commercially available silicon tubing. The air then goes up the stem of the funnel, drawing water with it.

Because of the resulting lift, water flows through the holes in the bottom of the funnel, drawing it through the pumice stone and the filter wool.

Admittedly water does flow through the filter materials in reverse order, but the pumice stone compresses the wool and so improves the efficiency of its mechanical filtration.

The pumice stone does get dirty as quickly as the wool, but the cleaning of the filter material presents no problems. The whole filter is taken from the aquarium and some tank water syphoned off into a bucket. Then all the contents of the plastic container are put in the bucket and the wool and pumice stone washed out in aquarium water. The filter bacteria are not killed, as approximately the same temperature and obviously the same chemical conditions (pH, hardness, conductivity) prevail.

When the filter material has been rinsed, the filter is reassembled and restarted as usual, so that the bacteria can continue their work.

A simple but efficient internal filter can also be made from a simple preserving jar, a piece of foam and a plastic pipe. The foam should be resistant to bacteria, otherwise it will disintegrate in time.

With this type of filter the water is again moved by rising air bubbles, so that the resulting surface movement provides the gas exchange and the supply of oxygen for fish and bacteria.

The construction and working are explained by the following drawing.

Anyone able to use a glass-cutter and silicon cartridge has further possibilities of making internal filters for his aquaria.

For example, a small piece of glass can be stuck on the bottom glass in one of the rear corners, to form a small triangle. A piece of foam is cut to fit this triangle and supplied with a plastic pipe and placed into the triangle. The air pumped into the tube from the air-line causes the current which sucks the water through the foam. The principle is shown in the following drawing:

More complex is gluing together a complete internal filter with several pieces of glass. In constructing this filter, one must bear in mind that the water has to flow through several filter chambers, in which different filter materials may be placed. This type of filter is recommended for tanks of over 50 litres. One should remember that the filter material has to be taken out of the chambers for cleaning, which is why the chambers must not be too narrow. Here again there is a drawing to explain how this filter works.

The air-pump used in the previous drawing is sold in aquarium shops and consists of two plastic tubes placed one inside the other. In the hollow space between the two tubes air is forced down. It then rises in the inner tube and draws up the water with it. At the upper end of both tubes there is an attachment at right angles, so that the water can flow out horizontally.

Equipment of this kind can easily be made by the aquarist. One buys transparent green plastic tubing of 9 millimetre external diameter from the aquarium shop. The shop will also supply corner pieces to fit onto this tubing. A piece of the plastic tubing is cut to the right size, and then a hole is carefully drilled at the lower end, so that an air tube can be fitted into it. If this tube fits tightly, there is no need to use glue, which might later lead to incidents of poisoning.

If required we can insert a corner piece to allow the water to flow out to the side at the water surface. For the filter types in which the water is meant to escape upwards (pp 142 and 143 and page 144 above), a corner piece is not used, as the air is required to rise as easily as possible.

The filter types shown here are just a fraction of the possibilities an aquarist keen on experimenting could use. Maybe the reader can develop even simpler and better designs for air powered internal filters.

In addition aquarium shops have a wide range of internal filters which can be used for filtering small and medium sized tanks.

When installing a filter in a killifish tank one should bear in mind that the species of the genus *Aphyosemion* in particular need clean water, but they do not look for the open current. So the water movement should not be too strong.

Phenotype 8 Location "LEC 93/14", 14 km west Mitzic at the road to Sam

Aeration. In an aquarium with filtration aeration is hardly necessary, as the water movement always allows enough oxygen to enter the water. For tanks without filtration we recommend the use of a gently working airstone, to ensure an even but not too strong movement of the water. As most killifish set-ups are equipped with air powered internal filters, we will explain briefly how several air powered pieces of equipment in such a set-up can be driven with one pump.

A prerequisite for this is an air pump of the best quality with a minimum capacity of 220 litres per hour. Since the air is usually introduced into the aquaria in relatively thin silicon tubing, the pump has to work constantly against a high resistance, which leads firstly to increased wear and secondly to less efficiency. But if the air is led directly into a compression chamber with a volume of several litres, the pump only works against the relatively slight pressure which is present there. As the air is led from the compression chamber into the air tubing leading from it, the pressure necessary for aeration or driving the internal filter builds up again due to the small diameter of the silicon tube.

The shape of the compression chamber is immaterial, which is why many killifish keepers have built their own air-line system, which allows the output of an air pump to be used to best effect. The following drawing shows in diagram form how such an air-line system can be put together. It should be noted that the air pump is placed high up in the tank set-up, so that it cannot come into contact with water from the aquaria, which might then get into the air-line system. This could definitely be a possibility in the event of a power-cut!

The plastic tubing that can be used for this purpose is available in several finishes at reasonable prices at a builder's merchant's and is very easy to work with.

Sticking together the tubing follows, using a suitable glue. When it has hardened, one must be aware that the fumes released may still be inside the tubing and - when introduced into an aquarium - could cause incidents of poisoning. Therefore it is necessary, before operating the air-line system, to pump air through it for a few days in order to expel these gases.

In order to increase the volume of the air-line system (and to reduce the air pressure to be kept up by the pump), a tall main tube with a diameter of 5 cm was chosen for the example on page 146. For each row of the set-up, a tube 2.5 cm in diameter leads from it at right angles. These tubes have outlets for the silicon connectors drilled at the appropriate points, so that the air is led into the tanks at the desired place. Aquarium shops sell these plastic connectors, whose external diameter corresponds exactly to the internal diameter of the silicon tubing. With the glue mentioned above we stick these connectors into each hole. When the glue has hardened, we can attach pieces of tubing of suitable length.

For future alterations to the aquarium set-up we make additional connecting points. Whilst these are not being used, we simply lead a silicon tube from one connecting point not in use to another. This way we can save on the use of tube clamps.

After the final hardening and airing of the points glued, we check the air-line system for leaks, so that they can be made water-tight with glue. When the system is finally switched on, the tube clamps have to be adjusted, so that the desired amount of air enters each tank. Obviously this process takes longer the more tanks there are, but in the end one gets a maintenance free aeration system, which will provide an ample supply of air to both air powered internal filters and air-stones.

It is just the air pump that needs to be regularly checked according to the maker's instructions and serviced when necessary.

Feeding. On pp 74 and 75 we tried to clarify what is eaten in the wild by the killifish we are dealing with. Despite inadequate observations and reports from the rainforest streams, feeding these fish successfully in the aquarium does not present insurmountable problems.

In general it must be said that completely different methods must be used compared with the maintenance of the majority of our aquarium fish. Whereas very many fish kept in fresh-water aquaria can be fed "artificial food", it must be said that this food will lead to poor results with killifish, including representatives of the "*cameronense*"-group.

By artificial food we mean dried food, which can be bought in aquarium shops in the form of tablets, flakes, pellets or granules. If such products are fed to hungry *Aphyosemion*, they will start by taking some food and swallowing it. But before very long their readiness to take the food will decline. Killies' interest in this food will eventually sink to zero.

A part of Norbert DADANIAK's fish-room; he also uses an air-line system to supply air to the numerous tanks in his fish-room

The small *Daphnia* species (also called water fleas) are brownish and, depending on species and feeding, reddish in colour

Mosquito larvae are a very popular food; they make our killies more eager to spawn

The packets of eggs, from which the mosquito larvae develop, float on the water surface and are called "rafts" (page 151 lower)

If killies are given exclusively dried food, it will be observed that they grow thinner and thinner. In addition fertility decreases, so that breeding from these fish is impossible. Young fish too will take small quantities of this food, but their growth rate is unsatisfactory.

This poor response to dried food is not just because it does not move, since frozen food produces excellent results.

We must therefore take the trouble to provide our killies with other kinds of food. All forms of live food are suitable (except for the freshwater shrimps of the genus *Gammarus*, which grow too large and have hard shells).

We can differentiate between live food that can be collected, bought or bred.

Despite the decline in the number of ponds, aquarists are still able to collect live food in the form of *Daphnia*, *Cyclops*, blood-worms, glass-worms and mosquito larvae. These kinds of food are ideal for the killifish of the genus *Aphyosemion*, even though they are virtually absent from the native streams of these fish. We will now discuss each of these kinds of food.

-*Daphnia* are small crustaceans that live in standing water. With a size from one to a maximum 3 millimetres they are especially suitable for young fish, but they are not refused by adult *Aphyosemion*. They can be caught in "*Daphnia* nets" sold by the trade. Depending on the season *Daphnia* may occur in large quantities. On occasions they are also available in aquarium shops. Unfortunately they cannot be kept alive for very long, so they have to be fed to the fish within three days.

-*Cyclops*, which are smaller than *Daphnia*, are an even better food for young fish. They too are found in standing water in varying numbers throughout the year. Sometimes *Daphnia* and *Cyclops* are caught in the same pond, but the proportions may vary with the seasons. Care is needed in feeding them to young fish. *Cyclops* are predators and it is said that they can attack and kill fry. Feeding small amounts of small *Cyclops* to rather larger young fish means that this problem will scarcely arise.

-Blood-worms live in the bottom of still or sluggish waters and must be separated from their casing before they are fed to fish. They grow to up to 15 mm long and are bright red in colour. They can be found in the warmer months. But they are not easy to collect and clean in sufficient quantity to make it worth-while. Live blood-worms can be bought in aquarium shops. If they are used carefully as live food, no problem should arise, provided they come from unpolluted water. There are always discussions among aquarists as to the quality of this food. There seem to have been cases of losses of fish after feeding blood-worms. This may be due to the fact that these insect larvae occur in less clean water, and they may have in them a high concentration of harmful materials (including heavy metals?). Clean blood-worms are a very good food for our *Aphyosemion*.

-Glass-worms reach about the same size as blood-worms but live in open water and are therefore easier to catch. They can be found above all in the winter in clean, still water. When kept in cool water they can be kept for weeks. So it is worth getting in a supply. This live food is also available at times from aquarium shops.

-Mosquito larvae are found from the beginning of March until late summer. They can be caught in forest ponds as well as in rain-water butts in gardens. It must be remembered that - unlike the larvae of the two midge species mentioned above - mosquito larvae hatch into insects that feed on blood. For this reason they can be very unpleasant for people in the home. After passing through the larva stage the insects pupate and emerge a few days later. So if any larvae reach the "bullhead" pupa stage, with the characteristic round body shape, they should be fed immediately to the fish. Otherwise within no time the house will be swarming with voracious insects.

Collecting these kinds of live food is not without problems, as it is forbidden in most places. But anyone who is able to use one or several of these sources food without conflict with the law should do so in moderation, so as not to harm the balance of nature. Special care should be taken of predatory water insects like water beetles and dragonfly larvae, as well as parasites (fish leeches, carp lice), which can easily get caught in the net along with the live food.

Hydra can also be introduced into the aquarium, where it will multiply. Admittedly they are of little danger to adult killies, but they are capable of catching fry in their tentacles. There are several recipes for *combatting* Hydra, but they are not effective in every case, and moreover they are not totally harmless to the fish (copper!). All these remedies should be used with the utmost caution. We would refer readers to the numerous articles in aquarium literature and also to the various products available in the trade designed to solve the *Hydra* problem.

Daphnia can also be "bred". Anyone with enough space can seed a garden pond or large water butt in the open air with a few *Daphnia*. In favourable conditions they will multiply, so that they can be collected on a regular basis. Very often *Daphnia* are found in great quantities where ducks are kept. This would suggest that a modest addition of manure might encourage the growth of algae to form green water, on which the *Daphnia* will feed and multiply.

In addition mosquito larvae can be found in rain-water butts, especially when they contain organic material. It is just when the water begins to smell that the female *Culex* mosquitoes seem to prefer to deposit their packets of eggs, called "rafts" (see page 149 below). The appropriate smell can be encouraged by the addition to the water of plant material (one "recipe" mentions stingin-nettle leaves!). Just a few days later the small egg rafts can be found on the water surface. They soon hatch into mosquito larvae.

A blood-worm, separated from the casing it will have built around itself

Glass worms, noted for their transparent bodies, are also known as "phantom larvae"

The newly hatched mosquito larvae are very small and are ideal for feeding to fry.

Aquarium shops sell all these kinds of food in deep-frozen form and usually of very good quality. It is worth acquiring a supply of different kinds of food, so that the killifish can be given the varied diet they require.

Adult brine shrimp (*Artemia*) can also be bought as frozen food. This usually comes from the USA, where these crustaceans can at times be caught in huge quantities in the salt lakes and sea inlets. Although they are marine creatures, their salt content is no higher than in the other live foods mentioned above. This is a very clean good value fish food, which is very much enjoyed by all *Aphyosemion*.

In July 1989 one of the authors was able to feed frozen *Artemia* to wild collected *Aphyosemion mirabile* and *Aphyosemion amoenum*. In just one day the fish had got accustomed to aquarium conditions. They received as their first food in the tank brine shrimp (five to ten millimetres long) which had been thawed out shortly before. Without ever having seen this food, they spat it out once or twice before eating it enthusiastically.

This shows clearly that killifish of the genus *Aphyosemion* accept food that is dead and does not move, if it consists of deep-frozen aquatic creatures.

In contrast it can be observed with the feeding of freeze-dried mosquito larvae, blood-worm and *Daphnia* that the fish lose interest in these foods relatively quickly. Nevertheless their diet can be enriched above all with freeze-dried blood-worms. But this food should be given one or twice a week at the most. If it is fed more often, *Aphyosemion* will eat it only reluctantly.

A particularly controversial food is *Tubifex*. These worms are two to three centimetres long and bury themselves in the bottom of muddy stretches of water. It is said that, like blood-worms, they may contain impurities - especially heavy metals. Those aquarists in particular who keep annual fish and the semi-annual *Aphyosemion* species need to give their fish very rich food. For this purpose many people use *Tubifex* without experiencing any problems. This food is generally regarded as too rich for the small *Aphyosemion* species including the representatives of the "*cameronense*"-group.

But here too different breeders have different ideas: Allan BROWN in Manchester succeeded in breeding the species he and his wife Barbara brought back from Gabon in 1990 ("GAB 90") by using well rinsed *Tubifex*. On the other hand there are other breeders who would not touch this food.

This example shows us that, even with the use of some foods, opinions vary and success is arrived at by different routes.

Over the years killifish keepers have developed or adopted methods of breeding some of their live food themselves. This includes fruit-flies of the species *Drosophila melanogaster*, white worms and Grindal worms.

The fruit-fly known as *Drosophila* for short can be found in hundreds on rotting fruit in some countries in late summer. A stump-winged form is used by aquarists. Because they have vestigial wings, they are unable to fly and this makes it easier for them to be fed to killifish.

For breeding *Drosophila* one first needs adult flies of a pure wingless strain. Starter cultures of good quality can be obtained from fellow aquarists or live food breeders, who regularly advertise cultures of various kinds of live foods in fish-keeping magazines.

Care needs to be taken, especially in summer, to prevent winged fruit-flies from getting into the cultures. The wingless form would cross with the wild form and the resulting hybrids would all be capable of flying.

For the culture medium for breeding fruit-flies there is a wide variety of recipes (different kinds of fruit, with or without stiffening medium, cooked or raw), so we refer readers to the numerous articles in aquarium literature. Of course it is not easy to compare the various "recipes". Nevertheless we will give here a short account of how one of the authors succeeds in producing good supplies of fruit-flies.

> The culture can be kept in a jam-jar or gherkin jar and has to be covered with fine gauze or other material which will allow the passage of air. A round hole can be cut in the screw-top and the chosen material glued to cover the hole (beware of sharp edges!). It is important to ensure that fuit-flies cannot escape and also that wild winged fruit-flies should not be able to get into the jar and thus corrupt the culture. A food medium can be made from mashed apples, to which a tenth part of rolled oats is added. When they have been stirred together for a short time, the mixture is ready. A little wood fibre in the form of toilet paper or hand tissues is placed on the bottom of the jar, and then a 5 cm layer of the food medium is placed on top. A few granules of dried yeast are scattered on the medium, so that the mashed apple can ferment. Then more wood fibre or wood wool is placed on top, so that the flies do not get stuck in the moist medium but are able to move freely in the jar. We can now put into the jar the fruit-flies which will soon start to breed. At an ambient temperature of 21-23°C the first pupae can be found on the side of the jar in about ten days. A few days later the young flies will emerge.

Of course there are many variations possible for the food medium. Instead of apple one can use plums, bananas and even kiwi fruit. Norbert DADANIAK has been able to enrich the medium with sugar and honey instead. He starts the fermentation process with the usual yeast.

After just a few days one notices the typical smell of fermentation develop. The alcohol produced is then converted by bacteria into acetic acid. One of these substances, or both of them together, prevent the growth of mould, since experience shows that cultures which acquire this typical smell hardly ever go mouldy.

Thomas BLUM (pers. comm. 25.6.1994) uses a different recipe which he has used for breeding fruit-flies for many years. The medium consists solely of a powdered baby food (e.g. Readibrek), which is mixed with water. This type of food contains many vitamins, trace elements and minerals. The addition of a small quantity of red wine vinegar makes the food acid. BLUM does not use either fruit or yeast, but he does add a vitamin preparation, of the type sold by aquarium shops.

In aquarium literature various authors mention the fungus inhibiting effect of artificial additives. In our experience a food mix can be made easily using a wide range of foodstuffs. Fermentation starts quickly, the flies breed almost explosively, and the failure of a culture hardly ever takes place. So we do not regard as essential the use of fungus inhibitors.

Often *Drosophila* do fail, even though one has endeavoured to copy closely a successful recipe. In this case it may be worth-while to try out different methods and recipes.

Since the containers used for fruit-fly cultures should not be air-tight (as mentioned above), the food mix tends to dry out in time. In order to prevent the culture from getting hard and dry (the maggots can no longer move around properly in the culture), it is advisable to moisten the culture now and then with water from a pipette. The frequency with which this has to be done depends on the consistency of the medium when it was prepared, the temperature and the extent of the evaporation.

When the first fruit-flies have hatched in the jar, new cultures can be started. If this has been done in sufficient number, flies that hatch subsequently can be fed to the fish.

The jar is given a tap, to make the flies fall from the side of the jar onto the wood-fibre, wood-wool or food medium. The lid is taken off and the amount of flies required shaken onto the water surface. As they cannot fly, they stay on the surface. The movements of their legs and the slight hopping action arouses the predatory instinct in the *Aphyosemion*, which then proceed to eat them.

New cultures of fruit-flies are "seeded" in the same way. After a tap on the jar, about 20 flies are shaken into the new jar that has been prepared. Both jars are then closed as quickly as possible. Admittedly the flies cannot fly, but they constantly gravitate towards the light, in order to get to the top of the jar and escape.

The following drawing shows a fruit-fly culture ready for use.

Breeding *Drosophila* does entail some effort and is not as simple as feeding thawed out frozen food. But as the flies feed on fruit and probably by doing so absorb vitamins, one can conclude that some of these vitamins are absorbed by the fish. Whether these vitamins are vital for the fishes' well-being, we cannot say. All the same they are less suspect than many colourings that dried food might contain.

Moreover *Drosophila* come nearer than all the other kinds of food mentioned to the ants and insects which were earlier mentioned as the possible natural food of killies. Their chitin content might be good for the digestion of *Aphyosemion*.

The following picture shows some *Drosophila* of the wingless strain. On the inside of the jar the maggots have pupated. The almost completely developed flies can be seen through the almost transparent pupa casing. In the background we can see a tissue lying on the food mix.

The breeding of Grindal worm (or Grindal for short) also requires a certain amount of effort. Grindal can be acquired from aquarists or live food breeders (see advertisements in aquarium magazines). One needs a polystyrene box with a lid, like those used in sending aquarium fish from wholesalers (inquire in your local aquarium shop). Alternatively a plastic box with a lid can be used. Peat or peat fibres are boiled and a layer a few centimetres deep is placed in the box. Instead of peat many aquarists use compost without added fertilisers or plastic foam. The latter material has the advantage that after a given time it can be rinsed and the Grindal's waste products washed out.

The small worms can be fed with baby food, ground oats or white bread. This food is simply placed on the moist substrate.

In our experience the best temperature for Grindal to breed seems to be around 20°C. It is possible to put a piece of glass on the substrate. The worms will collect under it, and they can then be removed simply and quite cleanly by taking out the piece of glass and collecting the Grindal with a brush or other implement. The worms are then spread around the various tanks. With gentle wriggling movements they slowly sink to the bottom. They are eaten by fish with a body length of 10 millimetres or more.

If a culture is fed regularly and is in good condition, Grindal can be harvested from it on a daily basis. Depending on the number and size of the fish to be fed, several cultures will be needed. This will be insurance in the case of a culture failing or being overrun by mites.

If this should happen, a few Grindal worms are removed and placed with a fresh substrate in a thoroughly cleaned container, so that a new culture can be started.

When feeding Grindal, one should bear in mind that they are less suitable for adult fish, which are no longer at the growing stage. It has been observed that when given this food in quantity, fish show the undesirable symptoms of fatty degeneration, which may be attributed to the use of Grindal.

White worms (*Enchytrae*) are also small white worms. They are a little larger than Grindal. Basically they can be bred in the same way as that described above for Grindal.

The boxes should however be rather larger. Polystyrene boxes (or home-made wooden boxes) are suitable. They are half to three quarters filled with compost without added fertilisers. The culture can be fed stale bread, rolled oats and baby food, which can again be covererd with a pane of glass. Removal and feeding to the fish are as per the Grindal worms described above.

All the food on a culture should be used up before any more is added.

A new culture becomes necessary when the rate of production of the worms drops noticeably.

As with Grindal, the rule should be to give these worms only to sub-adult fish, and then in moderation.

Freshly hatched *Artemia* naupliae (brine shrimp) are actually the most commonly used fry food, which is why we will describe in detail their "breeding" in the second part of this chapter.

Despite their small size, these small crustaceans are also enjoyed by adult *Aphyosemion*. The main reason for this may be the jerky movements of the naupliae, which arouse the eating instinct of the killifish.

Of course an adult *Aphyosemion* would need a considerable number of the naupliae to satisfy its hunger. But, if other kinds of live food are not available, it is worth hatching brine shrimp for adult fish, so that they get the desired variety of diet. In any case brine shrimp have to be hatched for the rearing of fry, and, when there happens to be an excess, they can be given to the older fish, before the naupliae die for lack of food.

Variety of diet is crucial. All the foods listed here have their most beneficial nutritional effect when they are used in continuous rotation. Obviously it is not essential to have stocks of all the kinds of live and frozen food, but when given a varied diet, our killifish are better nourished and their vitality and fertility improve. For this reason always try to give your fish the greatest possible variety of foods.

Keeping representatives of the "*cameronense*"-group with other killifish. One does not always have enough room to keep apart all the *Aphyosemion* species in one's possession. Moreover many aquarists like to keep several of these superb fish species together. But it must be remembered that the *Aphyosemion* differ from each other in very few points when it comes to body shape, and the females in particular are similar to each other. It is just the males that have differences from other species in the colouration of the body and the fins.

Under no circumstances must females of different species be kept in the same tank, if they are of the same species group or subgenus! The differences between the species are so slight, that the females cannot be separated (the males on the other hand have sufficient characteristics of colouration to enable even closely related species to be separated). The females can no longer be identified exactly and are thus of no use for any subsequent breeding programme. They would most probably produce unwanted hybrids, which should be avoided at all costs.

We should be aware that aggression may be directed against fish of other *Aphyosemion* species, if they actually refer to males of the same species. When several males of different species are kept together, one should ensure that the number of fish is not too large for the size of the tank. Here too it is advisable to keep fewer males than females. Additional hiding places should also be provided.

If there is enough space available in an aquarium, several *Aphyosemion* species can definitely be kept together. The more distantly related they are from each other, the less chance there should seem to be of intraspecific aggression taking place against specimens of other species.

As we have seen in the description of the living conditions in the wild, *Aphyosemion* species of different species groups or subgenera may well occur side by side (see the chapter **The Accompanying Fauna in the Biotopes**). This should also mean that the different body and fin colouration of the males peculiar to their species prevents or at least restrains acts of aggression between the species (inter-specific aggression).

Whether this is true of fish kept in the aquarium cannot be said for certain, as the conditions in a tank do not necessarily produce identical or similar reactions to the same key stimuli as in the wild.

In general, however, it can be said that, if representatives of the "*cameronense*"-group are kept together with other *Aphyosemion* species in suitably good conditions, no special problems should arise.

In the event of injuries to individual fish or even death, the composition of the community in the tank will have to be altered appropriately, with the most aggressive specimens being taken out.

Fish with serious injuries have to be placed in isolation and, if necessary, treated with a medicament available from the trade. The experienced killifish keeper observes his fish regularly, so that he can act as quickly as possible when the need arises.

Keeping our fish together with killifish species that do not belong to the genus *Aphyosemion* should be less problematic, as these species behave quite differently from the *Aphyosemion* species. In particular the surface dwelling *Epiplatys* and also the lamp-eyes, which are always actively swimming around, will hardly be victims of aggression. The bottom spawning species of the genus *Nothobranchius*, as well as the South American *Rivulus* and *Cynolebias* species differ in body shape and colour pattern so much from the members of the "*cameronense*"-group, that no quarrels to speak of should occur.

Keeping representatives of the "*cameronense*"-group with other fishes. Killifish are mostly kept by aquarists who are fascinated by them and work intensively on the maintenance and breeding of these fish. For this purpose most enthusiasts own several tanks used exclusively for killies. Only individual fish or specimens not of use for breeding are sometimes kept in ornamental planted tanks, in which "ordinary" aquarium fish are also to be found.

As this does not happen very often, we do not have enough experience to be of much help. What we have said for the killifish outside the genus *Aphyosemion* should also be true for *characins*, barbs, catfish, *cichlids*, gouramis, labyrinth fish and live-bearers. As long as these do not attack the *Aphyosemion* or even regard them as food (for every lover of killifish a horrible thought!), keeping together fish that differ so much from *Aphyosemion* should present no problems, if the requirements for the living conditions of all the tank dwellers have been completely satisfied.

In normal circumstances the representatives of the "*cameronense*"-group will only recognise in their tank-mates fish which will not arouse any inter-specific aggression.

Aphyosemion maculatum "PEG 93/14"

Breeding

As we have seen, the successful maintenance of killifish in the aquarium already makes some demands on the aquarist. Even more attention is needed to breed these very special fish.

It must be one of the aims of this book to guide the reader in how to maintain the fish successfully. By this we do not mean keeping over a short period fish obtained from someone else. Rather we mean in particular the maintenance of a species or strain (or many!) by breeding them oneself over several generations.

So it is not without reason that the second part of this chapter is one of the most comprehensive sections of this book.

The experience of the last few decades with numerous representatives of the "*cameronense*"-group has shown that they can be regarded as belonging to the small *Aphyosemion* species. The breeding methods generally successful with these fish can also give us good to very good results.

The methods described below have partly been taken over from other killifish enthusiasts (our "craft" learnt from them, so to speak). But over the years we have found out many "tricks" ourselves. It is not of interest who first successfully tried out which trick with which species. It is more important to make clear that there can never be a 100% successful recipe for the breeding of a specific *Aphyosemion* species or even a specific strain. Rather a range of ideas and flexibility are required.

However it is important to recognise and supply the conditions required by the fish. In this the following factors play a decisive role:

- Tank size
- Water temperature
- Water quality, filtration
- Quantity of food
- Varied and regular feeding
- Adult breeding fish ready to spawn
- Spawning medium
- Storage of eggs during development
- Suitable fry food

All these aspects are very difficult to measure, so it is important to give fish optimum conditions. For this, intuition, ambition and a certain amount of experience are called for. Not to be forgotten, of course, is the good fortune of getting good parent fish.

It is for every breeder to decide how much effort he or she is prepared to put into breeding a species or strain. Besides there are really difficult species, whose reproduction only succeeds in small numbers (e.g. *Aphyosemion franzwerneri*, *Aphyosemion joergenscheeli* and *Episemion callipteron*). But one should never give up, if no progeny can be produced from a breeding pair. Frequently slight changes can bring about a distinct improvement in fishes' willingness to spawn.

It happens time and again that "good" breeding pairs or trios (= one male and two females) are passed on from one aquarist to another and then set up for spawning using the same method. But suddenly the fish which had previously been keen to procreate suddenly do not want to any more; or else the eggs fungus or the fry do not hatch or...

In such cases it is advisable to change one or several of the conditions mentioned above, that is within tolerable limits. With a bit of luck conditions will occur in which breeding will succeed.

It can also happen that a compatible breeding pair will spawn regularly over a period and - apparently with surprising suddenness - all activity in this area stops. Then it may be necessary to change the water temperature or give the fish a different spawning medium. It often helps too to separate the fish for several days, so that the female in particular can recuperate.

In the second part of this chapter we intend to cover the breeding of representatives of the "*cameronense*"-group and describe some of the many little tricks and methods that are possible. The list of these methods is not comprehensive. There are probably breeders who go down other routes in order to breed their fish. We cannot exclude the possibility that in this way more fry are produced more simply.

These methods can be used for the breeding of the representatives of the "*cameronense*"-group as well as for most of the "small *Aphyosemion*".

We hope that as many readers as possible will be encouraged to "experiment" within their possibilities and develop their personal breeding methods (or should we say "recipes for success"?).

Choice of breeding stock. Even before the breeders are put together, one must see to it that they are compatible. This is not just a question of size, age and sex (if at all possible a male and female should be placed together, otherwise the prospects of success are minimal!). Of considerable importance too is the fact that the fish should be of the same species and even the same strain.

Never use for breeding fish, about whose origins you do not have precise information!

When you obtain killifish from a breeder, you should find out if they belong to a definite named strain. Ask for the specific name (that is if you cannot establish it beyond doubt yourself) and for the locality and code. Check the spelling of location names (countries, villages, streams) and code numbers. Write down the specific name and the code of the strain and keep this information in a safe place.

It is often enough to write in a small note-book when, for example, you acquired *Aphyosemion cameronense* "GWW 86/2" and from which breeder. If you succeed in reproducing the fish, you will sooner or later want to pass on the fish you have bred. You will then be in the position to hand on the correct information on your strain.

If you omit the additional "GWW 86/2" for the strain, within a few generations we will be left with a nameless strain of *Aphyosemion cameronense* instead of the originally precisely defined strain "GWW 86/2W (imported by Peter WAGNER and Roland WENDEL, caught on the morning of 6th January 1986 from a stream near the village of Latta (Lata), 17 km east of Makokou in north Gabon, 13°00'E and 00°39'N).

After the loss of the precise description of the place of origin it later becomes almost impossible to identify with certainty the fish as belonging to the strain "GWW 86/2". It will become all the more probable that these fish will be crossed with another strain of *Aphyosemion cameronense* and consequently the particular colour features of both strains will get mixed. This again would mean the loss of the unique variability of the killifish as documented in this book. These principles are valid for all killies and should be respected by every serious lover of these uniquely beautiful fish.

This is a particularly beautiful male of the "GWW 86/2" strain of *Aphyosemion cameronense* mentioned above

Make sure that the fish chosen for breeding are neither too young nor too old. We cannot actually give here an "ideal age" for breeders. Later we will show that the rate of growth of the fry and with it the beginning of sexual maturity may be influenced by this factor. But a very considerable role is also played by factors like the conditions in which the fish are kept, the feeding and also the individual potentials of the males and females. If females are placed in a spawning tank too soon, they can be driven too fiercely by the eager males and get injured or even killed. For the males all the young females represent potential sexual partners, even if they are not yet able to produce enough eggs.

Moreover fertility declines in older fish. In this case a lot of time and energy would be invested (and probably wasted) in the search for the best method and also with experimenting. And possibly success would be achieved faster and more easily with younger fish.

Of course, compared with the short lived bottom spawners of the genera *Nothobranchius* and *Cynolebias*, the killifish of the "*cameronense*"-group live surprisingly long, but their fertility drops off appreciably after a certain time. It cannot be said exactly when this stage of life begins. This depends largely on how the fish are kept and also on the individual fish themselves.

It can often be seen that the dominant males and females kept together in a group are especially keen on reproducing. Thus it is better to observe the fish in question and select them from a small shoal for breeding.

Fish destined for breeding should always have the colouration of the type of the species and strain. It is virtually impossible to set up standards for killies, as is the case with live-bearing toothcarps.

But if, for example, you have a male *Aphyosemion amoenum*, in which the yellow blotch on the caudal peduncle is missing (a typical feature of this species, which may be absent only on individual males and as very rare exceptions), this specimen should not be used for producing the next generation if no better (= "typical") coloured male is available.

Physical deformities such as a bent caudal peduncle, a missing or malformed gill-cover, or an abnormally formed spine are reason enough to exclude such fish from a breeding programme if at all possible.

The females must have a belly line curving outwards slightly. If they are markedly emaciated, they are either ill, badly fed or have spawned just recently. Such females are not suitable for spawning when in this condition. They should be kept apart and watched. They should be given a particularly rich and varied live food diet until they have increased perceptibly in bulk and acquired the "normal" body shape.

The drawing below shows two females. The belly of the upper fish markedly hollow, the body shape of the lower female corresponds to that of a healthy specimen.

Recognising females ready to spawn. It is not just the body girth that establishes whether an *Aphyosemion* female is carrying eggs. For even well fed females can give the appearance of being filled with eggs.

In order to be able to see the eggs in the belly of a female, the fish is placed in a small glass container or plastic bag and held against a window or light. The female is viewed against the light and numerous yellowish clear eggs are visible in the belly. The upper picture on page 168 shows the translucent eggs in the belly of a female.

When females are fully fed, only a few eggs are visible, as the body is full of the food just taken.

In very rare cases females occur which do not spawn, even though they can be seen to be full of eggs. This could be what is called being egg-bound. We do not know the reason for this phenomenon, but we suspect that old females in particular are liable to suffer from it.

In one instance one of the authors observed a female that had been placed in a spawning tank depositing all the eggs without the male taking part (so they were unfertilised and therefore lost). Then, after being well fed, this female did not produce any more eggs. So it can be said that in most cases such females can no longer be used for breeding.

As this occurs so rarely, we know of no solution to the problem of egg-bound females.

Feeding the breeders. This aspect is of particular importance, since for both sexes spawning places an exceptional burden on the fish. Even before they are placed together, the fish selected should have been separated and given a varied diet. Besides, they can be observed more closely and their state of health can be determined more accurately.

As for the food istelf, obviously all the kinds of food listed in the first part of this chapter are relevant. Many experienced aquarists give the best available food to the fish used for breeding, so as to keep them in good condition.

As there is the temptation to give the fish large amounts of food, we would like to point out again that not too much food should be given at a time. Otherwise the water might get polluted. After all, it is well worth avoiding the loss of valuable specimens specially chosen for spawning.

Separation of the sexes. Killifish do not pair off or know any lasting union. They spawn when they are sexually mature and meet fish of either sex ready to spawn (and if the other necessary conditions are satisfied). So these fish can be called permanent spawners.

In order to obtain a higher number of eggs, it is necessary to spearate the females from the males. It is worth noting at this point that *Aphyosemion* females will also spawn with males of closely related species and of course with males of other strains of the same species, if the opportunity arises. If male and females fish of different species and strains were kept together, the effectiveness of the breeding programme would suffer and aquarists would end up with unwanted hybrids.

So the females chosen for breeding will in general be separated from their own as well as closely related males. As described above, they will be given a good and varied diet.

After being separated for 8 to 10 days, these females can be placed together with selected males. The separation time should be found out individually for each female and each breeding method.

The spawning tank. The tank the breeders are placed in should conform to the conditions described in the first part of this chapter for the well kept aquarium. The size of the tank depends on the kind of spawning method (see also **Natural breeding method - Artificial breeding methods**). If the breeders are just a pair or a trio, a 20 litre tank will often be sufficient. For longer spawnings with two pairs or a small breeding group, a larger tank of up to 50 litre capacity should be chosen.

In view of the stress the females suffer from the constantly driving males, they must be given a sufficient number of hiding places. This can be achieved most simply by the provision of a large quantity of spawning medium (see **The nylon mop**).

The water hardness should in principle be rather lower than the readings described as satisfactory for maintenance. A total hardness of 2 to 10°dGH is advisable. However, variations in water hardness are of less importance than changes in the pH. Many *Aphyosemion* species will indeed reproduce at higher degrees of hardness, but with representatives of the "*cameronense*"-group, breeding is distinctly more successful with soft water.

In our opinion the pH should be around 6.5 for spawning. Frequently the fry of one generation sex out with an extremely uneven sex-ratio. Offspring of *Nothobranchius*, *Cynolebias*, *Rivulus*, *Aphyosemion* and other killifish species have been observed with up to 100 specimens of one sex and two to three of the other.

Killifish enthusiasts repeatedly discuss the possible reasons for this phenomenon. It is suggested that the pH of the aquarium water is responsible. It would surely be worthwhile bringing together and comparing the various conditions, in which such extreme fluctuations of sex-ratio occur. Fortunately in our breeding attempts at around pH 6.5, we have never experienced such annoying problems.

Male *Aphyosemion obscurum* "EMS 90/13"

This adult female *Aphyosemion halleri* "EMS 90/6" shows against the light that she is carrying a lot eggs

Temporary set-up - Permanent set-up. *Aphyosemion* females that are not kept separately from their males and thus spawn regularly normally have a relatively small supply of eggs in their body. For this reason both sexes are separated before being used for breeding. After spawning starts, practically all the fully formed eggs are deposited. A few days later the females will again have in their bodies the normal supply of eggs.

If the males are particularly aggressive or intolerant, they should be left in the spawning tank for just a short time. This will help protect the females. In this case we speak of "temporary set-up". The maximum duration depends on the natural conditions. When it comes to difficult, valuable or reputedly aggressive breeders, we recommend that a constant check be kept of the spawning tank, so that immediate action can be taken at the first signs of injuries. One or two days later it may be possible to get eggs from the same selected fish without any further problems.

If the quarrelsome behaviour continues, other breeders should be chosen. It is often enough just to exchange one of the partners.

A further advantage of a temporary set-up lies in the fact that all the eggs are fertilised in a relatively shorter space of time than is the case with the "permanent set-up" (in which we get eggs that have been laid over a period of up to two weeks).

This second procedure can be considered for pairs or trios that get on well with each other or else when a larger number of specimens are placed in a larger tank for spawning. The breeders are left to spawn for several days or even weeks.

In this method it is necessary to collect either the eggs or the fry after hatching. We have to distinguish between the two following methods.

Natural breeding method - Artificial breeding methods. In general we can divide the breeding methods into two groups.

The natural breeding method is based on the use of well planted tanks, in which the breeders are kept in a permanent set-up - that is over a longer period - and the newly hatched fry find protection in fine leaved plants.

For this purpose floating plants such as *Riccia fluitans* or *Pistia stratiotes* and the *Ceratopteris* species with their fine roots should be present. In fact females often choose to spawn on the roots that reach from the underside of aquatic plants down to the tank bottom.

If there are enough aquatic plants in the tank, the tiny fry can hide among the floating plants. They stay immediately below the water surface where they find their first food in the form of minute water organisms.

If in addition freshly hatched brine shrimps (see also pp 190 to 194) are added to such a tank, some of them always keep to the surface, where they are eaten by the small *Aphyosemion*. As mentioned above, the surplus *Artemia* naupliae are eaten by the parent fish, which in turn improves their general well-being and eagerness to reproduce.

The advantage of this method is that the necessary workload is reduced and a degree of selection means that only the strongest fry survive. On the other hand it is not possible using this method to breed a strain in large numbers.

Depending on the conditions at the time, the fry can be left in the tank. Later the half grown fish are taken out, either to be given away or to be used for breeding the next generation.

In addition it is a good idea to scoop up fry regularly from the surface with a small beaker or flat dish. The fry can then be put into a rearing tank. The number of fry obtained will then increase to a certain extent.

Anyone with his own garden or balcony can set up containers with a capacity of at least 20 litres out of doors. In the months of June, July and August, and also in the first weeks of September, *Aphyosemion* which are ready to spawn can be added. Karlheinz KOHLER used this method in the early nineties to keep *Aphyosemion dargei* in a black plastic "mortar tub" with a capacity of 50 litres (supplied at reasonable cost by builder's merchants).

For decoration a few bunches of Java moss and floating plant of the genus *Salvinia* were placed in the container. The sunlight entering the tub caused the formation of masses of filamentous algae, in which spawning took place. The numerous fry were scooped out and reared in small aquaria.

This natural breeding method out of doors can be used with many other species of the genus *Aphyosemion*. In contrast with fish kept in aquaria, those kept in the open air showed much less tendency to want to jump out. The *Aphyosemion* found enough food, so that it was only occasionally that live food had to be added.

With the artificial breeding methods one tries to remove the eggs from the aquarium as soon as possible, in order to protect them from the parent fish. On many occasions killifish have been observed eating the eggs they had spawned earlier. Egg robbery of this kind is a very negative accompanying phenomenon, but there are ways to circumvent it to some extent.

The fish can be given a spawning medium, in which the eggs can only be found with difficulty. Especially suitable for this is peat fibres, obtained from aquarist shops as a filter material. Its filamentous structure induces the breeders to spawn on the top of the bundles of peat fibres. The dark brown colouring makes it difficult for the fish to find and eat the eggs. The picture on page 172 shows on the upper right a clump of dry peat fibres, as available from aquarium shops. In the small plastic dishes below one can see how the colour of the peat darkens when it is wet. Below on the right there is a small dish with a little Java moss (*Vesicularia dubyana*).

The bottom of the spawning tank can also be covered with a layer of garden peat a few centimetres deep. This peat should be without added fertilisers, and it should be well boiled beforehand. The small *Aphyosemion*, including the representatives of the "*cameronense*"-group are not actually bottom spawners as are the large *Aphyosemion* and the species of the genera *Nothobranchius* and *Cynolebias*. Nevertheless, a large proportion of the small *Aphyosemion* eggs are deposited in the soft substrate.

This may reflect the spawning behaviour in the biotopes, where fine mud on the bottom of the streams is possibly the most frequently used spawning medium.

If fish are given different spawning media (e.g. peat fibres, peat, Java moss, nylon wool and the wool described in the next section), different pairs choose different materials. When one observes *Aphyosemion* pairs spawning, one sometimes gets the impression that the females choose where they will spawn by making towards their favourite spawning medium.

Nylon mops. Besides the green nylon floss which is sometimes available in aquarium shops, synthetic wool is a second artificial spawning medium. The use of natural wool is out of the question, as it would start to rot in the water. The toxic substances given off could be a danger for the parent fish and for the eggs.

The colours preferred by the fish appear to be black, dark brown, dark grey and dark blue. When the synthetic wool has been boiled, it is cut into pieces of about ten to twenty centimetres long. Depending on the size of the aquarium and of the nylon mop being made, 30 to 50 lengthes are tied at one end to form a loose bunch. On page 172 one can see that the left and right-hand mop consist of nylon wool threads several metres long, which have been tied together in a circle.

As the wool is heavier than water, this bundle can simply be laid on the tank bottom, where it will, so to speak, imitate a bunch of Java moss. In contrast with Java moss and peat or peat fibres, using nylon fibres makes it very simple for the aquarist to collect pretty well all the deposited eggs (see also the section **Collecting the eggs**!).

The picture on page 173 shows that the eggs deposited in nylon mops can easily be seen as light coloured little balls, especially when dark wool is used.

There is also the possibility of providing the tied end of the bundle with a small float. For this, small pieces of cork, wood or polystyrene (all untreated!) are suitable. An empty film canister can also be used. One of the nylon threads is put into the canister and then kept there by replacing the lid. On page 172 one can see that the nylon mop in the centre has a float in the form of a normal bottle cork.

With the so-called floating mops we are free to choose the length of the nylon threads. Especially useful are those mops whose lower ends at least touch the tank bottom. It is even better if they lie on it. In this way the breeders have the freedom to choose where they want to spawn. A combination of both types of mop is also possible. On the one hand floating mops give the fish the possibility of depositing the eggs just below the water surface, and on the other hand numerous mops lying on the bottom provide hiding places for subservient specimens.

If a lot of submerged or floating mops with long threads lying on the bottom are used, we must remember that uneaten food and droppings will collect between the nylon fibres. In this case the mops should be taken out of the tank briefly and rinsed quickly, whenever there is a water change.

Filtration. What is true of the maintenance of *Aphyosemion* in general, must also be borne in mind when fish are placed together for spawning. Every aquarium, in which fish have been placed for the purpose of long-term spawning, should be adequately filtered. Keeping effective biological filtration in good working order prevents the appearance of toxic substances which can drastically reduce the fishes' willingness to spawn.

In this context a regular partial water change is also advisable, as was recommended on pp 130 to 132. If the chemical composition of the fresh water does not differ too much from that of the water in the spawning tank, there need be no fear of problems for the eggs. We should remember that, in the small rainforest streams and neighbouring pools, the eggs of *Aphyosemion* are exposed to quite considerable environmental influences.

Water temperature for spawning. The representatives of the "*cameronense*"-group live in the wild in streams that flow throughout the year. They can therefore reproduce without significant interruptions (non-annual way of life). It can be assumed, however, that conditions for reproduction are better during the rainy season than in the drier months. The streams overflow their banks, the surrounding areas are flooded. The available habitat is larger (less pressure from predators) and more food in the form of insects is washed into the streams (less competition for food).

As the increased rainfall influences the chemical composition of the water and also its temperature ("thinning" of the water through rainfall and also a drop in temperature), it is understandable why *Aphyosemion*'s willingness to spawn can be increased by additions of fresh water.

Materials to offer *Aphyosemion* as a suitable medium for depositing eggs: nylon mops, peat fibres and Java moss

This close-up shows that the clear and slightly yellowish killie eggs are easy to see between the individual threads of the dark synthetic wool

A quick look will show the eggs between the wool strands. How many eggs may this spawning of an *Aphyosemion* pair have produced? The nylon mop is placed on a soft surface. The individual strands are pulled apart and the eggs removed with the fingers to store on peat fibres or in water from the spawning tank

We have had good results at temperatures between 18 and 24°C. The optimum temperature is probably around 22°C. If the water temperature rises to above 24°C, most representatives of the "*cameronense*"-group stop spawning.

In addition we have established that at higher temperatures of 23 to 24°C, the frequency of partial water changes has to be increased.

In one or two cases we have found that lowering the temperature to 16°C has induced particularly aggressive fish to spawn, with no injuries being suffered by the subservient fishes. This might be a way of getting specimens to mate, which are otherwise intolerant.

The fish in spawning tanks should be monitored by the aquarist. As mentioned above, we recommend that the spawning tank be checked regularly when the fish are known to be aggressive or when they are particularly valuable.

When several females are compared, it will be seen that their spawning phases differ to quite an extent. If a shoal of young fish is reared together till the onset of sexual maturity, one sometimes finds among them very large and dominant females. They also give the impression of being very "plump". They have in their body a large number of eggs. It has been shown that only very large and dominant males are able to persuade such females to spawn regularly.

If a male is weak compared to its mate, the pair will only produce a few eggs. When they do spawn, it is usually after one of the regular water changes.

But there is something the aquarist can do to help. The regular water change is delayed a few days, and then especially cool water is used. This frequently stimulates the breeders considerably. One should see to it that the water temperature of only about 16 to 18°C is kept constant over a period of several hours. This can be achieved by the regular addition of fresh water. This procedure can in a short time bring about increased egg production when the male is weaker than the female.

If strong males are mated with small, subservient females, spawning usually takes place regularly. The number of eggs produced varies from pair to pair.

Many years of breeding experience with the species and strains kept by us have shown that well matched pairs can be expected to produce an average of 8 to 12 eggs a day. After a water change with a drop of temperature of 2 to 3°C, the number of eggs produced may temporarily rise by 100% or even more.

A prerequisite for regular and constant spawning is an adequate supply of food for the females. They must not be allowed to be short of food as a result of the males harassing them persistently. It is an advantage if the males allow the females short breaks in spawning. Then the females can recuperate and produce new eggs. This is particularly true of those breeding pairs that spawn only at certain times of the day.

Well matched pairs can be left in a permanent set-up for weeks or even months without the fish suffering any harm.

Males which are aggressive and drive persistently can bring about a high average egg production. But there is the danger that the females will deposit their complete supply of eggs. In addition they may be harassed to such an extent during feeding that the amount of food they eat is not sufficient to produce enough eggs. The reduction in the females' willingness to spawn increases too the pressure exerted on them by the males. The females get increasingly weaker, and this can lead to their deaths if they are not removed promptly from the spawning tank.

To prevent this, it is necessary to separate females from the aggressive males regularly. In this way the females recuperate in these rest periods and are able to produce new eggs.

Collecting the eggs. The fact that our *Aphyosemion* eat their own eggs means that the eggs need to be taken away from the parent fish. One possibility is to remove the fish from the spawning tank. Then it does not matter if it is a temporary or permanent set-up, or if it is the natural or artificial breeding method. If fish are placed in a tank to spawn over a shorter or longer period and then removed after spawning successfully, fry will hatch continually on the days and weeks that follow. The fry can then be fed in the ways we recommend.

This procedure has however the disadvantage that it requires a large number of tanks for all the successive hatchings. At this point a further peculiarity of killifish is worth noting. Compared with the eggs of other fish, their eggs have one great advantage. They are so hard-shelled that they can be taken out of the water for a short time, without being damaged by contact with the air. The resistent egg-shells protect the inside from drying out. Obviously there is a limit to the length of time an egg can be exposed to the air.

Before taking out the peat fibres or mops, one should always check whether there are any killies in them. This is where they will choose to hide when disturbed.

The pictures on pp 172, 173, 176 and 177 show that a spawning medium can be taken out of the water and searched for eggs. The eggs are not at risk and they can be easily collected. The individual eggs are considerably easier to see between the nylon strands than in the thick and uneven fibres of the peat.

One can even collect the eggs carefully with the fingers from the spawning medium (see page 177 below). Excessive pressure can destroy the surface of an egg, which will die as a result.

In every case the medium is folded in a soft towel or paper tissue and carefully squeezed before a search is made for the eggs. The absorbent quality of the surrounding material reduces the necessary pressure that has to be exerted, and this helps to protect the eggs.

An important fact to bear in mind is that the shells of freshly deposited eggs are still soft. They have to pass through the female's sexual orifice and in addition the sperm has to penetrate the eggs. It takes at least an hour for the eggs to harden. In order to give the eggs the necessary time, one can leave the spawning medium in a small dish for a few hours before beginning to pick off the eggs.

The hardened clear eggs are transferred directly from the nylon mop on to moist peat and then stored in an airtight container

Peat fibres can also be used. For the protection of the eggs a thin layer of peat fibres is placed on top

This close-up shows the different constituents of the peat fibres as well as its fibrous structure. The eggs are in different stages of development

This *Aphyosemion* egg appears on the thumb as a tiny little ball, but it is - compared with eggs of similar sized fish - relatively large

After the eggs have been collected, the spawning medium that has been used can be put back in the spawning tank. In this way the possibility exists of letting the fish always have their favourite medium. At the same time the maximum number of eggs can be obtained.

The storage of eggs during development. Killifish eggs need a relatively long incubation period, as the fry are fully formed when they hatch. They can immediately see, swim and eat.

The small *Aphyosemion* species, including the representatives of the "*cameronense*"-group, require an average 14 to 18 days for their eggs to develop, that is from spawning to hatching. Even if all the eggs of a spawning are laid within a few hours, the fry will frequently hatch over a period of several days. This is probably explained as nature's mechanism for ensuring a staggered hatching of the fry, which will protect them from short-lived and only momentary harmful influences. This spread in hatching times is only observed if eggs are stored in water. This effect can be circumvented by "drying" the eggs and then "wetting" them after they have eyed up.

This possibility can be attributed to the eggs' astonishing powers of resistance. But the eggs should never be dried out completely during the development phase, which is why they are stored on or in moist peat. In the literature the degree of moistness of peat is repeatedly described with the expression "like moist tobacco". As we know of no better definition and as the concept is very difficult to define, we recommend to the interested aquarist the following procedure:

> An *Aphyosemion* pair or trio (one male and two females) is placed in a spawning tank. As a spawning medium peat fibres, which have been briefly boiled, are put in the tank. Dry peat (peat fibres or moss peat) floats at first until it has been completely soaked with water. One day after the breeders were placed in the spawning tank, the clump of peat fibres is taken out of the tank and gently squeezed in a towel. When this clump is held in the hand, no more water should drip from it. Then we try to make out the yellowish and clear eggs. In order to do this, we can carefully separate the fibres with the fingers and search the clump of fibres more closely. The two pictures on page 176 below and page 177 above show that, with a little experience, the eggs can be discovered between the fibres.
>
> So if the peat fibres contain eggs, the clump is left for another hour or so and then it is packed in a plastic bag or small plastic container. It is important that no water should be able to evaporate through the closed packing. In this way the peat fibres will not be able to dry out any more.
>
> We can neither measure nor describe the precise degree of moistness. So, if there is an adequate number of eggs, we recommend that they be separated into smaller clumps and stored with varying degrees of moistness. It may be possible to mark on the outside of the packing which parts of the spawning are stored "very moist", "medium moist" or "relatively dry". Hatching results will soon show which will be the best degree of moistness to use.

There is a rule which should always be followed when breeding killifish, in order to prevent the hybridisation of different strains or closely related species. It is:

Label all spawnings as accurately as possible!

Of particular importance is an accurate labelling of the dry stored eggs. For this a waterproof marker pen is used for writing on the packing material. We write on it the specific name, the finding place and code (if it is known) and the date of storage. Anyone interested in carrying out a close study and reaching conclusions on the hatching rate, can count or estimate the collected eggs beforehand and note down their number.

An example of a possible labelling might be: "*A. maculatum* "LEC 93/4", 14.11.95, at least 20 eggs". Even better would be to include this with all other spawnings in the notebook mentioned at the bottom of page 163, which contains all species, strains, numbers of eggs and hatching times.

Many killifish enthusiasts keep a calendar on which they note down the expected hatching dates of every spawning. In this way one can prevent the loss of valuable fry dying in the egg as a result of storing the eggs for too long. In contrast with the annual and semi-annual species, the embryos of the small *Aphyosemion* develop without interruption and the eggs must be wetted when they are ready to hatch.

If it is necessary or more effective to give the breeders nylon mops for spawning on, the eggs have to be picked from these mops. On page 176 upper picture you can see a floating mop made of black wool and next to it a flat plastic dish containing moist peat. The optimum degree of moistness should be worked out by each aquarist himself. The eggs are carefully removed from the wool fibres and placed on the peat. Of course, for "dry storage" of *Aphyosemion* eggs, peat fibres can be used just as easily as moss peat.

Male *Aphyosemion spec. aff. cameronense* Phenotype 9 "Ngoyang Chantier"

Easily recognisable are the clear fertilised eggs and those which have turned a cloudy white

This egg is virtually fully eyed up. The fry will emerge in a few hours. Note the astonishing size of this *Aphyosemion* egg

It should be remembered that the eggs should not be too close to each other. This will prevent the spread of fungus. A few eggs often fungus, as a result of not being fertilised. Or they may have been damaged despite careful handling. If the space between the eggs in the peat or peat fibres is large enough, the process of decomposition is limited to those eggs, and the greater part of the spawning will remain protected. On page 176 the even distribution in the peat fibres is clearly visible. With spawnings which are sufficiently productive, the eggs can be stored in several layers.

In order to ensure the eggs are evenly moist during incubation, when they have all been collected, the eggs themselves are covered with a thin layer of peat or peat fibres (also moistened in the customary way).

The well sealed and clearly labelled container or bag with the peat and eggs is now kept in a warm place (see **The storage temperature influences the hatching time**).

Besides the dry storage method described here, the small *Aphyosemion* species can also be bred with the water storage method, together with its variations. As they are non-annual species, the eggs develop constantly and do not need real rest periods. This can be seen in the "Natural breeding method", in which the eggs remain in the water in the spawning medium provided by us and chosen by the fish, until the eggs hatch.

The easiest procedure with the water storage method is to remove the medium from the spawning tank and place it in a small container with the necessary amount of water. The water level should be six to eight centimetres at the most. At a constant temperature (which can correspond to that in the spawning tank) the eggs develop normally. Only the unfertilised and possibly damaged eggs die. The latter should not happen if the spawning medium has been transferred carefully.

With this method it is immaterial whether the spawning medium is fine leaved plants, nylon wool, peat, peat fibres or nylon mops.

But if one decides to collect the eggs, in order to check their number or to increase the quantity, we recommend, for the reasons given above, the use of nylon mops for easier handling.

It is not absolutely necessary to leave the eggs in the spawning medium. The eggs can be collected with one's fingers and placed in small plastic dishes, which are filled with water from the spawning tank to a level of two to three centimetres. These containers should have tight covers, so that evaporation and a resulting change in the chemical composition can be avoided.

The lids of these containers are labelled as described earlier.

The storage temperature influences the hatching time. As a general rule, the collected eggs can be stored at the same temperatures that are suitable for the maintenance of *Aphyosemion*, that is around 18 to 24°C.

It is usually a fact that higher temperatures accelerate the development of the embryos and shorten the storage time.

The shortest development time we have met with in a representative of the "*camero-nense*"-group is 14 days at about 24°C. As a spawning often lasts from two to four days, the development period will be extended by this time span.

One of the authors found repeatedly with numerous spawnings (storage temperature also around 24°C), and with an average 20 eggs in each batch, that four to five eggs did not hatch till later. After 20 days all the developed eggs had hatched.

Storage is also possible at only 16 to 18°C, when the hatching time is extended to 20 to 22 days. With problem spawnings resulting in a high rate of fungussing, DADANIAK tried storing the eggs in cold water at 16 to 18°C. Surprisingly the number of fungussed eggs decreased, with the result that only a few died. We can find no explanation for this phenomenon.

Checking the spawnings regularly. After the eggs have been collected, packed and stored, they should be checked several times a week.

For one thing one should make sure that the eggs are fertilised. The originally clear and slightly yellowish eggs develop a dark pigmentation after a few days (centre of upper picture, page 177). When they are stored in water, it is particularly easy to see the progress of the embryo's development through the egg membrane. For this a magnifying glass is good enough.

With a simple microscope this development can be followed better, with even the heart-beat being visible. The lower picture on page 180 shows a fry in the egg ready to hatch. We can see the front part of the fish's body, with the dark eyes. Also visible inside the egg is the longer bent rear part of the body.

We must of course take appropriate action when a lot of eggs fungus. Basically the white fungussed eggs should be removed immediately, whether the eggs are stored in peat or in water.

Male *Aphyosemion spec. aff. cameronense* Phenotype 3 "CGE 91/6"

If eggs fungus. We have already mentioned that unfertilised or damaged eggs will fungus. First a change in the albumen structure takes place, in which the egg becomes opaque. Then fungus attacks these eggs. The enormous spore production causes the fungus to spread.

In many spawnings one finds individual eggs which first turn white, and then they are attacked by a white fungus before disintegrating. Possibly the remains of the eggs are then broken up by bacteria. Sometimes it comes to the fungus being spread throughout the spawning. There are two explanations for this: either the fungus spores actually attack healthy eggs or the originally clear eggs were damaged or die for different reasons and are only then attacked by the spores.

To our knowledge there is no confirmed evidence that fungus spores can also infect and destroy healthy eggs.

The picture on page 180 above shows that on the black nylon fibres some eggs have already started to turn white.

The dry storage method using peat seems to restrict the fungussing. On the one hand the acetic acid content and the low pH of the peat could be responsible for restricting the appearance, reproduction or spread of the fungus. On the other hand, with this form of storage there is no direct contact between the eggs to enable the spores to spread easily from one egg to another.

Such fungussing also occurs when eggs are stored in water. It should be much simpler for the fungus spores to spread freely in the water.

Aquarium shops offer a range of remedies, which can be added to the water in the case of water storage. Using them following the dosage recommended by the manufacturer might limit or even prevent the fungussing of eggs when water stored.

However we are convinced that it is better to fight the causes of the fungussing rather than its consequences. Admittedly this is easier said than done, but an above average rate of fungussing is definitely an indication that one or several of the necessary conditions are not right.

In such cases one ought to try to change the temperature and chemical composition of the water, the food of the parent fish, the spawning medium, the quality of the peat and also the method of storage. As eggs seem to die above all when they are not fertilised, a change in breeders might be a remedy. Obviously there are males with poor fertilisation rates, which might be the result of a low sperm production. On the other hand we cannot exclude the possibility that there might be females for which fertilisation is impossible (?), or which produce eggs that are not viable.

It must also be remembered that closely related representatives of a subgenus or species group within *Aphyosemion* will sometimes cross in the first generation. There are genetic reasons (Different chromosome numbers) why the eggs are usually not viable.

Perhaps for some reason fish of different species were unknowingly mated. This would explain why a high percentage of the eggs fungus.

Hatching of the eggs. This signals the end of the fry's development in the egg. A few days before hatching the large eyes of the fish can be made out through the transparent egg membrane (see lower picture, page 180).

In both the natural breeding method and in water storage, the fry hatch on different days, so this process can last over several days. When the breeders are left in the spawning tank for longer periods, this can take weeks.

This phenomenon is observed above all when the parent fish are taken out of the tank and the eggs are allowed to develop undisturbed. Every day sees more fry appearing just below the surface of the water.

With the dry storage method the fully eyed up eggs have to be "wetted". This term refers to the process of placing previously dried eggs in water, to cause fry to hatch from the eggs.

At the end of the incubation period (the date of spawning and expected hatching date have been noted exactly), the peat or peat fibres containing the eggs are put into a shallow dish. There is water to a depth of 2 to 3 centimetres in the dish. The chemical composition is as recommended for spawning, in other words the total hardness should be around 10°dGH and the pH 6.5. It is neither technically possible nor necessary from the fishes' point of view to copy the water chemistry prevailing at the moment of spawning.

In the sixties and seventies many aquarists removed from the spawning tank a certain amount of water, which was kept well sealed in a clear and chemically neutral container. When the dry stored eggs from this spawning tank were wetted with the very same water, the chemical composition of the water really was the same. The conditions in the wild described by us show clearly that the same chemical conditions are never the same, when spawning and hatching are separated by at least two weeks.

The upper picture on page 185 shows an example of one of the plastic dishes that can be used for wetting peat containing eggs. Neither the shape, size nor type of container is important, provided they are designed to store food, in which case they will be non-toxic and water-proof.

If the room temperature is on the low side, we recommend that these dishes be covered with a sheet of glass or their own lid. This will help keep the water temperature within the range required. In heated rooms and fish-houses this is not necessary. In their first weeks and months young fish do not jump, as they are not strong enough to break through the water surface.

From our experience it would seem that on wetting, the water temperature should be two to three degrees lower than that when they were developing in storage. Consequently we use cool water of 17 to 20°C.

Obviously the drop in temperature combined with the eggs' contact with the water encourages the fry to hatch. In addition we recommend that the peat be stirred a little with the fingers. We are convinced that the fry are definitely aware of this mechanical stimulation to the egg membrane, and it seems to have a positive effect on the hatching results.

Norbert DADANIAK has found that shallow plastic containers like these produce excellent results for wetting *Aphyosemion* and other non-annual killifish eggs of many other genera

Here the fry on the lower picture on page 180 just a few hours later. Easy to recognise are the large dark eyes, which were already visible in the egg

Norbert DADANIAK discovered by chance how eggs can be induced to hatch by being gently shaken. On one occasion almost all the eggs remained unhatched after the usual wetting procedure, so he decided to take them to an aquarist friend, to see if he would have better luck in trying to hatch the fully eyed up eggs. He had put the eggs with the peat fibres and water used for wetting into a plastic bag. During the roughly half-hour car journey the bag lay on the passenger seat. When he arrived at the destination, half the eggs had hatched! And the remainder followed within the next few hours. It is worth noting that all the tricks he had tried previously had proved unsuccessful.

We cannot explain this phenomenon, but it shows us that we must always try to find new ways (which are often found!) to achieve success in the breeding of the small *Aphyosemion* species.

In the literature there have been frequent reports on how carbon dioxide encourages hatching. Blowing into the container with human breath, with its higher content of this gas than the atmosphere, may help stubborn eggs to hatch. A similar effect can be produced by a scattering of flake food.

Various aquarists have even tried to pump carbon dioxide into the water from a pressurised container. In this case the carbon dioxide removes the oxygen dissolved in the water, which might possibly encourage the eggs to hatch. However, our attempts to induce hatching by blowing into the container have had no perceptible effect.

Scattering flake food on the surface will cause bacteria to develop, and they might also reduce the oxygen content as well. We have not yet had any experience of trying this method.

Another way of encouraging the fry to emerge from the eggs is to use one's finger or a fine brush to add a few microworms to the eggs in their container. This fine fry food can be bred very easily (see page 195). The worms sink to the bottom where they stay, wriggling quite actively. Is it possible that their presence hinders the oxygen from getting to the egg membranes (a parallel to blowing in carbon dioxide)? Or might it be that their constant movement causes fresh water to pass by the egg membrane and thus raise the oxygen content in the immediate vicinity of the eggs? But this would contradict the hypothesis made with reference to lack of oxygen.

Or it may be that the microworms' wriggling movements induce the fry to leave the egg. This would then correspond to the observations made by ourselves regarding stirring and careful "shaking" of the eggs. Then there would be similarities between the addition of microworms and the forced hatching occasioned by transporting the fully eyed up eggs on the passenger seat.

So you will see that there are many ways of forcing stubborn eggs to hatch. We have given some possible explanations (there are certainly others), so it is appropriate to stress again now how important it is to "experiment" when breeding killifish.

The fry are transferred. If a relatively small container has been used for wetting, the newly hatched fry need to be separated from the eggs that have not yet hatched. With the help of a spoon, they are therefore transferred to a slightly larger container, in which they can be intensively fed during the first days.

For up to ten fry we can use plastic containers used for packing dairy products (cottage cheese, yoghurt and the like), margarine or various salads. These containers have many advantages:

- They are to be found in every household, so they cost nothing.
- There is no problem in removing any left over food.
- They can be repeatedly cleaned with a piece of foam, filter wool or a small cloth.
- The plastic is non-toxic, chemically neutral and durable.
- They are light in weight and unbreakable.
- Containers and lids of the same size can be easily stored inside each other when not in use. They are light in weight and take little space.
- The lids close tight and can be written on repeatedly (names of species, locality and even hatching date).

For this most breeders use water-proof felt-tip pens. The writing can be easily removed with methylated spirits. It is better not to use acetone (nail varnish remover) or other solvents, as these are bad for the health and attack many kinds of plastic. Another argument for the use of methylated spirits is their lower price.

Correct labelling is imperative, as the fry that hatch later will also need transferring. Mix-ups with other spawnings are to be avoided.

Consequent rearing. As the fry increase in size, they must be transferred to larger tanks of 20 to 30 litre capacity. The temperatures and water readings are as those given on pp 130 and 134 to 136.

A rise in temperature and water quality also increase the rate of growth of the young fish. At this period regular water changes and a varied diet will contribute considerably to the development of strong, healthy fish.

It is natural that the fry will not all grow equally fast, even if they originate from a spawning of just a few hours and hatched within one or two days. Frequently among the fast growing young fish are males which as they become sexually mature harass the smaller siblings.

When injuries are noticed, or if one observes that many fish are prevented from getting an adequate amount of food, it may be necessary to take out aggressive or subservient specimens.

These fry are being kept over a peat base, which makes the water a light yellowish colour

If peat is not used, the water remains colourless; here a bare bottomed tank means easier maintenance

These half grown young fish are swimming both at the surface and lower in the tank; again the home made internal filter can be seen

On fully grown males the lower red band is easily recognisable; on this specimen of *Aphysemion cameronense* it extends as far as the gills

When the young fish have reached a size of about 15 to 20 mm, they can be transferred to tanks of 50 to 100 litre capacity, where they can grow on to full size. It is worth remembering that, alongside feeding and water changes, the tank size itself and the volume of water influence the rate of growth (see **The comprehensive fish set-up**).

If the young fish are not transferred to larger tanks in good time, or if there are too many of them, it can happen that they will grow very slowly. It can even result in growth coming to a full-stop. Moving to a larger tank and regular water changes will normally remedy the situation.

The pictures on pp 188 and 189 show young fish of different ages.

The rearing food. The feeding of the fry is naturally extremely important. Compared with other aquarium fish, killie fry are not only fully developed but large enough to cope with freshly hatched brine shrimp. A rough impression of the size of fry is given by the lower picture on page 185. It is the same fry as shown on page 180 below. There is an interval of just a few hours between the two pictures.

Those with experience in breeding characins, barbs and labyrinth fish, for instance, will appreciate this advantage. Feeding with slipper animalcules (*Paramecium*) or similar small foods is not necessary with killifish (with the exception of a few species outside the genus *Aphyosemion*).

Besides the freshly hatched mosquito larvae mentioned at the bottom of page 151, there are three other outstanding foods available to us: brine shrimp which has already been mentioned several times, microworms and micro-eels. These foods are given to newly hatched fry and are listed in order of popularity among lovers of the genus *Aphyosemion*.

Brine shrimp is readily available. It cannot really be bred, as the shrimps live in sea-water and in salt lakes. Shops sell the adult brine shrimp as frozen food (page 153 top), but it is neither simple nor efficient to rear brine shrimp to their full size.

Aquarium shops sell the dry eggs of *Artemia salina* and related species in different quantities. When treated appropriately, the eggs produce the small crustaceans.

As brine shrimp are frequently vacuum packed, they can be kept sealed for several years. When the packing has been opened, the eggs should be refrigerated and used within a year, after which the hatching rate will drop markedly.

Brine shrimp has to be hatched by being placed in a certain amount of salt water, in which the salinity (= content of dissolved salts) corresponds approximately to that of sea-water. In the literature widely varying concentrations of salt are to be found: "10 grammes to a quarter of a litre", "30 grammes to a litre", "two heaped tea-spoonfuls to a litre" and "two tea-spoonfuls to half a litre". These different concentrations show that brine shrimp are very salt tolerant creatures.

The optimum concentration of salt is difficult to determine and certainly depends on where the eggs came from. So we recommend experimenting with the "recipes" given above, to find out the best concentration of salt for the eggs in question. For this it is a good idea to use small marked beakers or plastic measures as are available in the trade for determining the chemical composition of a volume of water. The numerous measurement markings enable one to read off the quantity in question.

In addition we can add our own markings. If need be, a suitable small receptacle can be made into a simple isntrument for the even measurement of the amount of salt used (our own "measure").

When the naupliae hatch (that is what the first stage of the brine shrimp is called on hatching), a short note will be of help in judging the quality of the salt water with varied quantities of salt for a constant volume of water. With a few trial tests the "best" concentration of salt can be arrived at.

In the trade there are on offer several brands of brine shrimp eggs of different species and from various places of origin. The water temperature and the age of the eggs influence the hatching rate. These factors mean that, in our opinion, there is not much sense in suggesting one recipe that will be better than any other.

The same is true for the optimum water temperature. On the packaging one finds hatching times for different temperatures. But probably the greater influence on the hatching time of brine shrimp is the salt content.

In general it will be found that the hatching time depends on the temperature and can vary from between 24 to 36 hours. But the higher the temperature of the water, the shorter lived the naupliae are. At temperatures around 26°C they will live for as little as 48 hours. At lower temperatures around 22°C they will hatch later but will survive for three to four days.

Many killifish keepers use a special fish-room, whose air temperature of 20 to 24°C is therefore quite high. In this case heating the brine shrimp for hatching is not necessary.

In unheated rooms brine shrimp can most easily be kept at a constant water temperature of 22 to 24°C in what might be called a water bath. For this purpose a small aquarium is filled with water, which is kept in this temperature by the use of a normal aquarium heater. The receptacles are stood in the water and stay at the appropriate temperature. These receptacles should not be of metal, as the salt-water might cause corrosion.

For hatching brine shrimp different kinds of receptacles can be used, but whatever they are they will need constant aeration. The trade supplies various devices which can be connected to an ordinary air pump (or even to our aeration system).

These devices are made to fit most bottles available in the trade. They can be closed air-tight and several can be run off each other. The pressure that builds up in the first bottle is passed on through an air tube into the next bottle. The drawing on page 192 illustrates the principle of brine shrimp hatching bottles connected to each other.

These pieces of equipment, together with ordinary glass or plastic bottles, make brine shrimp hatchers that are cheap and easy to clean. The previously cleaned bottles are filled with the prepared salt water. Then with the aid of a small funnel, the required amount of dust fine brine shrimp eggs is added.

The upper picture on page 193 shows two glass bottles, in which one of the authors hatches brine shrimp for his killifish.

One can never predict how many of the eggs will hatch, how many brine shrimp a fry of a certain age will eat in one day or how many fry exactly will need feeding. The amount needed will be decided by experience and instinct.

At first the dry eggs float on the surface. A light shake of the bottle and contents will cause the surface of the brine shrimp eggs to get wet, when they will slowly sink to the bottom.

The airline is then fed in and connected. The constant stream of air keeps the water and eggs in perpetual motion. This ensures an oxygen saturation of 100%. In addition the swirling movement seems to help the eggs to hatch.

A short interruption in the aeration of not more than 20 to 30 minutes does no harm to the eggs or the freshly hatched brine shrimp. Only after this period of time elapses does the oxygen content in the hatcher reach the minimum tolerated level, after which the brine shrimp will start dying.

So there is no problem in turning off the aeration whilst the brine shrimp are being removed for feeding. When the water movement in the bottle stops, it can be seen that the orange-red brine shrimp will sink to the bottom, where they collect at the deepest point. The empty shells and unhatched eggs on the other hand rise up to the surface.

The lower picture on page 193 shows a hatching arrangement with and without aeration, so that the brine shrimps can be seen settling at the bottom of the bottle.

Norbert DADANIAK uses such glass bottles for hatching brine shrimp for his killies

When the aeration is switched off, the naupliae sink to the bottom

If the bottle is tilted a little, the naupliae will become concentrated at the deepest point, which will become clear by the strong orange-red colouring. As the lower end of the pipe through which the air is pumped in has to lie on the bottom of the bottle, the end of this pipe can be brought to the lowest point at the bottom of the bottle by being turned the appropriate amount. It will then be in the middle of the mass of brine shrimp.

Now it will be seen why the bottles have to be air-tight when closed. If we now carefully blow in air, where it normally escapes from the bottle (and possibly led to the next bottle), the naupliae will be forced by the build-up in pressure into the air tube and so out of the bottle. We catch the high concentration of naupliae with a brine shrimp strainer, as available in the trade. They can then be rinsed in the water bath (advantage of the same temperature).

If the brine shrimp is not rinsed, the amount of salt getting into the rearing tanks with the brine shrimp is admittedly small, but repetition of this procedure once or several times a day can lead to an appreciable rise in the salt content in small containers used for rearing fry. We have not yet been able to see any disadvantages for the fry, but we would not like to exclude this possibility entirely.

The naupliae, which are now in the strainer, are then put into a shallow dish containing water from the water bath or water of the same temperature from a different source. If the water is only a few millimetres deep, there will be a sufficient supply of oxygen in the dish for the brine shrimp to stay alive for one or two hours.

If the brine shrimp are not rinsed but left in salt water from the hatching set-up, they will live longer. The quantities of brine shrimp can be fed repeatedly over several hours, as is appropriate. The risk of a too high salt content is non-existant, especially when brine shrimp is fed to half grown or adult killifish, owing to the larger tank size.

The picture on page 196 shows freshly hatched brine shrimp in a shallow dish. The small balls are unhatched eggs or empty egg membranes.

The more or less pure concentrations of brine shrimp can be taken direct from the shallow dish and put into the rearing tanks and plastic containers. For this, measuring precise quantities is virtually impossible. It is better to draw up the brine shrimp from the dish with a 20 cm long air tube following the principle of a mouth pipette. The brine shrimp can then be divided among the fry to be fed.

Of course it is easy to make a mistake, especially in the beginning, and get a few naupliae in the mouth. But one soon gets the knack of removing the correct amount of brine shrimp. This is necessary to avoid over-feeding.

Any brine shrimp left over will decompose, and, as they are rich in protein, nitrite will be produced. Fry seem to be particularly sensitive to this toxic substance, and there have been reports of drastic losses after excessive over-feeding.

Brine shrimp naupliae can be "produced" very easily and in quantities which can be determined to a certain extent. If there is an excess, it can be fed to older fish without any problem. Brine shrimp is the most frequently used rearing food for killifish. This food can be given to our killies practically through to old age.

Microworms (or "micro" for short) are also a good fry food. They are easy to breed and have just the small disadvantage that occasionally they give off a smell. It is advisable to keep the culture containers closed and let air in for a short time every day. If this cannot be done regularly, the lid can be provided with small holes.

For a culture one needs a shallow container of about 200 ml capacity, some food medium and a small quantity of worms, obtainable from aquarist friends or suppliers of live foods (see adverts in aquarium magasines). Within the DKG and its sister associations there are many breeders who can supply starter cultures at any time.

The culture medium for the tiny worms can be prepared in different ways. Rolled oats or baby food is mixed with full milk or skimmed milk to a sticky consistency. The actual proportions of the mixture are not critical. Anyone who wants to collect more findings on the reproduction of micro should use food media of different consistency and set up several cultures to arrive at the most favourable conditions for the worms.

Provided one makes sure always to have several cultures of varying age, no problems will arise, should one culture fail (mould, going off, over-acidity). In this eventuality a new culture is quickly prepared. Within a few days it will be producing worms.

The medium can be acidified with a little wine vinegar, but this is not absolutely essential.

The worms feed on yeast (hence the alternative name "yeast worms"), which is why a new culture gets yeast mould from the starter culture. The new cultures are kept at room temperature. Within a few days of the "seeding" of the fresh cultures, the first worms can be seen gathering on the side of the container (see page 197).

The use of transparent containers has the advantage that the development of the cultures can be followed more easily.

The depth of the medium in the containers can vary from one to five centimetres. After about two weeks the reproduction rate of the microworms slows down and fresh food must be added. This means that the volume of the cultures will automatically increase. So it is advisable to start up new cultures regularly and throw the old ones away.

A fine water-colour paint brush can be used for collecting the micro from the side of the container above the food medium. If this is done carefully, scarcely any of the medium will be removed at the same time, so no danger will arise.

The brush is then stirred in a shallow dish containing aged water and the worms distributed to the fry tanks.

The micro sinks slowly to the bottom with wriggling movements. They are about one millimetre long and are much less in diameter than *Artemia* naupliae. They are eaten by the smallest fry.

They live on the tank bottom for several hours. The rule for sensible and moderate feeding applies also to micro.

The freshly hatched pink to orange-red brine shrimp in a close-up

The so-called real micro-eels (also called vinegar eels) are seldom seen in fish-rooms of killifish keepers. Nevertheless we will mention this food here.

When one has acquired a starter culture, a feeding solution is made up of the following ingredients: half a litre of good wine vinegar is mixed with 650 ml of water and half a tea-spoonful of sugar. The mixture is then divided between two bottles and these "seeded" with half of the starter culture.

The micro-eels swim freely in the feeding solution and can be separated with a coffee filter. The solution that drips through can be returned to the bottles. The filter paper is folded and rinsed briefly under a tap in order to wash out the vinegar. Then the paper is unfolded and dipped into the tanks containing the fry. The little worms are about the same size as micro, but they do not sink to the bottom. The fish eat them as they find them hanging in the water.

A culture in good condition can last for as long as twelve months. Nevertheless, to be on the safe side, several parallel cultures are set up, as an insurance.

The disadvantage of micro-eels compared with micro-worms is that they are less productive. Their advantage is that they do not give off a smell.

In a culture a few days old, the micro begins to collect on the sides of the container,...

... where it then concentrates and is easily wiped off and distributed to the fry

What food can be given after brine shrimp, micro and vinegar eels? With a varied diet, regular water changes and no overcrowding, our little *Aphyosemion* grow quickly and can soon cope with larger foods.

Suitable at this stage are *Daphnia* and *Cyclops* naupliae. In addition Grindal and white worms can be given to the fish. But it has to be remembered that these worms are a very rich food and must not be fed too often. Admittedly the danger of fatty degeneration is not as great with young fish as it is with adult fish, but the other foods mentioned should form the main part of their diet.

If these foods are not available, either long-term or short-term, it is also possible to break into smaller pieces frozen food before it is thawed out.

Bloodworms, with their long, thin form, in particular, break easily into small pieces, which in part consist of just the individual segments of the larvae. Brine shrimp also quickly disintegrates into pieces which can be eaten by small *Aphyosemion*.

To break up frozen food into small pieces, some of the frozen food is placed on a hard surface and hit with a small hammer or something similar. So that the broken pieces do not fly all over the place and need carefully picking up, the frozen food is wrapped in a piece of cloth. The small pieces are then thawed out in a small quantity of water, and then measured out carefully before being fed to the fish.

For this, too, an air-pipe can be used as a mouth pipette.

Even when the rather larger young fish can cope with *Daphnia*, *Cyclops* or crushed frozen food, they are still given the three foods mentioned earlier, so as to give them as varied a diet as possible.With such high quality food the young*Aphyosemion* eventually reach the size at which they can easily take the food described for adult fish in the first part of this chapter.

The comprehensive breeding set-up. Anyone wishing to breed a strain of the "*cameronense*"-group or any other small *Aphyosemion* species in sufficient quantity, will need at least four or five aquaria of different sizes:

- One tank at least is needed to keep the adult fish, from which the breeders will be chosen.
- In a separate tank females intended for spawning will be conditioned for breeding and be particularly well fed.
- One tank will be used for the breeders to spawn in.
- In one or several tanks the fry will spend the first weeks of their lives. They will have been scooped out of the spawning tank (natural breeding method) or hatched on wetting (artificial breeding method).
- As they grow in size the fry will need a larger aquarium; plastic dishes or small tanks will be too small now.
- If several spawnings are made in succession, the fry of various ages have to be divided into several tanks, if they differ to much from each other in body size (aggression and competition for food may take place).

If the parent fish are taken out after a certain time, so that the fry that hatch subsequently can grow on in this tank, the number of tanks required will be reduced.

It is possible to have just one such spawning for each generation and strain and bring on the resulting fry to breed the following generation. This method, however, produces only small numbers of fish and, in the case of technical failure (heating out of action, gaps in the tank, other disasters!) or a serious disease problem, a generation can be wiped out.

It is then always doubtful whether in this eventuality the parent fish will still be available for a further spawning or if they can be persuaded to breed in enough quantity.

Many members of the DKG or other killifish associations have at some time begun as aquarists with one or two pairs of killies. With the first progeny arose the need for more tanks, so there are some aquarists who have built complete set-ups or even complete fish-rooms with aquaria.

The pictures on pp 200 and 201 give a good idea of what possibilities there are. Those not fortunate enough to have a complete room for a killifish room, can nevertheless try to set up a cabinet somewhere. With a width of one metre, 40 centimetres depth and a height of 180 to 200 centimetres, it is perfectly possible to erect four shelves, each holding five tanks, with a bottom surface measurement of 20 by 40 centimetres and a height of 20 to 25 centimetres.

These twenty aquaria make it possible to keep and breed several species and strains of the genus *Aphyosemion* or the "*cameronense*"-group.

Handyman aquarists will be able to build their own tanks and a large part of the technical equipment (lighting, aeration, filtration). There may be a friend or an experienced D.I.Y. member of an aquarist society who can give help and advice.

By being members of the DKG we learnt from killifish keepers how to make tanks using silicon glue. This enabled us to build efficient and comprehensive breeding set-ups at very reasonable cost. A further advantage of the do-it-yourself method is that the set-up can be built according to one's own situation (space and financial means) and also one's own requirements. In addition it can be repaired and altered if necessary, or even perhaps rebuilt.

It would be a success for this book, if some readers decided to take up killifish (and of course in particular the "*Aphyosemion cameronense*"-group!) and even build set-ups suited to their needs.

Do not hesitate to contact members of your national killifish association, when you will be able to acquire these beautiful fish direct from the breeder. As a beginner in the world of killies you will certainly be welcome in their fish-rooms, where you will see and learn a great deal.

This fish-room is in André CERFONTAINE's cellar (Visé, Belgium). The large number of tanks allows him to breed successfully many species and populations

In his breeding set-up André carefully keeps the very similar females well apart, in order to avoid unwanted hybridisations

René Hannecart from Mons in Belgium has this killie fish-room with the capacity of a medium-sized pet shop

This picture shows just a small section of this perfectly organised fish-room, in which many prize-winning show fish have been bred

Diseases and other Problems

A less pleasant but nevertheless important aspect of keeping *Aphyosemion* in the aquarium is the diseases that can affect them. The illnesses discussed in the first part of this chapter frequently occur when our fish are not kept in ideal conditions. This is why in the second part we explain the factors that can lead to the outbreak of disease. Finally we suggest how the outbreak can (at least in theory) be prevented.

The Diseases

Time and again even experienced keepers of killifish report surprising losses of individual specimens or even whole tankfuls.

Very few aquarists are in a position to consult an expert on fish diseases who has specialised in tropical aquarium fish. Nor are they often able to submit diseased or recently dead fish for examination, except on rare occasions. That is why we do not know precisely what diseases our *Aphyosemion* may suffer from.

For an accurate diagnosis the correct training, experience, specialist literature, laboratory equipment and special skills in the use of microscopes and knowledge of the anatomy of fish are required. But what aquarist can fulfil one of these requirements, let alone several?

So we refer to the information we have been able to take from the literature available to aquarists (REICHENBACH-KLINKE, 1968; AMLACHER, 1972; SCHUBERT, 1978; SCHMIDT, 1979; SEEGERS, 1980; WILDEKAMP, 1981; Birgit and Heinz MELHORN, Günter SCHMIDT, 1993). When diseases occur we recommend that these works be consulted for the symptoms and possible methods of treatment.

In principle killifish are sensitive to all the causes of illness that can attack fresh-water aquarium fish. These can be divided into viruses, bacteria, fungus, internal endoparasites and external ectoparasites.

The most difficult to diagnose is a viral illness, as all we have to help us is the outer manifestation of the disease. As a rule bacteria are rather larger than viruses, but a microscope is still necessary for a positive diagnosis.

Endoparasites can only be recognised when they can be identified in the affected organs. But for this the fish has to be killed.

It is only the ectoparasites that can be recognised visually by the aquarist, in many case indirectly through the accompanying symptoms of the infection.

Then we deal with the diseases that in our experience occur most frequently in representatives of the "*cameronense*"-group when kept in the aquarium. When it comes to an accurate diagnosis and effective methods of treatment, we have to refer to the literature mentioned and also to the remedies available in aquarium shops.

At the same time there may well be other diseases liable to occur, which we have not mentioned here. They are either very rare, difficult to diagnose or resemble other diseases, so that they "mimic" them.

Ichthyophthirius multifilis **or white spot** is a relatively common disease for aquarium fish (to their misfortune!). Most aquarists will probably have come across it. It can attack killifish of the genus *Aphyosemion*, including members of the "*camero-nense*"-group. On the fins and body appear large white and rounded spots with a diameter of 0.5 to 1.0 mm. In addition the affected fish try to free themselves from the parasites by rubbing against solid objects.

The aquarium literature contains plenty of advice on the treatment of affected fish. In the trade there is also a good selection of effective remedies.

Oodinium **or velvet** is a disease much feared by killifans. The symptoms are similar to white spot, but the pale spots are smaller and more numerous. They occur above all on the back of the fish, so that one has the impression the diseased specimen has been sprinkled with icing sugar.

Some aquarists have had good results using cooking salt to combat *Oodinium*. Two methods can be used:

- -for long-term treatment a low concentration of sea-salt is added to the aquarium as a preventative (about a teaspoonful to ten litres of water).
- -One can also try to use a higher concentration of salt for a short period. The fish are kept in these conditions for just a few minutes or hours (depending on the amount of salt).

In addition so-called copper baths with a solution of copper sulphate in various concentrations (1.5 mg $CuSO_4 \cdot 5\,H_2O$ to one litre of water) have been reported as possible remedies. The utmost care is recommended when it comes to the dosage, in view of the toxicity of copper.

Fish tuberculosis is sometimes attributed as the cause of death of their fish by some owners of killifish, when the fish have not suffered any of the other usual symptoms. How far this is the true cause of death cannot be stated with any certainty, unless the fish are examined properly.

This disease caused by bacteria is discussed more fully in WILDEKAMP (1981, pp 52 and 53). He himself does not consider an effective treatment with anti-biotics possible in every case. He recommends quarantine for newly acquired fish.

Dropsy very often affects individual fish. The body becomes distinctly round and appears as if it has been pumped up. The scales protrude from the body. According to WILDEKAMP (1981, pp 53 and 54), this too is a bacterial disease which is very difficult to cure.

Fungus can often be observed on injured fish: the outer layer of skin is destroyed during transport, catching the fish or as a result of fights with other fish. A whitish fungus growth appears on the edges of the fins, on the front of the mouth or where the fish has been bitten. The trade supplies some effective remedies, whose use should always be according to the prescribed dosage.

The outside wall of the hotel in Booué was where we discovered this moth with a considerable wing-span

One day, perhaps, this caterpillar will develop into a similarly large butterfly

Often found are grasshoppers with very striking colour patterns...

...as well as stick grasshoppers, which are better camouflaged in the grass

Unfavourable Conditions

Besides diseases and parasites there are some other factors which affect the health of our *Aphyosemion* and can even lead to serious harm or even the loss of the fish. We would like to try to identify them, explain how they work and make suggestions on ways of avoiding such circumstances.

Aquarium conditions which we like to call "not ideal" are the most significant. If important water readings are excessively high or low over a significant period, this can lead to a considerable weakening of the fish. Symptoms are changes in behaviour, reduced appetite, activity, colour and spawning.

A bad diet can also have harmful consequences, if it is not varied enough, or if it is too rich (too much white-worm and Grindal, or even the fatty degeneration caused by beef heart, which we strongly advise people not to use).

If too many fish are kept together in a too small aquarium, they can be put under stress, which will show itself in the changes of behaviour mentioned above. The resulting lack of space and the constant close contact with members of their own species (competition for food) lead to slower growth rate, reduced appetite and increased aggressiveness. In addition fish can cause injuries to each other, and these encourage the outbreak and spread of various diseases.

A high concentration of organic waste in the aquarium water causes a marked decrease in the vitality of *Aphyosemion* species. We think it possible that a densely populated small aquarium with insufficient water changes will not only cause a build-up of fish excreta and waste products, but may also cause the fish to release substances in the form of hormones which will restrict the growth of a fish and its tank mates.

This would be a natural mechanism within a set of rules, which limits the food consumption as well as the reproduction rate of the fish and adjusts them to disadvantageous environmental conditions.

If things improved, the drop in concentration of these substances would result in the fish eating more and starting to breed once more. In this way, nature appears to see to it that the fish do not invest much effort in reproduction when living conditions are unsuitable - the fry would in any case have practically no chance of survival. Instead nature prefers to encourage the survival of the individual, so that when better conditions occur later, the fish can breed adequately and maintain the species. The less active behaviour would reduce the aggression arising from the large number of fish in the tank. Consequently the number of losses through disease caused by injuries would be kept low.

On pp 130 to 132 we have explained the importance and efficacy of regular water changes. It is also possible that water changes not only remove nitrate and other end products of metabolism from the aquarium but at the same time keep at a low level the concentration of substances that restrict growth and activity, and which are produced (= secreted) by the fish.

At this point we would again stress the importance of regular water changes, a varied diet and the use of sufficiently large aquaria (see also in the third part of this chapter: **Prevention is Better than Cure**).

In this connection it would be informative to have series of experiments carried out in which fry from one spawning or from one pair of parents (the same or very similar genetic make-up) are divided into groups and reared under different conditions which had been clearly laid down beforehand. It would be worth finding the answers to the following questions:

- Is the rate of growth of fry of the genus *Aphyosemion* perceptibly influenced by total hardness, carbonate hardness, pH, electrical conductivity and content of metabolic products (nitrate) in tanks of the same size with similar temperature, together with food consistent in quality ?
- When fish are kept in aquaria, is it possible under controlled conditions, to establish any difference in effect between water quality, water temperature, number of fish in a tank and diet? Then it could be said which factors are of greater importance for the rate of growth of young fish, at least in the aquarium.

It would be important, in series of experiments, to alter deliberately the factors being investigated while keeping the others unchanged. This would continue over several generations and require a vast number of rearing tanks and spawnings. In addition one would have to work out precise procedures and draw up detailed reports on the results.

It would always be questionable how far information learnt from fish-keeping or aquaria could be transferred to conditions in the wild. Nevertheless we would still have sound principles to make it easier for us to provide optimum conditions for our killies in the aquarium.

Poisoning can be a danger for our fish which should not be ignored. A wide range of substances can be of significance.

Most common is the metabolic product nitrite, which has already been mentioned several times. How it arises and how it can be broken down by efficient biological filtration is discussed on pp 138 and 139. Symptoms of nitrite poisoning are given by the aquarium literature as breathlessness, increased nervousness of the fish and red gills.

Chlorine is a slightly greenish gas, whose strong smell can be noticed especially in indoor swimming pools. It is sometimes added to drinking water in order to kill any organisms in it that might cause diseases.

We can easily test our tap water for chlorine. Some water is poured from a shower head into a bucket, with the water being sprayed as finely as possible. The same thing happens as can be observed when a bottle of heavily carbonated mineral water is shaken. The chlorine gas, which is slightly soluble in water, escapes as it gets into contact with the atmosphere. If we do not detect the typical smell, then the chlorine concentration in the tap water is very low or even nil, since our sense of smell is very sensitive to chlorine.

The people in Cameroon and Gabon know how to grow superb flowers around their homes; here a picture taken at Djoum in south-east Cameroon

This photograph was taken outside the hotel "Relais de l'Ivindo" in Makokou (north Gabon)

Two more splendid flowers from the Catholic Mission at Djoum

This flower was photographed by a small stream in the "Monts de Cristal" in north Gabon

In the case of little or no appreciable content, the tap water can be used directly for small partial water changes. For one thing the concentration in the mains is always very low, and the chlorine is reduced in concentration as it enters the tank water, which logically speaking should itself contain no chlorine.

But to be quite safe, we recommend that tap water with a low chlorine content should be left to stand for at least an hour before it is used for water changes. If for instance the water is allowed to run into a bucket from a shower head, just this action will expel a considerable amount of the chlorine. The rest of the gas then escapes in a short time without any further action on our part.

If there is a relatively high chlorine content (distinct smell), the water must be left for a longer time span before it can be used. In this case there is also the possibility of accelerating the release of the gas by aeration (air-stone).

Aquarium shops sell products that can be used to condition tap water for aquarium use. But anyone with enough patience and the necessary space can do without them. What is there against leaving the tap-water for a water change in a simple bucket for a few hours?

Alternatively a separate tank in our set-up can be used, with the addition of an air-stone for aerating the water. In this case chlorine poisoning is virtually impossible, and the money saved on the chlorine treatment chemical can be invested in another way for the good of our fish.

Filter wool can in many instances contain production residues (phenols). These chemical compounds are toxic for aquarium fish. So we recommend that this irreplaceable filter material be rinsed under the tap before being used in the aquarium.

We have carried out special experiments: when the water used for rinsing is poured into a clean bucket before it is brought into contact with the filter wool, no particular scum is seen to appear. After rinsing the wool, however, scum can clearly be seen to have formed.

Copper piping has also been blamed for having toxic effects on aquarium fish. In the first years in particular after its installation, no coating has yet formed on the inside walls of the piping, so that copper ions (Cu^{2+}) are released and may enter the aquarium via the tap-water.

Here too the aquarium shops sell the products mentioned above to solve the problem (binding heavy metals), although this can be achieved much more simply. Before taking any tap-water, we let it run for a short time, so that a few litres are wasted. This water had been in the domestic supply for some time and might have absorbed copper. The subsequent water comes from the supply system outside the house, is considerably fresher (and normally of better quality) and should at least be free of copper.

The wide variety of sprays affecting the environment may be responsible for these substances getting into the aquarium (and our own bodies?) via the tap-water. Measuring these chemicals in very small concentrations (and the proof of the presence of these substances themselves) in water is impossible for the aquarist. Therefore we cannot say if there have been to date cases of fish dying in the aquarium as a result of pesticides, herbicides and/or fungicides.

Total protection from these substances is probably an impossibility. They can only be removed to a certain extent by filtration over activated charcoal or a reverse osmosis unit.

If instances of poisoning should occur, one should try to remove most of the unknown substance from the aquarium by a water change. In addition, filtration over activated charcoal is advisable. After a few days the charcoal must be removed from the filter. Otherwise it can happen that the toxic substances will be released from the charcoal and result in further losses.

Prevention is Better than Cure

This proverb from the world of health can be applied to the maintenance of our killifish.

In the previous chapters we have repeatedly pointed out the importance of good aquarium conditions. This principle applies not only to the maintenance of the fish and good breeding results, but also to the avoidance of diseases.

Diseases break out above all when one or several of the tank inmates is weakened in any way. In this connection one speaks of "weakness parasites". Most pathogenic agents and parasites are present in aquaria in latent form. The fish are normally in good to very good condition, which is why there is not an outbreak of the disease.

It is never possible to rid an aquarium or even a whole fish set-up of every disease. The drastic treatment required would do more harm than good. Moreover we keep getting new species or strains from other aquarists.

But by keeping to certain basic principles, we can see to it that our fish can live with these pathogenic agents and that no outbreak of disease occurs.

Anyone with enough space and tanks can set aside a quarantine tank - or perhaps, in view of the danger of female *Aphyosemion* getting mixed up, several. New acquisitions are observed in them and integrated into the set-up after a quarantine period.

In addition we make sure the fish get regular water changes and a varied diet, which is, of course, not too rich. We check our fish as often as we can, so that sick specimens or any behaving strangely can be promptly transferred to the quarantine tank (separation from other fish, scratching, rubbing). If one has the chance to get new fish from an aquarist oneself, one can check that the specimens are healthy and in good condition.

It is better, for the sake of one's whole fish collection, not to accept a species you are after, if the fish are in any way suspect.

Behaviour: Aggressive and Peaceful Disposition

Numerous fish species are the subject of scientific publications dealing with the biology of their behaviour. Unfortunately we know of no publications that discuss this topic with reference to the genus *Aphyosemion* and the "*cameronense*"-group in particular.

Only Brosset (1982b) investigated the behaviour patterns of killifish by studying the genus *Diapteron* both in its biotopes in north Gabon and in the aquarium. How far he was able to work out principles that can be applied to the related and syntopic *Aphyosemion* of the "*cameronense*"-group, we are unable to say.

Even though we have repeatedly been able to observe the behaviour of members of the "*cameronense*"-group and other species of the genus *Aphyosemion* in aquarium conditions, it has not been possible for us to make objective and verifiable findings, which could be used to provide a basis for a biology of the behaviour of these fish.

To be honest we must admit that the amount of work involved in breeding the large number of strains has been too great to allow us to venture into this territory, which is foreign to us. With the successful collecting trips of 1989, 1990, 1991, 1993 and 1994 (a total of seven trips with roughly 60 new strains!), the responsibility of maintaining these populations has outweighed all other considerations.

Moreover we lack of course experience and methodical (= scientifically meaningful) procedures for investigating the biology of the behaviour of killifish: certainly a very interesting area for biologists. We would support attempts in this direction with all the means available to us (see also the chapter **Summing-up**).

One of their characteristics has given killifish a particularly bad name among aquarists. It can be summarised as "Killies are shy, aggressive and short-lived fish". Nevertheless, in Germany alone about 1,000 aquarists have joined together in the Deutsche Killifisch Gemeinschaft to make an extremely successful association. So there must be something wrong with this general judgement.

Obviously one of the basic requirements of an aquarist is to be able to enjoy his charges for as long as possible, without having too many problems with the fish. An unfortunate impression will be the result, if the aquarist sees his recently acquired fish fighting to such an extent that only a few fish are left. An equally unpleasant experience is the sight of the strongest specimens of a swarm of carefully reared young fish coming through successfully at the expense of the weaker fish, and treating them as welcome food.

These experiences have certainly been shared by many members of the DKG and other aquarists, who bought killifish in order to "give them a try". Beginners in particular have not been spared misfortune. But is this not true of other aquarium fish?

In this chapter we want to try as best we can to describe the behaviour of the fish dealt with in this book and thus counter the above-mentioned prejudice concerning their excessive aggressiveness.

Behaviour in the wild. In nature dominant males occupy the best places in the biotope, in order to attract as many females as possible for mating. Probably these places also provide sufficient protection from predators, so that the most strikingly coloured specimens (in fact the dominant males) are at least risk there. The less colourful subservient and younger males together with the uniformly brown females have to stay in less protected places. This distribution can also be observed in the aquarium: the dominant males always have the most intense colouration.

If a female approaches a dominant male (which is always ready to mate), he will mate with her. How this takes place precisely and what stimuli and sets of rules operate would be very difficult to observe in the wild. One would have to stay absolutely still on the banks of the stream for a period of several hours, when one might be very lucky to observe the process of mating and spawning.

If the female is ready to spawn, she will probably deposit eggs. If this is not the case, the males will become aggressive towards the female, probably in order to drive her away from the vicinity. One can imagine that the male would like to make the territory he has acquired available for the next female.

This assumption would explain why the territorial male *Aphyosemion* are brightly coloured and the females that move around are correspondingly plain. In addition subservient males in heavily populated biotopes are forced to protect themselves with their less bright colourations. The males use their splendid colours to attract the females and to signal to fish of the same sex and species that they claim this territory and will defend it, should the need arise. The risk of being discovered and eaten, thanks to their bright colours, would be compensated by a high number of fertilised eggs.

When *Aphyosemion* are caught in their native streams, it is repeatedly found that the young fish keep to the extremely shallow places, above all near the bank and in quiet spots where leaves and mud have settled. The water level frequently amounts to only one or two centimetres. This makes the small fish safe from larger and deep-bodied fish like barbs, Characins, cichlids, bush fish and cat-fish.

It is probable that as they approach sexual maturity, the *Aphyosemion* move around more in the streams. The young males will be looking for suitable places for spawning and the females will look for partners, if they are ready for spawning.

As there are also streams in which the *Aphyosemion* seem to have no predators in the form of fish, the killies can on occasion be observed and photographed from the bank, without their being disturbed. The picture at the top of the next page was taken between Sam and Médouneu in January 1993 and shows an adult male *Aphyosemion cameronense*. If you look carefully, you can see in the middle of the picture that the fish is just below the surface of the water.

The chance of observing the actual process of spawning is virtually out of the question during a collecting trip. There just is not enough time available.

This specimen of *Aphyosemion cameronense* mentioned on page 215 was photographed at the locality in north Gabon

A male *Aphyosemion cameronense* from the "Biobouleman" locality in Cameroon. It has a weaker body colouration and a deportment which could be called "normal"

This adult specimen of the *Aphyosemion cameronense* strain "LEC 93/3" is dropping its lower mouth, so that its head appears larger

A male *Aphyosemion amoenum* of the "Sonbo" strain shows the curved spine during the confrontation

Behaviour in the aquarium. Keeping representatives of the "*cameronense*"-group presents the experienced aquarist with no problems, if the necessary technical resources are available. He will then have the opportunity to observe these fish in the so-called "normal" deportment and "colouring". Such a male can be seen on the lower picture on page 216.

When adult fish are in a certain "basic mood", i.e. without any rivals at the time, the fins are not completely extended. The fish stand in a favourite place or slowly swim around the whole tank looking for food.

The species of this genus are not shoaling fish, so they can be called "loners". This characteristic could be the main reason why a hierarchy is established. This will take place shortly after several semi-adult or fully adult *Aphyosemion* are placed in the tank.

The same also happens when individual fish are introduced into a group of fish kept together which already have an established hierarchy.

It seems that usually the males take up a dominant position, and that their tendency to aggressive behaviour is in general more strongly developed. Ritual confrontations for the setting up and maintenance of the hierarchy are observed in most cases between males, less frequently between males and females, and only in exceptional cases between females.

The social position of an individual fish within a group is determined by different behaviour patterns, which can last from a few minutes to an hour, depending on the degree of dominance of the stronger fish.

If two equally strong individuals meet, they first begin by swimming around each other and threatening each other with outspread fins. This behaviour can be seen in the upper picture on page 220. It is worth noting that in this case the two males fighting are *Aphyosemion amoenum* "Sonbo" and *Aphyosemion cameronense* "LEC 93/3".

These two species do not occur syntopically in the wild (they do both belong to the "*cameronense*"-group). Moreover, according to our reckoning, the distance between the two localities is 450 km as the crow flies. Nevertheless it was very simple to place them together after a short separation and thus cause a ritual confrontation.

Systematic experiments could perhaps show what stimuli males react to in particular, and how strong their aggressive behaviour towards representatives of other species groups is in comparison with members of the same species, or representatives of the "*cameronense*"-group.

One could also use the *Diapteron* species or the *Aphyosemion* species that occur syntopically with these fish (*Aphyosemion exiguum*, "*Aphyosemion herzogi*"-group, *Aphyosemion punctatum*, *Aphyosemion loennbergii*, *Aphyosemion raddai*) or even from quite different areas ("*Aphyosemion gardneri*"-group, *Aphyosemion bualanum* s.l., "*Aphyosemion calliurum*"-group, "*Aphyosemion coeleste*"-group, "*Aphyosemion elegans*"-group and a few others). We discuss these possibilities further in the chapter **Summing-up**.

In fact when one observes killies fighting, the colours of the males can be seen to get more intensive. Probably *Aphyosemion* are able to react to certain colours, colour patterns or combinations of these in connection with certain patterns of behaviour and sets of movements. Stronger colours are perhaps meant to signal clearly to a member of the same species that there is in front of it an adult specimen of the same species.

After this phase of mutual threats the fish begin to display to each other by moving in front of or alongside the other. Strong movements with the rear part of the body produce a current which is directed at the adversary.

When a male stands in front of the head of another male, facing the same direction, he stretches out his unpaired fins and quivers with his tail. One gets the impression that the fish is trying to swim against a strong head current. The water flowing backwards meets the rival head on.

If the males are positioned parallel to each other, one of them tries to perform twisting movements with its fins which are stretched to splitting point. The aim is to cause a current on to the side of the rival. The widely extended fins strengthen the resulting movement in the direction of the rival.

We guess that this behaviour is meant to give the other male a clear impression of the physical strength of the combatant. From our observations this phase can last up to 15 minutes. It is continually interrupted by threats with outstretched fins.

If both fish are about as strong as each other, the combat continues. At this point it can happen that the fish start to bite. These attacks are made on the mouth and the unpaired fins of the rival. On the upper picture on page on page 217 we can see that the fish's dorsal fin has already been torn towards the back. This is the result of the attacks made by the other male.

To further emphasize their own strength and size, the males can lower the flaps of skin in the bottom area of the operculum, so that the head appears even larger (top of page 217).

Frequently the fish bend their back-bone, as can clearly be seen on pp 217 and 221. Both pictures on page 221 show the same male. In the upper picture the normal position of the spine can be seen, whereas in the lower picture it appears to be bent vertically in a slight S-shape. It is possible that this behaviour serves to create an "optical illusion" of greater size.

Even if the fight continues and the aggressiveness of the fish carries on increasing, really serious injuries only occur when the fish are kept in a tank which is too small and does not have sufficient hiding places for the weaker male. In a larger aquarium, in which other killifish are kept as well, the weaker male will give up and the aggressive behaviour of the stronger male will be turned on other fish.

In the wild one imagines that subservient males swim away to avoid further harassment from the dominant fish. Because of the *Aphyosemion*'s tendency to stay in a limited area, backing off the relatively short distance of a few metres should be enough.

The first phase of the fight: a male *Aphyosemion cameronense* "LEC 93/3" (behind) and *Aphyosemion amoenum* "Dibang" swim round each other

This male *Aphyosemion mimbon* of the "GEB 94/25" strain has incurred a harmless injury on the dorsal fin during a fight

This male *Aphyosemion mimbon* "LEC 93/19" is not yet displaying fully outstretched fins...

...but shortly afterwards it displays fully and bends its back-bone; male *Aphyosemion* show their full colours in this body position

This detailed description of the fights could give the reader the impression that *Aphyosemion* are always fighting each other. In fact, such altercations are seen only rarely. They can be produced intentionally by keeping adult males on their own for a few days and then placing them together.

A prerequisite is that they should be about equally "strong". Whether a male, however, is in "fighting mood" or rather disinclined to test rivals' strengths depends on his frame of mind at the time and also on the other males. In addition, an important part is played by other factors such as water temperature and water quality, which the aquarist can control.

When fish are kept in good conditions in sufficiently large tanks with hiding places, this behaviour is seen only in the rarest of cases. A permanent hierarchy is established in the tank which means there are only insignificant quarrels, which are seldom noticed by the aquarist.

Altercations can also be caused by placing together breeders after they have been separated for some time. The females show little reaction to the males' threatening gestures and repeatedly react for short periods by responding with similar behaviour, but virtually no long-lasting fights develop from them.

Females that are injured on these occasions are probably not in the right mood or else too young. This increases the males' aggressiveness (see pp 174 and 175).

In contrast with many other aquarium fishes, our *Aphyosemion* (and almost all killifish, by the way) have only a weakly developed instinct for protecting their progeny. In fact it is limited to hiding the eggs as well as possible in the spawning medium and then leaving them to themselves. Moreover they are liable to look for the eggs they have deposited themselves - as we have stated at the top of page 170.

We cannot give any further information on other instinctive patterns of behaviour, as we cannot say to what extent these can be caused or altered by fish being kept in aquarium conditions.

Male *Aphyosemion cameronmense* "CGE 91/9" from south Cameroon; on the opposite page Phenotype 1, locality "CGE 91/12" from Mvilé

The peaceful disposition of the representatives of the "*cameronense*"-group amongst each other as well as towards other killifish makes these fish interesting and easy to keep aquarium inhabitants. This is always true if we keep in the same aquarium fish from other families and places of origin.

It seems to have some bearing how much a member of the same species is recognised or at least suspected. The more an aquarium inmate differs from the body shape and colouration of an *Aphyosemion* and particularly of the species in question, the less likely it seems that it will be attacked by our killies.

The observations made in the chapter The accompanying Fauna in the Biotopes show us that a representative of a syntopic species group of the genus *Aphyosemion* differs so markedly in external appearance, that in the wild these fish can live side by side in a relatively limited area. This suggests of course that an *Aphyosemion* male will show no interest at all in an aquarium fish with a completely different appearance.

We go so far as to say that many breedable pairs or males of the most different aquarium fish (angels, Siamese fighters, gouramis, *Anabantids*, *Apistogramma* species, *Pelmatochromis* species and other cichlids) or certain shoaling fish (tiger barbs, serpae tetrae) can disturb the tank population far more than most killifish.

One must not forget either the fish which in later life become decided loners or grow so much that they harass the other aquarium inmates: the sucking loach (*Gyrinocheilus aymonieri*), the red-tailed black shark (*Labeo bicolor*), the Bala shark and many armoured catfish of the genera *Plecostomus* and *Ancistrus* can all turn into real problem fish. Nevertheless these fish are more often sold by the trade than killifish, which are at least as interesting and definitely more beautiful.

Our killies' peaceful disposition towards peaceful aquarium fish such as live-bearing toothcarps, characins, *Danio*, *Brachydanio* and *Rasbora* species, labyrinth fish, catfish and small cichlids is pretty well exemplary.

Unfortunately this aspect is usually neglected in the literature. Perhaps this book can help change widely held views on this aspect of killifish keeping.

The two males from the upper picture on page 220 facing each other in a different position

A further phase of the threatening behaviour is a position slightly to the side, in which both males approach with their mouths close to each other

Rivals in the same position as in the previous picture

One male each of the two strains "EMS 90/4" (left) and "LEC 93/3" (right) measure each other up; note the 265 km distance between the two localities

The Variability of Killies in the "*Aphyosemion cameronense*"-group

In the chapter following this one we will discuss in detail the species described to date and the divergent phenotypes of the "*cameronense*"-group. Before we do so we will first investigate their variability. In doing so we would like to show that every single killifish has its own individual body markings (like a "face") and that it gives a certain degree of variability, which in the past led to the description of separate species. Today we know considerably more locations as well as the body colouration of the populations according to their geographical location. In our view this requires a detailed method of considering the known species and the phenotypes that differ from them. This should lead to a comprehensive revision of this species group.

An almost unique characteristic of killifish is the fact that they always differ from each other in appearance. This becomes visible at every zoological level: the family of killies (or, more correctly, *Cyprinodontidae* = egg-laying toothcarps) can be divided into many sub-families, genera, subgenera, species groups and species. At the same time these fish differ sometimes considerably from other genera of the same family and again from other species groups within the same genus.

Variability in the wild. Anyone who visits the native countries of *Aphyosemion* and looks for them very intensively in a given area will very soon discover that in different streams he will find fish of the same species or at least having a similar appearance. Using the literature available he will work out the colouration features which will enable him to place the fish in a certain species. Nevertheless, the fish he caught will not agree in every respect with the species illustrated in the book he has brought along with him.

On the caudal fin, for example, there is a very broad yellow band, which actually should be light blue and narrower. Or the red spots are much more regular than usual. The situation gets even more confusing when, in another stream just ten kilometres or so further on, this species is found again, and this time it differs again from the previously found population - and also from the illustrated fish.

For many people on collecting trips this will be no reason for concern or special consideration. Others, on the other hand, will wonder if they really have the right species in the net, or if they might have found something new. Finding an answer to this question is really not at all easy.

The basic problem with killifish and the genus *Aphyosemion* in particular is the difficulty we have identifying a species. When most of the species known now were described, only a few strains were known; moreover many type specimens came to Europe as fixed material. Little was known of the colouration of live fish, and colour photography was in the early stages of development, so it was of little help. Today we have more detailed knowledge available to us. This is in no way meant to belittle the people who worked on these fish in the past.

It was not until the early sixties and subsequently in increasing scope that numerous killie locations became known. Their distribution areas were visited more or less systematically, so that these fish could be brought back live to Europe.

It is abundantly clear that, using a single locality, one cannot say exactly what the fish look like in other streams. Collecting fish from locations here and there can only have the value of random sampling. Besides, distribution frontiers cannot be determined, as one does not know if a divergent fish has "only" a different colouration and thus belongs to an already described species. Or else it might with some qualification be described as a new species. To make this way of thinking clearer, we will use an "experiment" with two fish well known to us:

- On page 228 we can see two adult *Aphyosemion* males, which at first sight show themselves to be very similar. The basic body colour is blue-green, two red bands parallel to each other run along the rear part of the body. The markings on the front part of the flanks are almost identical and, with a little imagination, one can see the body shapes and fin markings as being the same.
- Both fish come from very similar forest streams in the south of Cameroon. They are the same size and show no difference in behaviour.
- Fortunately we have the relevant females, which show no difference at all from each other.

If we had only these two "forms" available to us, they would enable us to make two important deductions: the fish are very closely related to each other and yet there is a striking difference in that one fish has a large yellow blotch near the caudal peduncle.

If one studies this special case of variability in isolation, without knowing further locations and without having the possibility to compare the body colouration of the relevant fish, two conclusions are possible:

- The two forms belong to one species, the differing colouration of the caudal peduncle is more or less a matter of chance and occurs now and again without any particular regularity. Between the purely blue form (in this case one of two locality variants) and the form with the yellow caudal peduncle, there are transitional forms which belong to the same species. These forms have in the caudal peduncle a yellow blotch, which ranges from being more or less distinct to being completely absent. The size and intensity of the yellow blotch would then be subject to a local to regional variability.
- The distinguishing feature of the yellow blotch is from this viewpoint reason enough to consider the two forms as separate species within a group. All further populations with the yellow blotch will be placed with the second species. Forms without the yellow blotch automatically belong to the blue species. This way of considering in detail the starting point should allow us to predict that on the frontier between the two species there is an area without transitional forms. They come very close to each other, so that we can find two neighbouring but unconnected streams, which each contain one of the two species.

Aphyosemion cameronense "HJRK 92/11" has no yellow blotch on the caudal peduncle...

...whereas *Aphyosemion amoenum* "EMS 90/9"!

Without an adequate number of location variants (= populations), together with their appearance and place of origin, it is therefore virtually impossible to decide in favour of either of the two possibilities mentioned. So it is impossible to solve satisfactorily the problem of the divergent body colourations.

One way out of this problem would be to collect fish in a planned and systematic way, first in the immediate vicinity of both localities, and then in the area between them. One would have to concentrate particularly on seeing whether the yellow blotch is present in several populations, how variable it may be within a locality (there may be individual specimens which lack it completely) and how it changes particularly with regard to the blue forms.

The crucial question is whether, despite the variability from one location to another, there is a stable characteristic which can be used as a general argument for the description or recognition of a separate species.

In the example chosen by us, RADDA & PÜRZL's collecting efforts in the seventies produced a large number of populations from the south of Cameroon (Méfou, Lolodorf and others), which showed a uniform blue-green shade on the flanks, but never a yellow blotch on the caudal peduncle. They recognised that these fish all belonged to the same species, which was described as *Aphyosemion cameronense* by BOULENGER in 1903.

But in addition, on 4.12.1975., they discovered at their locality 24 a killifish which probably corresponded in appearance to the male in the lower picture on page 228. The most striking feature was the yellow blotch at the back of the caudal peduncle. The other characteristics of the specimens examined corresponded largely to the data and colour pattern reported for *Aphyosemion cameronense*. RADDA & PÜRZL chose this locality as the terra typica when they described the new species. They recognised the stability of this distinguishing feature and they thought it justifiable to regard the fish as a separate species. It is still today considered to be a valid species.

All subsequent collecting efforts in the area around the terra typica of *Aphyosemion amoenum* have produced fish similar in appearance, but so far no transitional form to *Aphyosemion cameronense*. The fish from the individual localities of this species do differ from each other in the body colouration of the males, but this degree of variability is not sufficient for each of these populations to be regarded as a separate species. Moreover these populations would probably be interfertile, with nothing to stop them hybridizing with each other.

So RADDA & PÜRZL decided to solve the problem by using a constantly recurring feature (the Yellow Blotch) as a characteristic in the description of a separate species (*Aphyosemion amoenum*).

There are fish discussed in the following chapters which are today regarded as valid species (or subspecies by many authors). There are others, Phenotypes 1 to 9 of the "*cameronense*"-group which have not yet been investigated fully. All these fish provide further examples of forms which, because of the males' divergent colouration features, cannot be regarded as belonging to the species *Aphyosemion cameronense* itself.

A theoretical consideration of the variable features. We are assuming that the killifish discussed in this book - i.e. the members of the "*cameronense*"-group - represent a closed entity within the enormously variable genus *Aphyosemion* (see also the chapter **What is a Killifish of the "*Aphyosemion cameronense*"-group?**). We, in agreement with other authors, call it a "species group".

In some other cases one would speak of subgenera.

This approach is justifiable by different externally recognisable characteristics, such as the number of scales and fin rays as well as the frontal scalation pattern, which scientists study in particular. In addition there are the colouration features already mentioned on pp 19 to 38. These can be used by the aquarist without scientific training.

In particular the first mentioned characteristics, not concerned with colouration make it possible to place an *Aphyosemion* into this species group with confidence. Unfortunately for the killie enthusiast, these are in practice not visible to any appreciable extent. These characteristics are present in all representatives of the group, clearly constant and therefore stable. This fact we would like to describe with the concept "group-relevant homogeneity" (homogeneity = uniformity).

By this we mean quite simply that all the representatives of the "*cameronense*"-group can be defined together with these criteria. We think of the criteria themselves as "primary characteristics", as they do not vary from one species to another, or from one phenotype to another. By the nature of things these must be stable within the species group (i.e. always present).

The colouration features, which allow a separation of the species and phenotypes are very unstable at the level of species group. They are therefore regarded as "secondary characteristics" (i.e. as specific for the individual representatives).

However, if we consider the next smaller entity as a species or a phenotype, then the previously unstable secondary characteristic becomes stable and primary, since it has to define this species or phenotype. So in this case we talk of "species-relevant homogeneity". When the different strains and locality variants are compared, differences again occur, and these can be called unstable and secondary at the species level. They enable us to recognise a particular coloured male with some degree of probability as belonging to a certain strain.

At the next level the characteristic previously called unstable becomes the "population-specific characteristic" with which to recognise a strain or population. It is common to all males of a population. In addition we can recognise in each male special colouration features which enable us, after a certain time (depending on the number of individuals), to recognise each individual fish. In this case we speak of stable characteristics which give us the "population-relevant homogeneity". To distinguish one fish from another we use individual features.

So with various stages of variability "from top to bottom", we are able to define a species group, a species (or phenotype), a strain (or population) and finally an individual.

With the following table we mean to represent this idea in condensed form:

Level	**Characteristic**	**Homogeneity**	**Variability**
Genus *Aphyosemion*	meristic, morphometric, biogeographical	group-relevant	defines the subgenus or species group
"*cameronense*"- group	meristic, morphometric, partly the colouration patterns, biogeographical	species-relevant	defines species or divergent phenotypes
Species or phenotype	Colouration of the flanks and the fins, regional or hydrographic	population- relevant	defines from the exact place of origin a strain or a population
Strain or population	distinct colouration characteristics; variable in number, size and arrangement; local	individual relevance	makes it possible to distinguish individual specimens

We are having to deal with a high degree of variability, which is not found with any other aquarium fish. Of course the vast majority of killifish, as decided loners, develop an individual body colouration, which is why they cannot be compared with characins, barbs or loaches. But if we consider cichlids, labyrinth fish, catfish or live-bearers, which on the whole do not live in shoals but in some cases can even be called "loners", we never find the colouration so developed in individual specimens. Exceptions like *Lebistes reticulatus* (*Poecilia reticulata*), the genus *Symphysodon* and a few other examples (cichlids) prove the rule.

Aphyosemion spec. aff. cameronense Phenotype 2 from Nsessoum

Variability in the aquarium. What we can observe when catching *Aphyosemion* in their biotopes is also true when they are kept in the aquarium. Just by looking at a tank containing several males of one strain, one is struck by the fact that each male has its individual characteristics. This can affect a wide range of features:

- General colouring; the fish seems to be more bluish or greenish; the relative proportion of red colour elements is higher or lower.
- The breadth of borders and bands varies from narrow to broad.
- Depending on the individual, these features are white, light blue or yellow.
- The number, thickness, size and arrangement of the red coloured elements on the flanks or fins are also subject to wide variations.
- Individual points of the unpaired fins have longer or shorter extensions and have different colouration (white, light blue, yellow or orange).

The two pictures on the opposite page show that two males of one strain exhibit distinct differences in body colouration, even when they come from one spawning and - provided just a pair was used for breeding - are brothers.

The relatively dull colouration of the females makes it difficult to identify individual variability, but close examination and direct comparison will show that the number and arrangement of the red spots on the flanks are also arranged differently in each individual female.

The wide variations between the males of one spawning mean that the killifish keeper can use the most beautiful specimens for breeding. In this, of course, subjective feelings play a significant role.

In contrast with live-bearing toothcarps, it is neither meaningful nor in fact practicable to set up guide-lines for the evaluation of a single fish. Line breeding with the aim of splitting up a strain into colour forms might seem an attractive idea, in view of the extreme variability of individual fish. However, the enormous variation in subsequent generations would make it impossible.

Even with rigorous selection according to a definite and clearly existing criterion, the breeder will never succeed in making this feature a fixed hereditary characteristic. For example, it would be pointless to select a male *Aphyosemion amoenum* with particularly intense yellow bands in the caudal fin and use it to create a strain in which the progeny always had brilliant yellow bands. Males would always occur which had only one or even no band at all.

So, although it is impossible to fix a specific characteristic genetically, we still have the sum of the colouration characteristics which make a strain or population recognisable. This is also true of a species and a phenotype.

If we therefore wish to keep going a pure strain without bringing in unrelated fish to breed into it, we will never get two perfectly identical males or females, and the successive generations will nevertheless be recognisable as belonging to this strain. This unique characteristic is part of the fascination produced by killifish.

The variability of *Aphyosemion* is enormous. At first sight one and the same fish,...

...but two different males of *Aphyosemion maculatum* "LEC 90/4". These F1 fish both came from a single spawning

Conclusions for the breeder. On pp 163 and 164 we pointed out that hybridisation with fish of another strain is to be avoided just as much as the use of specimens for breeding without a precise identification. What works with other fish species and so appears sensible for the production of new breeds or hybrids, is pretty well useless when it comes to killifish. Obviously we exclude from this well planned and systematic crossing experiments with scientific objectives.

At this point we would again like to point out that the responsible killifish enthusiast always tries to keep going the pure strains which have been imported after the expenditure of much time, effort and money. By doing so he maintains the diversity of killifish in the aquarium and hopes to enable as many aquarists as possible to share the beauty of these fish.

It is a very short-sighted policy to mate together fish of different origins, with the purpose of combining attractive qualities (high proportion of a preferred colour, long fins and so on) and at the same time to cover up or even eliminate less appealing ones (short fins, lack of colour). What works with live-bearing toothcarps and other fish will, with killifish, lead only to a senseless mixture of previously pure strains and ultimately to their loss for the hobby (and science).

This leaves every aquarist with certain obligations, if he breeds several species or strains of closely related killifish (and experience shows that an original one or two species grow quickly in number after the outbreak of "killi-fever").

We have already pointed this out on page 179. In addition we must remind readers to adopt a precise and clear method of marking his different tanks. Ensure that the fish swimming in the aquaria are in fact those stated on a label on the tank or in the notebook which we have mentioned several times.

A mix-up of males and females can have fatal consequences. One aims to get from a spawning a large number of fry. Little attention is paid to the parent fish, which by now are old in any case. In a few months the young males begin to colour up and one realises that their colouration does not tally with that of the father. This may be due to the great variability of the fish, but it could be caused by the use of a wrong female.

These hybrids are of no use for future breeding, as they are probably sterile. And if the parent fish are now too old for breeding or already dead, the aquarist has lost this strain and will have to acquire it again.

It is wrong to give away these unintentionally produced hybrids to other aquarists. The fish could give more grief than pleasure! And this can hardly be in the interest of an honest aquarist.

Make a habit of clearly labelling every tank and receptacle containing your fish, fry and eggs. The additional effort involved pays off in the long run. You will derive great pleasure from your fish over a long period, and you will be able to pass them on to others.

The variability and the nine phenotypes of the "*cameronense*"-group. The great differences in the appearance of the representatives of this species group led in the past to the description of several species or subspecies.

In 1976 RADDA & PÜRZL published "Der *Aphyosemion cameronense*-Komplex", which contains three first descriptions. On page 134, lines 11 to 17, the authors write: "The Ambam populations show in their meristics hardly any differences from the hitherto known populations of *Aphyosemion cameronense*. However, their colouration and marking pattern is clearly distinguishable, especially in the males' pronounced orange shading of the caudal peduncle and large red-flamed patterning of the deep blue unpaired fins."

So for this reason these authors distinguish *Aphyosemion cameronense halleri* (in their sense, as we understand it *Aphyosemion halleri*) from *Aphyosemion cameronense*. At the same time they stress that there are no real meristic or morphometric differences. The status of subspecies is, according to our definition, based only on the different colouration of the body (yellow spot) and the fins.

On page 132, lines 28 to 33, after mentioning *Aphyosemion raddai*, they write: "In November/December 1975, on our last collecting trip in Cameroon, we found near Sonbo another form closely related to *Aphyosemion raddai* north-west of the small area of this relict form. However both sexes showed a different colouration and marking pattern. It will subsequently be described as *Aphyosemion amoenum* sp. nov."

Aphyosemion amoenum was placed closer to *Aphyosemion raddai* than to *Aphyosemion cameronense*, which later turned out to be a mistake (see pp 90 and 91). But the validity of the species *Aphyosemion amoenum* has not been questioned to date, and it strengthens our view that purely external differences in the markings of the flanks and fins, together with a special geographical distribution, can justify the status of a species.

If RADDA & PÜRZL were able to describe two divergent forms in one instance as a subspecies, which has not been questioned to date (*Aphyosemion cameronense halleri* sensu RADDA & PÜRZL or *Aphyosemion halleri* sensu AMIET) and in the second as a separate species (*Aphyosemion amoenum* in the opinion of all authors), AMIET's 1987 Phenotype 3 and the forms defined by us as Phenotypes 4, 5 and 9 of the "*cameronense*"-group must be investigated more closely.

It is not acceptable that *Aphyosemion amoenum* and *Aphyosemion cameronense halleri* or *Aphyosemion halleri* should be considered good names, while the phenotypes mentioned should be called just the "normal" *cameronense* (pers. comm. of PÜRZL on AMIET's Phenotype 3 in November 1991).

In addition we want to present in this book further phenotypes which differ markedly and are separated geographically from *Aphyosemion cameronense* and the described species. Some, but probably not all, of these may well be valid species.

Perhaps we can encourage the experts to investigate in more detail the phenomenon of the "Yellow Blotch" and its almost ring-shaped grouping on the periphery of the distribution area of the "*cameronense*"-group.

The Species of the "*cameronense*"-group

In this chapter we wish to present the forms of the "*Aphyosemion cameronense*"-group which have to date been described as separate species or subspecies of *Aphyosemion cameronense* and which are also still recognised at the present time. We have already discussed the concepts of species and subspecies on pp 9 and 10. We do not think it appropriate to define them in more detail, as we lack the necessary training. We refer to the available literary sources, but we are not afraid of putting forward clearly our own personal opinions. In contrast with many authors we do not make any distinction between the real species *Aphyosemion cameronense*, *Aphyosemion amoenum*, *Aphyosemion maculatum* and *Aphyosemion mimbon* on the one hand (they were like *Aphyosemion obscurum* first described as valid species), and on the other hand the "forms" *obscurum*, *halleri* and *haasi*, which are often described as subspecies of *Aphyosemion cameronense*.

We are convinced that there is no real argument for regarding on the one hand *Aphyosemion amoenum* as a valid species of the "*cameronense*"-group and, on the other hand, *Aphyosemion halleri* as "only" a subspecies of *Aphyosemion cameronense*. In spite of the contradictory names in RADDA & PÜRZL's publication quoted on page 235, we believe that "the Ambam populations" (= *Aphyosemion cameronense halleri* sensu RADDA & PÜRZL) differ no less from *Aphyosemion cameronense* than the separate (and generally recognised) *Aphyosemion amoenum*.

Besides the striking "Yellow Blotch", the geographical separation of both forms from *Aphyosemion cameronense*, the great distance between *Aphyosemion amoenum* and *Aphyosemion halleri* and the consequent lack of connection between them, their enclosed distribution area and the arguments put forward by AMIET (1987) (see also *Aphyosemion amoenum*) suggest that both taxa (scientific term for "specific name", the singular is "taxon") should be treated in the same way. In 1924 *Aphyosemion obscurum* was described by AHL as a separate species and since 1976 has been regarded by many authors as a subspecies of *Aphyosemion cameronense.* The colouration pattern of this form differs considerably as well, so we go along with AMIET (1987) and regard this species as valid, the reason being its distribution area and the experiences of one of the authors (EBERL). The 1976 publication we have quoted from several times describes the third form from north Gabon as a subspecies of *Aphyosemion cameronense*. In the mid seventies *Aphyosemion haasi* (or *Aphyosemion cameronense haasi* sensu RADDA & PÜRZL) was only imported live on a few occasions. It was not then distributed in the hobby. Subsequent attempts to collect *Aphyosemion haasi* at the terra typica and in the immediate vicinity were made by GRELL 1992, LEGROS, CERFONTAINE and EBERL in January 1993 and PASSARO and EBERL in July 1993. All these efforts produced nothing except "only" *Aphyosemion cameronense*. So at the present time we have only the preserved type specimens and a few of E. PÜRZL's colour pictures.

In line with our previous argument and to make the naming of the fish simpler, we here consider this form to be a valid species, even though we cannot support this with absolute certainty (see also the section ***Aphyosemion haasi*** in this chapter).

A historical review. The sources of literature available to us (especially SEEGERS, 1988) enable us at this point to give a brief résumé of the historical development of the representatives of this species group.

At the end of the last century and the beginning of this one, extensive collecting work was carried out in the various colonies of Africa. A considerable amount of material reached Europe in the form of freshwater fish which were dry or preserved in alcohol. Among this material were a few specimens of small fish, whose place of origin was given as "Dja River", a large river in south Cameroon (see also page 247).

Today we can assume that these killifish were caught not in the Dja itself but in one of its small tributaries. At the same time it is no longer possible to give the place of origin of these specimens more precisely.

The Belgian ichthyologist BOULENGER had been entrusted with this material. In 1903 he published in the Annual Magazine of Natural History, ser. 7, year 12, on pp 435 to 441 under the title "Description of new freshwater fishes from southern Cameroon" an article in which he describes these fish as *Haplochilus cameronensis*.

In 1905, 1910, 1911, 1915 and 1916 he published further papers, in which this taxon was mentioned. In BOULENGER's work "Catalogue of the Fresh-Water Fishes of Africa in the British Museum (Natural History), Vol. III", which appeared in London in 1915, there is on page 48 a drawing of *Haplochilus cameronensis*, which is fairly certain proof that he described the species which we today regard as *Aphyosemion cameronense*.

Besides BOULENGER, PELLEGRIN also published works in 1907, 1915, 1923 and 1929. He too dealt with or at least mentioned *Haplochilus cameronensis*.

In 1924 the German ichthyologist Ernst AHL had described *Panchax obscurus*, he had at his disposal a single specimen, which had been caught by ZENKER in or around Jaunde, the present capital of Cameroon (the modern spelling is Yaoundé). The generic name "*Haplochilus*" used by BOULENGER had in the meantime been replaced by "*Panchax*".

In 1930 this specific name was regarded by HOLLY as a synonym of *Panchax cameronensis*. In 1968 SCHEEL, in his work "Rivulins of the Old World", was not sure whether AHL's taxon "*obscurus*" was a synonym of *Aphyosemion cameronense* or a valid species. From 1974 he regarded it as a subspecies of *Aphyosemion cameronense*.

In the same year as he described "*Panchax obscurus*", AHL described three other forms: "*Panchax microstomus*" (terra typica: Nkianga Lokundje/Cameroon) and "*Panchax bellicauda*" (terra typica: Sangmelima, Cameroon, on the upper Lobo river) in his publication "Über neue afrikanische Zahnkarpfen der Gattung *Panchax*" in the Zoologischer Anzeiger 60, pp 303 to 313. In the following edition of this periodical he then described "*Fundulus beauforti*" in the article "Neue afrikanische Zahnkarpfen aus dem zoologischen Museum Berlin" (Zoologischer Anzeiger 61, pp 135 to 145, terra typica: Sangmelima, south Cameroon, on the upper Lobo river).

SEEGERS (1988), on pp 10 and 11, shows that today these taxa can mostly be regarded as synonyms of *Aphyosemion cameronense*.

Panchax microstomus and *Panchax bellicauda* were considered by Holly in 1930 and Scheel in 1968 ("*Aphyosemion microstomum*") as synonyms of *Panchax cameronensis* (or *Aphyosemion cameronense*). Scheel (1968) and Huber (1978) also declared *Aphyosemion bellicauda* to be a synonym, but in this case of *Aphyosemion obscurum*. After its first description *Fundulus beauforti* was not mentioned again until 1930, when it was referred to by Holly and subsequently by Myers (1933), Radda (1963: as a synonym of *Aphyosemion gulare*!), Scheel (1968: as a probable synonym of *Aphyosemion batesii*!) and Huber (1977: as a definite synonym of *Aphyosemion batesii*). The type locality "Sangmelima" as well as the description of two taxa with practically the same terra typica but different generic names ("*Panchax bellicauda*" and "*Fundulus beauforti*") by one and the same author (Ahl) within a year indicate that "*Fundulus beauforti*" is not the same fish as "*Panchax bellicauda*". Radda's suggestion is weakened by the terra typica "Sangmelima" in the interior of Cameroon, since *Aphyosemion gulare* comes from the coastal area of Nigeria, an ichthyologically completely different area.

The situation becomes even more complicated when Seegers' arguments (1988, page 12) are borne in mind. He suggests that, in view of the position of the dorsal in relation to the anal on the types of "*Fundulus beauforti*", this fish cannot be related to *Aphyosemion batesii*. Finally Seegers stresses that the type specimens of "*Fundulus beauforti*" and "*Panchax bellicauda*" were caught at the same location by Schreiner. For this reason, and in view of AHL's measurements given in the first description, Seegers concludes that Ahl described the males acquired at that time of *Aphyosemion cameronense* as "*Panchax bellicauda*", the one female was described as "*Fundulus beauforti*"! In 1933 Myers used for the first time the generic name *Aphyosemion* for these fish. This is why the specific name of the masculine form "*cameronensis*" had to be changed to the neuter form "*cameronense*". Since then *Aphyosemion cameronense* has been mentioned or discussed by the following authors (list according to Seegers probably not complete!):

-Poll, 1951.
-Clausen, 1967.
-Lambert & Géry, 1967.
-Scheel, 1968, 1971, 1973, 1974, 1975.
-Radda, 1970, 1971, 1974, 1975, 1977, 1978, 1979, 1980.
-Roman, 1971.
-Schrieken, 1971.
-Haller, 1976.
-Radda & Pürzl, 1976, 1977, 1983.
-Böhm, 1977.
-Bochtler & Heinrich, 1977.
-Huber, 1977, 1978, 1980, 1981.
-Radda & Wildekamp, 1977.
-Daget, 1978, 1979.
-Seegers, 1979.

As can be seen, in the years during the Second World War and in the fifties and sixties, few publications were written about *Aphyosemion cameronense* and the related species. It was not until LAMBERT & GÉRY and SCHEEL went collecting in the sixties and SCHEEL, RADDA, PÜRZL and others in the seventies, that detailed findings on the distribution, ecology and relationships of these killifish were made. Special mention should be made of aquarists such as GASPERS, BURGER, WARDEGA, HOLLER, BÖHM, BOCHTLER, HERZOG, HAAS, HALLER, HEINEMANN and LENZ.

The first descriptions of *Aphyosemion amoenum*, *Aphyosemion halleri* and *Aphyosemion haasi* have been mentioned several times. These followed in 1976 and can be considered the direct result of these collecting activities.

Subsequently numerous articles on these species were written. The collectors and killifish enthusiasts dealt mostly with the maintenance and breeding, as well as a description of the conditions in the natural habitats.

Again it was RADDA & PÜRZL who in 1977, in the article "Cyprinodonten-Studien in Gabun, II. Nordgabun", published the first description of *Aphyosemion maculatum* (using fish they themselves had caught as type specimens). The import of wild fish to Europe from the terra typica and the first breeding attempts were a success, but subsequently this strain was lost. For a long time this superb *Aphyosemion* was not available in the hobby. It was not until 1990 that Allan and Barbara BROWN managed to find the type locality given by RADDA & PÜRZL and bring fish back to Great Britain ("GAB 19/90").

In the "Revue française d'Aquariologie 1" of 15th June, 1977, the first description of *Aphyosemion mimbon* was published by Dr Jean H. HUBER in Paris (Museum National d'Histoire Naturelle, Laboratoire d'Ichtyologie Générale, 43 rue Cuvier, F-75731 Paris, France).

This magical species was not kept long in the hobby before it disappeared. It was not until Peter WAGNER and Roland WENDEL brought back to Swabia, Germany, live material from their finding place "GWW 96/30" (11.1.1986, 3 km west of Médouneu) in the "Monts de Cristal" (north Gabon). They were able to distribute this population and thus get it established in the hobby.

Since 1987 no really important or comprehensive publications on the representatives of the "*cameronense*"-group have been published. All the same, numerous articles in aquarium magazines and the DKG-Journal have reported on the maintenance and breeding of various species and strains.

We hope the present book will rouse the interest both of aquarists (not just killifish keepers) and of biologists in these fascinating fish. As will be seen later in the **Summing-up**, a revision of the "*cameronense*"-group is more than overdue.

Explanation of How the Species are Presented

An important prerequisite of specialist literature is the comprehensive overview of information. Examples of this are the works of Jean Louis AMIET (1987) and Olivier LEGROS (1990). In our opinion both of these authors have found a method of presenting material which is ideal for their situations and purposes. They have guided us in the way we have set out the individual species and then the nine undescribed phenotypes in the following chapter.

Firstly we consider a uniform classification appropriate for achieving the best possible overview. We have adopted the style of the "Information Pamphlet" which many killifish associations use to present individual species and print in compressed form as parts of their regular journals.

In "Le sous-genre *Chromaphyosemion*" LEGROS has shown impressively that a single publication can present several species and phenotypes related to each other (in his case the representatives of the subgenus *Chromaphyosemion*) in this way. The layout also makes it easy for the species and phenotypes to be compared.

Section headings. Each species (or each phenotype) is given its own section in this (and the following) chapter. The full specific name (the name given to the phenotype in our sense), the author of the first description and the year of its publication are given at the top.

The two last data are missing in the chapter **The Various Phenotypes in the "*cameronense*"-group**. But we hope that in a later edition of this book we will be able to present one or more fish as valid species after their first description by a scientist, which are here referred to as phenotype forms.

A colour picture then follows, to give the reader an impression of the appearance of the species (phenotype) directly alongside the exact name. As we are dealing with living creatures, it is impossible - with the exception of a first description - to present the typical fish of a species. There is so to speak no "prototype" of a species. For one thing, this is made impossible by the great variability of *Aphyosemion*.

We have taken pains to select a specimen that shows particularly well the specific characteristics of the species concerned. In addition the reader should refer to the numerous colour pictures in this book, in which adult males or females of the species discussed can be seen.

A comparison with similar or widely differing species and phenotypes can help one get the feeling, mentioned on page 20, for an exact way of looking at these fish.

Since the females of the "*cameronense*"-group hardly differ from each other, we have not included pictures of females of all the representatives of this group. Only the really experienced killifish breeder can distinguish the females with any certainty, and then only when he has had long enough experience of working with this group.

The history of a species or phenotype is meant to give a brief impression of when this form was first imported and whether fish were collected subsequently.

We have tried to provide as much information on the representatives of the "*cameronense*"-group as possible. There will, however, certainly be dates and facts not known to us, which could increase considerably our knowledge in this or another context. We hope to be able to extend our collection of data even further with the help and co-operation of our readers (see also **Summing-up**!).

The first descriptions of the individual species were mentioned in more or less detail in the previous chapters. Nevertheless we consider it appropriate, when each species is presented, to give the date, the author and the publication in which the first description was published. We found the detailed information in SEEGERS (1988) very helpful, and we have had to make use of it here.

Some of the scientific works we have in the original or as copies. We are thus always in a position to provide more detailed information.

The meaning of the specific name is explained as fully as possible.

The terra typica, if it is known exactly, is given with as much information as possible.

Synonyms are then given, if they have been used for the species in question quite intentionally. In addition, the literary sources and their authors are mentioned, in which these synonyms were used.

There is always the possibility that publications not available to us mention one or other *Aphyosemion* form as *Aphyosemion cameronense* which does not correspond to our definition of the species. For instance the "Bélinga" strain is still considered by most killifish keepers as belonging to *Aphyosemion cameronense* (here we call this form Phenotype 4).

Meristics are given by various authors. They have either counted them themselves or copied them from other people. We are not able to take these figures ourselves (see page 28), which is why we try to add the source of the author of the data we have used.

In this context the abbreviations have the following meanings:

- -D is the number of fin rays in the dorsal.
- -A is the number of fin rays in the anal.
- -D/A shows the relative position forwards or to the rear of the insertion of the dorsal in relation to the anal fin. The fin rays of the anal fin are counted directly to the beginning of the dorsal: +3, for instance, means that the first ray of the dorsal is situated above the third ray of the anal fin; -3 means that the first ray of the dorsal is situated in front of the first ray of the anal and the third ray of the dorsal is situated in front of the first ray of the anal (Definition according to HUBER, 1994).
- -Sq. 1. indicates how many scales are situated on the side of the body in a longitudinal line. To measure this, one needs a good microscope and the relevant training in the field of ichthyology.

The Karyotype of a species should give the number and structure of the chromosomes. Work in this area has only seldom been carried out (for example by SCHEEL). So the results available to us are sparse. For many species and most of the phenotypes there is no information at all on their karyotype.

This could be a very interesting area for biologists to work in.

The geographical distribution of every representative of the "*cameronense*"-group is given as accurately as possible, using our present knowledge. In this respect too there may be information which for one reason or another has not come our way.

The known localities are given with as much detail as possible. We would like to use this opportunity to explain as fully as possible the many code numbers known to date. This should give the reader a clear idea of the precise place of origin of the populations.

In addition we will mention - when the information is available to us - whether a strain is still in the hobby or whether (unfortunately) it is no longer available.

The syntopic killifish are, in contrast with pp 77 to 106, mentioned for each individual species by name and just in brief, as they have already been dealt with in detail.

The Description of the species or phenotype is intended to help one quickly identify fish using the colour characteristics of adult males. The most important colour criteria are explained both in a detailed written description and with drawings and sketches.

Relationships are set out as well as possible, to show the connections within the "*cameronense*"-group. We want to try to bring together closely related species and phenotypes and show the differences between them.

The diagnosis is intended to give a general statement on the position of the species or the phenotype and also its geographical role within the "*cameronense*"-group.

We want to take this opportunity to point out the special relationships and striking features in this species group.

The discussion finally explains why we consider the fish in question is a valid species (and not a subspecies). We also say why we consider a phenotype sufficiently divergent to be possibly deserving of being described as a distinct species. This argument is not equally strong for each of the nine phenotypes. This is the place to set out our personal views on the systematics of the "*cameronense*"-group.

Aphyosemion cameronense BOULENGER, 1903

Aphyosemion cameronense "CGE 91/9"

History

This was the species that was first described and thus gave its name to the whole group. Much has therefore been written about it over the years. On pages 19 and 239 and 240 we mention the historical facts known to us with reference to the first half of this century. So at this point we would like to discuss the significant developments that have taken place since the late sixties regarding *Aphyosemion cameronense.*

The first systematic collecting trips were made by SCHEEL with the collaboration of Stenholt CLAUSEN in the late sixties. The object of these trips was the inland plateau of Cameroon and Equatorial Guinea, from where SCHEEL brought back some strains which he placed in *Aphyosemion cameronense*. Unfortunately we do not know much about the exact locations of his finding places nor about the appearance of the adult males. So we cannot exclude the possibility that one or more of the populations imported at that time might not correspond to our present day concept of the classical phenotype (i.e. *Aphyosemion cameronense* according to BOULENGER's specimens).

At the beginning of the seventies there followed collecting trips by Austrian and German aquarists who imported various populations from localities in south Cameroon and north Gabon (HERZOG, GASPERS, BOCHTLER, BÖHM, HAAS and others). Among these populations there were certainly some forms which we would now refer to as phenotypes of the "*cameronense*"-group. HERZOG reports on a fish north of Booué, which he called "*Aphyosemion cameronense* yellow". This is most probably Phenotype 5 (see the bottom of page 117).

RADDA (1971, pp 157 to 167) reports on several localities of *Aphyosemion cameronense*, but on page 160 he points out that he also found populations which had "considerably more spots arranged in rows on the flanks of the males". This is a further indication of the great variability of this species or else of the existence of phenotypes that differ from each other.

During their very successful trip in December 1975, RADDA & PÜRZL (1976), with the support of HALLER, were able to travel through large areas of south Cameroon and north Gabon, where they found *Aphyosemion cameronense* in many localities. In this instance as well, not all the localities of representatives of the "*cameronense*"-group belonged to this species - e.g. the pictures shown on page 131 (lower left: Phenotype 2), page 133 (second from bottom: Phenotype 5) and page 143 (upper left: Phenotype 2).

Unfortunately all we have now of the strains imported at that time are a few colour pictures and some not very precise information on locations. So at the present time these forms cannot be named with sufficient accuracy.

Towards the end of the seventies HEINEMANN and LENZ collected in south Cameroon and north Gabon, from where they brought back, besides some *Diapteron* populations and other *Aphyosemion* species, *Aphyosemion cameronense* as well.

Right up to the mid-eighties further collections and imports were made (Jan PAP 1980, Maurice CHAUCHE and others 1985, BARDIN and LOMBARD 1985 and BARDIN, HOUDU and LOMBARD 1986). But of these strains all we have today is written records and some pictures.

In January 1986 WAGNER and WENDEL found numerous localities of *Aphyosemion cameronense* near Makokou and in the Mitzic-Oyém area, but technical problems meant that they only managed to bring back "GWW 86/2" successfully.

At this time AMIET fished in the distribution area of the "*cameronense*"-group and made crucial progress in our knowledge of the distribution of *Aphyosemion cameronense* in south Cameroon. He was the first to recognise the importance of divergent body colouration. He defined *Aphyosemion cameronense* in exemplary fashion and separated three phenotypes with different colouration (AMIET, 1987).

It has been only since 1990, partly through our efforts, that different populations of *Aphyosemion cameronense* have been imported and established on a long-term basis in the hobby (EBERL and others and VLIJM and others in 1990, GRELL and EBERL 1991, GRELL 1992, further collecting trips EBERL and others 1993 and 1994.

Even though the individual strains of this species show only slight differences when looked at superficially, they are nevertheless worth enriching the aquaria of killifish keepers over a longer period. So we hope to be able to distribute and maintain as many populations as possible in their pure form.

First Description

George Albert BOULENGER: "Description of new freshwater fishes from southern Cameroon", Annual Magazine of Natural History, ser. 7. year 12, 1903, pp 435 to 441. In the original work the taxon used was *Haplochilus cameronensis*.

Meaning of the Specific Name

To name this species BOULENGER used the Latinised form of the country Cameroon, where the specimens he examined had been caught.

Depending on generic name ("*Haplochilus*", "*Panchax*" or "*Aphyosemion*") the masculine form "*cameronensis*" or the neuter form "*cameronense*" of the specific name was subsequently used.

Terra typica

In the first description the finding place "Dja River" in south Cameroon is given. From our viewpoint today this is a very vague description of a type locality.

No further information is available to us, so we interpret this description as a small stream in the drainage area of the Dja. The presence of an *Aphyosemion* in a river of this size (see map 1, page 14) would be at variance with all experience made to date.

On the other hand it is impossible that the locality was a small rainforest stream with the name "Dja". In theory there could be a few small streams in the south of Cameroon called "Dja" by the locals, but in this case the collector of the type specimens would probably have given more precise data on the finding place (perhaps the name of a village or a distance from a town).

One presumes, however, that the specimens were caught in a small stream, and all that was known about it was that it belonged to the drainage of the Dja.

We are of the view that it is not possible to determine the exact location of the type locality.

Aphyosemion cameronense "EMS 90/4" from a stream 3 kilometres south of Nsessoum on the Ebolowa-Ambam road

Aphyosemion cameronense "CGE 91/8" from Meuban I in the south of Cameroon on the frontier with Gabon

Aphyosemion cameronense "HJRK 92/7" from Mfoumou between Ma'an and Méyo Centre

Aphyosemion cameronense "PEG 94/36" was caught in the village of Mbomo about 20 kilometres north-west of Oyém

Synonyms

-*Haplochilus cameronensis* in BOULENGER (1903, first description).
-*Panchax cameronensis* in AHL (1924), HOLLY (1927) and DAVID & POLL (1939, in part).
-*Aphyosemion spec*. in ROMAN (1971).
-*Aphyosemion obscurum* by several authors.
-*Aphyosemion striatum* (not BOULENGER, 1911) in RADDA (1970).
-*Panchax microstomus* in AHL (1924, first description) and HOLLY (1930, *Panchax microstomus* as a synonym of *Panchax cameronensis*).
-*Aphyosemion microstomum* in SCHEEL (1968, *Aphyosemion microstomum* as a synonym of *Aphyosemion cameronense*).
-*Panchax bellicauda* in AHL (1924, first description) and HOLLY (1930, *Panchax bellicauda* as a synonym of *Panchax cameronensis*).
-*Aphyosemion bellicauda* in SCHEEL (1968, *Aphyosemion bellicauda* as a probable synonym of *Aphyosemion cameronense*).
-*Fundulus beauforti* in AHL (1924, first description) and HOLLY (1930).
-*Aphyosemion beauforti* in MYERS (1933), RADDA (1963, identification of a population of *Aphyosemion gulare* as *Aphyosemion beauforti*), SCHEEL (1968, *Aphyosemion beauforti* as a probable synonym of *Aphyosemion batesii*), HUBER (1977, *Aphyosemion beauforti* as a synonym of *Aphyosemion batesii*) and HUBER (1978).

This comprehensive list of the synonyms and their use by different authors show that for a long time it was not known precisely what species *Aphyosemion cameronense* was. Initially the variability of *Aphyosemion* species led to the descriptions of several populations of this species as separate species, until it was later realised that they were just synonyms.

The data given above all derive from SEEGERS (1988, page 8). As in this book we regard *Aphyosemion obscurum* as a valid species, its first description was not included in this list.

Meristics

We do not have information from the first description, which is why we have to refer to the data given by SCHEEL (1973). He had examined a total of 163 specimens from Cameroon and Rio Muni (Equatorial Guinea). These are the figures he took himself:

D = 10-14
A = 14-18
D/A = 1/7 to 1/8
Sq.l. = 29-35

In our opinion it is questionable whether the specimens from Equatorial Guinea are in every case *Aphyosemion cameronense* in the narrower sense.

RADDA & PÜRZL (1985, page 28) give the following data for *Aphyosemion cameronense*:

D = 11-13
A = 15-17
Sq.l. = 31-33

We do not know what specimens these data were taken from. In any case they differ from SCHEEL's data. This will be due to a different method of counting.

Karyotype

In the same publication (1973) SCHEEL gives the results of his tests:

n = 12 to n = 17

In addition he states that the karyotype can vary considerably from one population to another.

Geographical Distribution

A rough comparison of the distribution area of *Aphyosemion cameronense* with those of the other representatives of the "*cameronense*"-group shows that this species has by far the widest distribution.

This species can be found in south Cameroon and north Gabon. SCHEEL, ROMAN and HUBER report *Aphyosemion cameronense* from Equatorial Guinea and the extreme north-west of the Republic of Congo (we do not have precise information about the appearance of adult males in these countries).

Since *Aphyosemion cameronense* is present along the Méyo Centre-Ma'an-Nyabessan road in south Cameroon, between Sam and Médouneu and west of Oyém in north Gabon, we consider it more than likely that this species also occurs in Equatorial Guinea. The map on page 254 shows the approximate distribution area of *Aphyosemion cameronense*.

On the other hand we doubt whether the populations found by HUBER in the Republic of Congo in 1978 are really the true *Aphyosemion cameronense.* The special position in the eastern border area of the "*cameronense*"-group together with the proximity of AMIET's Phenotype 3 along the Djoum-Mintom road and Phenotype 4 from Bélinga suggest that in the Congo the fish are one of these phenotypes (at times with the Yellow Blotch) or a further divergent form.

In the north of Gabon there is an enormous forest area, whose outlines are formed by the course of the borders between Cameroon, the Congo Republic and Gabon, the towns of Minvoul, Oyém, Lalara and the roads from Ovan to Makokou and from Makokou to Bélinga. This area is not accessible. There are no roads there, so at the present time it is impossible to collect fish there. This area is some 24,000 to 25,000 square kilometres.

Aphyosemion cameronense "GAB 10/90" from the Lalara-Mitzic road in north Gabon

This wild male from locality "PEG 94/41" on the Oyém-Sam road along the border with Equatorial Guinea corresponds basically to *Aphyosemion cameronense*

Aphyosemion cameronense "LEC 93/3" was caught near Ebé west of Ovan

This strain of *Aphyosemion cameronense* was imported by Wolfgang GRELL from north Gabon in 1992

The distribution area of *Aphyosemion cameronense* in comparison with the whole "*cameronense*"-group

There are examples of populations on the edge of the area mentioned on page 251 that look very similar:

- On the north-eastern and south-eastern corners two strains of *Aphyosemion cameronense* were found, which are practically indistinguishable: "CGE 91/8" near Meuban I south of Djoum and "GWW 86/2" near Latta east of Makokou. The distance between the two localities is 205 kilometres as the crow flies.
- The population "LEC 93/1" from Laboka II near Lalara corresponded exactly with the typical colouration pattern of *Aphyosemion cameronense*. The estimated distance from Meuban I in the south of Cameroon is 260 kilometres as the crow flies.
- The populations "LEC 93/1" and "GWW 86/2" mentioned here from Gabon are also 165 km apart as the crow flies.

The following map shows the special situation and a few further finding places of *Aphyosemion cameronense* in north Gabon and enables one to compare the distances mentioned above with each other.

Our knowledge of the distribution of *Aphyosemion cameronense* in Cameroon to the north-east of Yaoundé, in the direction of Diang is only fragmentary and needs further investigation! Despite their isolation from other strains, AMIET places this population (called "Diang") within *Aphyosemion cameronense*.

In addition there are some places on the edge of the distribution area which have not been adequately investigated or even visited.

It is not possible to estimate the surface area of the distribution area on account of its asymmetrical shape. The following considerations and maps give an overview of the extent of the distribution of *Aphyosemion cameronense*.

Following the principle used on pp 109 to 121, we circle the distribution area of *Aphyosemion cameronense* in clockwise fashion and give the extreme points as we know them today.

We begin our consideration with the most north-westerly known location known to date. It lies near Madang about eight kilometres north of Lolodorf on the road to Eséka. The following map shows the Eséka-Lolodorf-Makak area with the known finding places:

For the present we cannot give the distribution frontier of *Aphyosemion cameronense* from Mentanyé to the east owing to insufficient collecting work along the Eséka-Makak road. But the frontier with *Aphyosemion obscurum* must lie west of Makak.

The continuation of the frontier from Makak via Akono (along the distribution area of *Aphyosemion obscurum*!) and Mbalmayo, Akonolinga, Ayos and Abong Mbang (Mbong Mbang) to the extreme north-eastern point near Diang is not at all clear!

We do not know either if *Aphyosemion cameronense* occurs along the roughly 230 kilometre long line from Diang to Djoum via Akonolinga. This is what we mean to show on the map on the next page.

Near Djoum itself GRELL and EBERL were able to identify *Aphyosemion cameronense* in August 1990. In the village of Efoulan situated sixteen kilometres to the east, however, occurs AMIET's Phenotype 3 ("CGE 91/6"), so the frontier between the two forms must lie in this area.

We know some localities of *Aphyosemion cameronense* along the road from Djoum to the south via Yén and along the frontier with Gabon. But we do not know anything about its distribution to the south-east of Djoum, in the border area between Cameroon and Gabon and to the east in the north-westerly border area of the Congo Republic. As already mentioned, we cannot place precisely the populations caught by Huber.

It is not until we get further south near Makokou that we know definite finding places of *Aphyosemion cameronense*: along the road from Makokou to the east via Batouala to Mékambo this species was found by Bardin, Houdu and Lombard 38.8 km east of Makokou, in February 1986. There is no further information on this finding place or the exact point in Makokou where it was measured from.

In August 1994 Passaro and Eberl tried to find this locality but could not find in this area any stream that crosses the road. Collecting efforts in the surrounding villages produced only *Aphyosemion punctatum,* plus the information that the village of Ibenga (about 7 km west of La Scierie) has been abandoned.

The measured distances from Makokou to La Scierie (42 km east of Makokou) as taken by Passaro and Eberl, together with the position of Ibenga on the available maps, suggest that Bardin, Houdu and Lombard possibly identified *Aphyosemion cameronense* in Ibenga itself. Unfortunately this locality cannot be found today.

In August 1994 PASSARO and EBERL managed to find the locality "GWW 86/2" near the village of Latta (Lata) 17 km east of the bridge in Makokou. They were thus able to confirm WAGNER and WENDEL's findings on the presence of *Aphyosemion cameronense* in the 'Eboutéboungou' stream. This seems to be the most easterly confirmed locality known to date.

In February 1986 *Aphyosemion cameronense* was also found by BARDIN, HOUDU and LOMBARD 27.5 km south-east of Makokou along the road to Okondja. This locality too is still to be considered an extreme point. Unfortunately, due to insufficient information, precise data such as whether the locality is by the roadside or in the forest, name of the village or name of the stream, cannot be given.

In August 1994 PASSARO and EBERL tried to confirm this locality and thus locate more precisely the distribution frontier of *Aphyosemion cameronense* to the south-east of Makokou. But they were unable to find either the locality mentioned or other streams between Mbéla and Makokou with this species. Instead *Aphyosemion punctatum* was found in the streams fished to the south-east of Makokou.

The following map shows the known localities in the region east of Makokou on the roads to Batouala and Mékambo and also to the south-east in the direction of Okondja:

The distribution area as known at present to the south-west of Makokou follows naturally the road to Ovan, there being no turnings off to the south. The hydrographic situation suggests that *Aphyosemion cameronense* should also occur further to the south.

Not until we get to Lalara to the south-west of Ovan is there another locality, which can be regarded as the most south-westerly finding place of *Aphyosemion cameronense*. However, future collecting work to the west of Lalara on the road to Ndjolé could provide more findings.

To the north-west of Lalara lies Gérard LEBRUN's "Camp Forestier", where LEGROS, CERFONTAINE and EBERL were able to find *Aphyosemion cameronense* in January 1993. Lack of passable roads means that it is not possible to investigate the area west of Oveng in the eastern part of the 'Monts de Cristal', at least for the time being.

The next localities for *Aphyosemion cameronense* are further north on the road from Mitzic via Sam to Médouneu, where we know them to be numerous. The westerly distribution frontier in this area seems to be the 'Ndzembo' stream near the village of Egnieng Melen. Coming from Sam in August 1994, PASSARO and EBERL were able to find this locality ("PEG 94/42", see also page 292) and thus prove the existence of *Aphyosemion cameronense* only a few kilometres east of Médouneu in a tributary of the Mvo. This small river belongs to the Abanga system, which drains the eastern part of the 'Monts de Cristal' to the south.

The position of Egnieng Melen was given by the villagers as "PK 7 Médouneu", which was later confirmed by PASSARO and EBERL's measurements.

Aphyosemion mimbon has also been found both near the Médouneu Catholic Mission and to the south of this town at the airport (pers. comm. Hervé GONIN in December 1993: the 'Ottomitan' stream south of Médouneu).

The following map shows this frontier area of *Aphyosemion cameronense*:

The next section of the distribution frontier in Equatorial Guinea cannot be checked at the present time. Both near Sam on the Gabon-Equatorial Guinea border and to the west and north-west of Oyém in the direction of the border, *Aphyosemion cameronense* has been found by various collectors (BARDIN, HOUDU and LOMBARD 1986; LEGROS, CERFONTAINE and EBERL 1993; PASSARO and EBERL 1994).

The next localities are north of Equatorial Guinea in south Cameroon on the Méyo Centre-Nyabéssan road, of which AMIET's locality "Nyabéssan" itself is the most westerly.

Further to the north runs the Ebolowa-Kribi road, where the "Bibouleman" (Biboulémam) locality lies. To the north and almost parallel runs the road from Lolodorf via Bipindi to Kribi. Along this road the only locality is "Lolodorf" itself. Further west *Aphyosemion cameronense* is replaced near Mvilé (9 km west of Lolodorf) by Phenotype 1 (see also under the section on this phenotype).

Then finally on the road from Lolodorf to Eséka lies the village of Madang, where we started considering the distribution area of *Aphyosemion cameronense*.

Known Localities

Owing to the enormous distribution areas of *Aphyosemion cameronense* we know at present a large number of localities, which have been defined with varying degrees of exactness. In the literature it depends on the views of the author in question whether one or other strain belongs to *Aphyosemion cameronense*, even though according to our strict definition it should not be placed in this taxon. Besides we have not been able to compare the populations imported in the past using our criteria for defining species, so we have not been able to classify these fish.

In addition we do not know all the localities that have been visited to the present, as some collectors do not publish their findings with sufficient detail. In other cases we have not been able to acquire the relevant information.

The following list of localities of *Aphyosemion cameronense* (and in the following chapters the other forms of the "*cameronense*"-group) is therefore neither perfect, comprehensive, nor the last word on the subject. We hope that with the appearance of this book the interest in these killifish will grow in many quarters and that we will then be given more information on the localities of this and all other species and phenotypes (see also **Summing-up**).

"8 km South Sangmelima" is the location given to a male illustrated in RADDA (1971) in the lower picture on page 159. This is the eighth locality of his Cameroon trip, which he stopped at on the road from Sangmélima to Olounou on 15th January 1971. The geographical co-ordinates are 12°02' E and 02°54' N at 672 metres above sea-level.

The streams south-east of Sangmélima drain into the Afamba, which flows into the Lobo; this in turn is a tributary of the Dja. We do not know if this strain was distributed after its import. It is probably no longer obtainable in the hobby.

"Nsomi" is another locality name in the above mentioned publication. The description of the location of the stream says "Stream near Nsomi, Zoëtele District on the Sangmelima-Yaoundé road". This is the tenth locality of RADDA's Cameroon trip, where he also stopped on 15.1.1971. *Aphyosemion exiguum* and *Aphyosemion batesii* are mentioned as occurring syntopically.

The village "Nsomi" cannot be found on our maps, whereas there is a village "Nsimi" on the road from Sangmélima to Yaoundé. This is probably RADDA's locality, so we will give the geographical coordinates as follows: 11°50' E and 03°10' N at 705 metres above sea-level. The small streams in this area feed the Bives, which flows into the Awout. This river then joins the Soo, which in turn enters the Nyong to the west. This strain is no longer available either.

"Mefou" is a locality mentioned in RADDA & PÜRZL, 1976. The exact description of the stream runs: "...from a small stream in the rainforest near Mefou on the road from Ebolowa to Kribi". The maps available to us show on this road a small place by the name of Mefo orMéfo, which is probably the same as RADDA and PÜRZL's finding place.

The geographical co-ordinates as read by us are 10°49' E and 02°28' N, 673 metres above sea level. The streams north of the road drain into the Mefo, while those to the south of the road drain into the Awomo. Both rivers flow into the Biwome, which joins the Ntem near Nyabéssan. This strain is no longer available in the hobby.

"Southern outskirts of Oyem" is the name given to a strain of *Aphyosemion cameronense* in RADDA & PÜRZL, 1976. In the mid seventies Oyém was still considerably smaller than it is today. This means that the position of this stream can no longer be given exactly. Moreover the progressive urbanisation in this heavily populated area may well have caused *Aphyosemion* to have disappeared from the stream fished at that time.

Oyém has the following geographical co-ordinates: 11°35' E and 01°36' N, about 630 metres above sea level. The streams around Oyém belong to the head-waters of the Nyé, which flows north to join the Ntem. This strain is not in the hobby.

"Near Lolodorf" is the caption in RADDA & PÜRZL, 1976, for the picture on the upper right on page 143. The exact position of the stream investigated at that time is not known to us, nor is its distance from Lolodorf. The geographical co-ordinates of Lolodorf are, according to the information we have, 10°44' E and 03°14' N, height above sea level about 470 m. Lolodorf lies on the Lokoundjé, which flows south-west till it reaches the Atlantic. This strain is now no longer available.

"Gabon 74/3" is the code for a stream that GASPERS and others found two kilometres east of the ferry over the Mvoung near Ovan in 1974. This is in all probability the 'Benguié' stream, whose position on the Ovan-Makokou road we were able to determine as follows: 12°12' E and 00°21' N at 469 metres above sea level. After a few kilometres the Benguié joins the Mvoung, which flows south to the Ivindo. This strain is no longer in the hobby either.

"Gabon 74/9" means, as it says, the ninth finding place of this trip, whose position is given as "13.5 km from the mission in the direction of Ovan, stream to the right and left of the road". The road in question is the road from Makokou to Ovan. The distance measured was taken from the Makokou Catholic Mission.

The information given by the collectors gives no village or stream name, so we can only estimate the position of this locality: 12°44' E and 00°34' N at 475 metres above sea level. The streams in this region drain into the Nyabare which further south flows into the Ivindo.

To the right of the road (i.e. to the north as you come from Makokou) *Aphyosemion cameronense* and *Diapteron cyanostictum* were caught, while on the other side of the road a characin species and three different barbs were also caught. This population of *Aphyosemion cameronense* is no longer kept in the aquarium.

"Gabon 74/11" is the next but one finding place of GASPERS and others, and they called it "Mintoum". This is a small village (on our maps mis-spelt "Mintom") on the Makokou-Ovan road. We were able to determine its position as follows: 12°16' E and 00°25' N at 478 metres above sea level.

In this area the road runs on a small watershed. The streams north of Mintoum drain through the Mémia into the Metak, which flows into the Mvoung. The streams to the south of the village flow into the Mboulenkoulé, which joins the Mvoung near Ovan.

At that time *Aphyosemion cameronense*, *Aphyosemion bochtleri* and *Epiplatys neumanni* were found.

This strain is no longer available in the hobby, but in January 1993 LEGROS, CERFONTAINE and EBERL collected here and their efforts showed that *Aphyosemion cameronense* and *Epiplatys neumanni* occur to the north of the village. The *Aphyosemion bochtleri* they were looking for eluded them.

"Gabon 79/7" is one of the two localities of the collecting trip in December 1979, whose position is given by Hendrik HEINEMANN and Rainer LENZ as "3 km west of Makokou". This is a tributary of the Ntang or the Brial, both of which flow into the Ivindo after a few kilometres. The geographical position of this stream we can only guess: 12°50' E and 00°34' N at about 470 metres above sea level.

As well as *Aphyosemion cameronense*, *Diapteron cyanostictum*, *Diapteron georgiae*, *Epiplatys neumanni* and *Hylopanchax silvestris* were found. Unfortunately this population is one of the strains which is no longer kept by aquarists.

"Gabon 79/9" lies, according to HEINEMANN and LENZ, 41 kilometres west of Makokou, but we do not know from which point this measurement was taken. The same goes for the previous locality. No village or stream name is given.

Other killifish caught at the same time were *Diapteron fulgens*, *Epiplatys neumanni* and also a *Ctenopoma* species. In January 1993 LEGROS, CERFONTAINE and EBERL caught near Adoué (39 kilometres west of Makokou) *Aphyosemion cameronense* as well as some other killifish: see under **"LEC 93/6"**.

Adoué itself has the following geographical co-ordinates: 12°34' E and 00°32' N at 522 metres above sea level. The streams flow into the Adoué, which then joins the Louli and flows south and then into the Ivindo.

"K1" is the first finding place of the Cameroon trip by Heinemann, Lenz, Berger, Wardega and Holler at the end of 1978 and the beginning of 1979. The actual date of "K1" is 31.12.1978. They discovered "near Nko'ovos II, 24 km before Ebolowa in the direction of Sangmelima" a stream with *Aphyosemion cameronense* as the only killifish. On our maps we were able to determine the geographical position of Nko'ovos II as follows: 11°22' E and 02°55' N at 690 metres above sea level. The streams around this village flow north into the Memou'ou, which itself flows into the Fala, a tributary of the Soo. This finally joins the Nyong. Unfortunately none of the strains of this trip are available in the hobby.

"K6" is the sixth finding place of this trip and was discovered on 6.1.1979 "between Zvébefam and Meyos, 33 km from Sangmelima in the direction of Ebolowa". The information we have indicates that there are two roads, which run nearly parallel to each other from Sangmélima westwards towards Ebolowa and before they join near Zo'ébefam (Zoebéfam). The collectors probably used the southerly of the two roads and thus arrived at Zo'ébefam via Meyos. This village has the following geographical co-ordinates: 11°42' E and 02°58' N at about 710 metres above sea level. The streams north of this place enter the Minsolo, which flows into the Soo and so into the Nyong.

The streams to the south flow into the Ekoumboulou, which runs into the Sing and then into the Fale (Fala), which is also a tributary of the Soo, which runs into the Nyong.

Meyos (11°43' E and 02°55' N; the height above sea-level cannot be given accurately) lies about four kilometres south-east of Zo'ébefam in the drainage area of the Bivele, which flows into the Abolo, which then flows into the Soo and later the Nyong. Allocating the finding place to one of the streams mentioned is not possible; this population is no longer in the hobby.

"Diang" refers to a population which a few years ago was distributed among a few killifish keepers in Europe, but subsequently it was lost. Amiet (1987) too mentions this finding place and shows a colour picture of an adult male. Unfortunately none of the fish he caught in March 1985 came to Europe.

Diang is a village about 46 kilometres west of Bértoua on the road to Nanga Eboko: 13°21' E and 04°35' N at above 704 metres above sea level. North of Diang there are numerous tributaries of the Nyabekié, which runs into the Abessé. The streams to the south of the village flow into the Bengaka, which runs into the Ses. Both the Abessé and the Ses belong to the system of the Yong, which flows northwards into the Sanaga. It is not possible for us to give more precisely the finding place of *Aphyosemion cameronense* in Diang. *Aphyosemion wildekampi* is also known from Diang. We guess that it comes from another stream in the vicinity of this place. We do not know of it occurring syntopically with *Aphyosemion cameronense.*

"Nyezam" is also a location in Amiet, 1987. A male is shown on plate 55, picture 81. On our maps we have been able to locate two villages with the name "Nyiézam", as follows:

- -10°56' E and 02°20' N at about 550 metres above sea level. This village lies about 49 kilometres west of Ambam on the road to Mfoua. The streams belong either to the Nsoo or the Elan, which then both flow into the Mvila, an important tributary of the Ntem in south Cameroon.
- -10°39' E and 02°23' N at about 530 metres above sea level. This "Nyiézam" is an eastern suburb of Ma'an, about 65 kilometres west of Méyo Centre. The streams around Ma'an belong to the Mouémvi'ilii, which runs into the Mvi'ili, another tributary of the Ntem.

This population was only photographed by Amiet. It never reached Europe. Unfortunately we cannot say which of these two villages represents this finding place.

The following map shows the position of both places, the one near Ambam, the other near Ma'an:

"Akoabas" is also mentioned by Amiet as a locality of *Aphyosemion cameronense*. He caught fish of this population in February 1981. A male is shown on plate 56, picture 83.

This place lies 25 kilometres south-west of Oveng on the road to Nsak and Minvoul in north Gabon. The geographical co-ordinates as taken by us are 12°6' E and 02°21' N at about 653 metres above sea level. The names of the streams in the immediate neighbourhood are not known to us, but after a few kilometres they do run into the Kom, which then flows into the Ntem.

Aphyosemion cameronense "HJRK 92/7"

"Nsessoum" is also mentioned by AMIET, 1987. This village lies about nine kilometres south-east of Méyo Centre on the road to Ambam. According to our reckoning the geographical co-ordinates are: 11°7' E and 02°32' N at about 595 metres above sea level.

South of the village the streams run into the Dassee, which itself is a tributary of the Mboro, which flows into the Ntem. On our maps the streams to the north are unnamed, but after a few kilometres they also flow into the Mboro.

AMIET visited this village in March 1985 and made fundamental findings on the "*cameronense*"-group. Fish from this locality were not taken by him to Europe at that time, but EBERL and others (see under "EMS 90/4") managed to find AMIET's locality a few kilometres south-east of Nsessoum on the road to Ambam, from where they brought back *Aphyosemion cameronense* to Europe.

Of interest is the occurrence of a form of the "*cameronense*"-group in the immediate vicinity of Nsessoum, which basically resembles *Aphyosemion cameronense*. On the other hand there are considerable differences from the males of Nsessoum (see also "***Aphyosemion spec. aff. cameronense*** **Phenotype 2 from Nsessoum**", pp 376 to 384).

"Minkok" is only mentioned in AMIET, 1987 as a finding place. There is no photograph of a male. We found a village of this name with the following geographical co-ordinates: 11°28' E and 02°26' N at about 600 metres above sea level. This place is situated about 20 kilometres as the crow flies from Ambam, on one of the minor roads to the east. The streams around Minkok belong to the Bibomo, a tributary of the Bibé, which flows into the Ntem.

As we have no further information on this locality, we can only suppose from the remark "du bassin du Ntem" or "from the Ntem Basin" that this is AMIET's finding place. This strain is not available in the hobby.

"Assendjick" is mentioned as a further finding place for *Aphyosemion cameronense* by Amiet. A male is shown on plate 56, picture 85.

We found a village with the name of "Assandjik" about eight kilometres south-east of Ambam on the road to Eboro and the frontier with Gabon: 11°21' E and 02°23' N at roughly 590 metres above sea level.

The streams around Assandjik enter the Bisso'o, which runs into the Menyo'o, a small tributary of the Ntem. Its proximity to Ambam (the terra typica of *Aphyosemion halleri*!) makes one doubt whether *Aphyosemion cameronense* actually occurs there, especially when Radda & Pürzl report the presence of the first mentioned species near Bac Eking, i.e. south-west of Assandjik.

Systematic collecting work in this area could clarify this question and in addition provide valuable information on the distribution of representatives of the "*cameronense*"-group.

"Asseng" is Amiet's location for a male illustrated on plate 56, picture 86. This village lies about ten kilometres west of Ma'an on the road to Nyabéssan (Nyabizan): 10°32' E and 02°25' N at about 465 metres above sea level.

The Ntem is but a short distance away, so the streams around Asseng flow into the Mvi'ilii, a small tributary of the Ntem.

Amiet mentions in his book the presence of *Aphyosemion spec. aff. herzogi* in Asseng together with *Aphyosemion cameronense*.

"Bikok" is the name given to a finding place of *Aphyosemion cameronense* that Amiet discovered only four kilometres away from a stream with *Aphyosemion obscurum*.

The small town of Bikok lies south of Yaoundé about seven kilometres west of the Yaoundé-Mbalmayo road: 11°27' E and 03°38' N at about 731 metres above sea level.

The streams west of Bikok join the Negbe, a tributary of the Akono, which flows into the Nyong. In our opinion these streams form the south-east distribution frontier of *Aphyosemion obscurum*.

To the north of Bikok rises the small river Ossoe Mvelé, which drains into the Mefou and then into the Nyong.

South of the town the streams flow into the Kilintsam, an unimportant direct tributary of the Nyong.

This special hydrographic situation may be the reason why AMIET was able to find these two representatives of the "*cameronense*"-group so close to each other.

"Melen" is a very common village name in Cameroon and Gabon. That is why, at this point, we would like to stress how important it is to have the correct and unambiguous naming of a population when fish are to be distributed among serious killifish keepers.

According to the information available to us, *Aphyosemion cameronense* has only once been found in a place with the name "Melen" (Mélen, Melén, Mèlen or similar spellings!).

Nevertheless we list some of these places with a spelling similar to "Melen", in order to show how easily confusion could arise:

Name of place	Geographical co-ordinates	Distances to the larger towns	Hydrographic factors	Country
Mélen	11°56' E 03°05' N	16 km Sangmélima-Yaoundé	Minsabe, Se, Lobo, Dja	Cameroon
Melen	11°12' E 02°07' N	13 km south-west of Ebébiyin	Nsié, Woro, Ntem	Rio Muni
Mélen	11°17' E 02°04' N	11 km south of Ebébiyin	Kyé	Rio Muni
Melan	11°38' E 02°41' N	10 km north-west of Mvangan	Onwoo, Nlobo, Ntem	Cameroon
Mélen	12°3' E 02°04' N	18 km from Minvoul to Oyém	Ntem	Gabon
Mélen	12°32' E 02°47' N	22 km from Djoum to Sangmélima	Otoabat, Dja	Cameroon
Meulen	12°10' E 02°34' N	8 km from Endengué to Oveng	Minkono, Mboua, Ntem	Cameroon
Egneng Melen	11°22' E 00°51' N	22 km north-west of Mitzic to Sam	Lara, Okano, Ivindo	Gabon
Mélèn	11°24' E 01°34' N	24 km west of Oyém	Dabko, Woleu	Gabon
Mèlèn	11°34' E 01°59' N	between Oyém and Bitam	Ntan, Mvézé, Kyé, Ntem	Gabon
Melen	11°18' E 01°0' N	6 km north-west of Sam to Mitzic	Dzam, Nkam, Abanga	Gabon
Melen	10°27' E 02°27' N	8 km east of Nyabéssan	Ntem	Cameroon

Theoretically there could be (with the exception of the second village in this list - *Aphyosemion halleri*!) *Aphyosemion cameronense* in the streams in and around these places. So where exactly did AMIET find his strain?

In fact the answer is the last place on the list (letter CHAUCHE, 1993). Without more precise information or a map describing the position of the finding place, considerable problems could arise if finding places of another collector are to be found again. This is one of the main reasons why we always give unambiguous and as exact as possible namings of the different populations and strains of the killies.

Although there may be other killifish enthusiasts who hold different views on this subject, we hope that our method of naming populations will be accepted - either with clear locality names in the form of village or river names or with codes, which give information about the collector, country, year and number.

The "Melen" strain was distributed in the hobby in Germany around the end of the eighties and the early nineties, but then unfortunately disappeared, so it is no longer available.

"Madang" is also one of AMIET's populations, which he helped to get sent to France. Maurice CHAUCHE's very helpful information enabled us to locate this village precisely. We are thus able to give its geographical co-ordinates: 11°45' E and 03°17' N at about 466 metres above sea level. Madang lies about seven kilometres north of Lolodorf on the road to Eséka. The streams in the vicinity of this village flow after a few kilometres into the Lokoundjé (see also on the map on page 278).

Unfortunately, this superb population did not get distributed among aquarists. In appearance it corresponds to the male illustrated by RADDA & PÜRZL with the name *Aphyosemion cameronense* "Lolodorf".

"GBL 85/11" is the eleventh of a total of 31 finding places of BARDIN and LOMBARD's Gabon trip of February 1985, during the course of which 12 streams with *Aphyosemion cameronense* were discovered. Sadly these strains are no longer available in the hobby. All we have is a colour picture of "GBL 85/31" by Maurice CHAUCHE.

BARDIN and LOMBARD had left Oyém to travel northwards and after 1.7 km passed Angoné, where a road turns to Eboro east of Oyém. A further 5.5 kilometres north of Angoné in the direction of Assok N'gomo (Assok N'goum) they found a stream with *Aphyosemion cameronense*, the only killie present.

We have been able to take the geographical co-ordinates as follows: 11°37' E and 01°39' N at approximately 620 metres above sea level. The streams in this area join the Ngoum, which runs into the Nyé, which in its turn flows northwards into the Ntem.

"GBL 85/12" is the following finding place 6.8 kilometres north of Angoné, which means 1.8 km north of the previous locality. The geographical co-ordinates and the hydrographic situation are the same. *Aphyosemion cameronense* was also found.

"GBL 85/13" lies 9.5 kilometres north of Angoné and about 5 kilometres south of Assok N'gomo: 11°38' E and 01°40' N. The other readings are as above.

"GBL 85/14" is the name for two streams 2.5 and 6.5 kilometres north-west of Oyém on the road to Bivénel (Bivèn): 10°34' E and 01°38' N and 10°34' E and 01°39' N at an estimated 630 metres above sea level. With these distances we were able to establish that these localities near Endomé lie in the watershed of the Nyé.

BARDIN and LOMBARD found only *Aphyosemion cameronense*.

"GBL 85/15" is a finding place 13.5 kilometres north of Oyém on the road to Assok N'gomo. In this case too we can only estimate the geographical co-ordinates: 11°39' E and 01°41' N at about 635 metres above sea level. Here too only *Aphyosemion cameronense* was found.

"GBL 85/19" is given as "6.5 kilometres north-west of N'kolmegoa". Another spelling of this place is "Nkolmengboua". This is the crossroads of the Bitam-Minvoul-Eboro roads (= border with Cameroon). According to our maps the geographical co-ordinates are 11°28' E and 02°16' N at 566 metres above sea level.

This could be the "Tara" stream, which was investigated in August 1994 by Passaro and Eberl (see **"PEG 94/29"**). Bardin and Lombard report *Aphyosemion halleri* and "a blue *Aphyosemion*", while in 1994 only *Aphyosemion cameronense* could be found.

"GBL 85/26" is a finding place on the outskirts of Messang (Bindoumessang), 5 kilometres south of Bitam on the road to Oyém. The geographical co-ordinates are 11°31' E and 02°02' N at 605 metres above sea level.

The streams around Messang run into the Ntan, which flows into the Mvézé. This is a tributary of the Kyé, which flows north into the Ntem.

Bardin and Lombard give "*Aphyosemion spec*. with blue-white anal fin" as the only killie. The collections by Passaro and Eberl in August 1994 showed that the fish was *Aphyosemion cameronense*.

"GBL 85/27" lies 31.5 kilometres south of Messang, and thus 35.5 kilometres south of Bitam and 19 kilometres north of Assok N'gomo. Neither the geographical co-ordinates nor the height above sea level can be given accurately. This locality should be between the villages of Adzap and Abang, a few kilometres south of the Nyé.

The collectors report an *Aphyosemion* species with a blue-white and also yellow anal fin. In our opinion the fish is *Aphyosemion cameronense*; the variability in the colour of the anal fin lies within the usual parameters, according to our experience.

"GBL 85/28" refers to another finding place of *Aphyosemion cameronense* with blue-white anal fin 48 kilometres south of Messang (53 kilometres south of Bitam and 5 kilometres north of Assok N'gomo) on the road from Oyém.

Once again the geographical co-ordinates cannot be given exactly. The stream should be near the village of Medoumou (10°38' E and 01°44' N at 598 metres above sea level) in the drainage area of the Ngoum, which joins the Nyé and then flows north into the Ntem.

"GBL 85/29" lies 7 kilometres east of Oyém via Angoné on the road to Eboubo (Ebobo, Eboville). The distance between Oyém and Angoné is given by Bardin and Lombard as 1.7 kilometres, so the stream ought to be 5.3 kilometres from Angoné in the direction of Eboubo.

The geographical co-ordinates are 11°39' E and 01°35' N. The streams in this area join the upper stretches of the Nyé, which at this point is called the Mvié. So they belong to the drainage of the Ntem.

Here too *Aphyosemion cameronense* was the only killifish found. Syntopic fish mentioned are one *Mormyridae* and one *Ctenopoma* species.

"GBL 85/30" is the next locality 13 kilometres from Oyém via Angoné on the way to Eboubo. The stream is rather large, being two metres wide and 50 centimetres deep. The road crosses it by means of a wooden bridge. We cannot say exactly which stream this is. It could be either the Dziri or the Samkar, both of which flow south and join the Woleu.

BARDIN and LOMBARD call the species they found there *Aphyosemion cameronense*, without mentioning a blue-white anal fin.

"GBL 85/31" lies 22 kilometres east of Oyém via Angoné on the road to Eboubo. The stream is situated near the village of "Essong Medzom", which is not shown on our maps. So we cannot give the exact position of this locality. However it is certainly a stream that lies in the upper drainage area of the Woleu.

The collectors report that *Aphyosemion cameronense* is very common ("nombreux") but that *Aphyosemion bochtleri* (!) was difficult to find.

"GWW 86/2" is the second of the total of 33 finding places that Peter WAGNER and Roland WENDEL were able to investigate in January 1986. Even though *Aphyosemion cameronense* was found in 19 localities, it was only possible to bring one population back alive. This was the strain "GWW 86/2" of *Aphyosemion cameronense*.

On 6.1.1986 the collectors left Makokou and arrived at the village of Latta ("Lata"). They gave its distance as 17 kilometres east of Makokou on the road to Mékambo. We read the geographical co-ordinates as 13°00' E and 00°39' N at 502 metres above sea level.

The 'Eboutéboungou' lies north of Latta and flows into the Labé, which after a few kilometres flows into the Ivindo. The following sketch shows the position of the stream in the forest near Latta:

The villagers showed the collectors a stream in the forest behind the village, in which *Aphyosemion cameronense*, *Aphyosemion kunzi*, *Diapteron georgiae*, *Epiplatys neumanni* and *Hylopanchax silvestris* were present. It proved possible to establish successfully the first three of these species in the hobby.

On 11.8.1994 PASSARO and EBERL collected in the area and were taken by the villagers to the same locality. On this occasion all they found was *Aphyosemion cameronense* (numerous) and *Diapteron georgiae* (rather rare), the other killifish species were not present. This shows how the composition of species can change both in different months (January - August) as well as in different years.

"GWW 86/3" is a small stream 12 kilometres west of Makokou on the Ovan road. On 6.1.1986 WAGNER and WENDEL also found there *Aphyosemion cameronense, Aphyosemion punctatum*, *Diapteron georgiae* and *Epiplatys neumanni*.

It is no longer possible to say where in Makokou they measured from. Due to the size of this town, considerable variations could arise, depending on whether one starts from the town centre, the bridge over the Ivindo or the western edge of the town.

We guess the locality to be on the 'Mènyigu' stream, which flows into the Nyabaré and subsequently into the Ivindo: 12°46' E and 00°35' N at approximately 460 metres above sea level.

"GWW 86/6" is a stream 56 kilometres west of Makokou, which WAGNER and WENDEL fished on 7.1.1986. They found *Aphyosemion cameronense*, *Aphyosemion kunzi*, *Diapteron fulgens* and *Epiplatys neumanni*.

We are unable to give the exact position, but the measurements made by LEGROS, CERFONTAINE and EBERL suggest that this finding place is near Bissobilam (12°27' E and 00°30' N at approximately 515 metres above sea level.

In the vicinity of Bissobilam rises the Dzoué, which flows north-west into the Mvoung, which in turn flows south into the Ivindo.

"GWW 86/8" is described as a stream that crosses the road 63 kilometres west of Makokou. According to our calculations this finding place should be near Akana (12°22' E and 00°27' N at 443 metres above sea level). The streams in this region flow into the Mam, which flows into the Mvoung just a few kilometres south of Ovan.

WAGNER and WENDEL mention *Aphyosemion cameronense* and *Epiplatys neumanni* as being the only killifish.

"GWW 86/10" refers to a stream 78 kilometres west of Makokou. We cannot give the precise position, but this finding place is near Agnang in the drainage area of the Métak Menzom (a direct tributary of the Mvoung) or the Bengom, which also flows into the Mvoung via the Mam. The geographical co-ordinates for Agnang itself are 12°18' E and 00°26' N at 486 metres above sea-level.

Alongside *Aphyosemion cameronense*, other fish found were *Diapteron georgiae* and *Epiplatys neumanni*.

"GWW 86/11" is the terra typica of *Aphyosemion bochtleri*. It was from here that WAGNER and WENDEL successfully imported this species, which had not been distributed in the hobby. They also found *Aphyosemion cameronense*, *Diapteron georgiae* and *Epiplatys neumanni*.

The village of Mintoum (12°16' E and 00°25' N at about 485 metres above sea level) lies in the area of a small watershed. To the north of the village rises the Mémia, which flows into the Métak Menzom and then into the nearby Mvoung (*Aphyosemion cameronense* and *Diapteron georgiae* reported by LEGROS, CERFONTAINE and EBERL in January 1993).

South of Mintoum (wrongly spelt on our maps as "Mintom") there are tributaries of the Mboumenkoulé, which flows directly into the Mvoung, which is just a few kilometres away (*Aphyosemion cameronense*, *Aphyosemion bochtleri*, *Diapteron georgiae* and *Epiplatys neumanni* reported by numerous collectors).

"GWW 86/15" is a finding place 40 kilometres north-west of Mitzic on the road to Sam. As we have no further information, it is very difficult to give the geographical co-ordinates. We guess the stream to be situated near the villages of Mbélalen (11°20' E and 00°54' N) and Nkol (11°22' E and 00°53' N), which are surrounded by the Otong and Mékang streams. Both of these streams belong to the drainage area of the Nkam, which flows south-west into the Abanga.

Aphyosemion cameronense was the only killifish species. We do not know about any other accompanying fish.

"GWW 86/16" lies ten kilometres north-west of Sam on the road that goes to Mitzic via Bibassé. The geographical co-ordinates are 11°21' E and 00°59' N. The height above sea level cannot be calculated accurately. In this area the road is crossed by the 'Abian Oyon', which runs into the Menzivin, a western tributary of the Lara. It therefore belongs to the drainage area of the Okano. Here too the only killie was *Aphyosemion cameronense*.

"GWW 86/17" lies only two kilometres north-west of the previous finding place, that is to say twelve kilometres from Sam in the direction of Bibassé. This stream should be near the village of Ngouang: 11°18' E and 01°00' N. Again the only killie found was *Aphyosemion cameronense*.

"GWW 86/19" is a stream only four kilometres south of Bibassé on the road to Mitzic. Bibassé itself has the geographical co-ordinates 11°37' E and 01°25' N at 670 metres above sea level; the streams in this area flow into the Dégavi, which runs into the Woleu. *Aphyosemion cameronense* was the only killifish species.

"GWW 86/20" is the terra typica of *Episemion callipteron*, since WAGNER and WENDEL discovered this species on 10.1.1986 in a stream that crosses the road six kilometres south of Bibassé from right to left (from east to west). Here *Aphyosemion cameronense* was much more numerous than the new species.

The geographical co-ordinates are 11°48' E and 01°23' N. The stream also belongs to the previously mentioned Dégavi (see finding place **"PEG 94/39"**, p 292).

"GWW 86/21" refers to a stream 21 kilometres south of Bibassé. At this point there are many small villages (Avang and Nkomélèn: 11°42' E and 01°17' N) and a few small streams, which cross the road from east to west and flow into the Nda, a tributary of the Lara, which itself runs into the Okano.

Wagner and Wendel were able to find *Aphyosemion cameronense* again.

"GWW 86/22" lies only three kilometres further south and ought to be one of the streams mentioned above. The only killie was again *Aphyosemion cameronense*.

"GWW 86/23" lies 13 kilometres north of Mitzic on the road to Bibassé and Oyém. Here too we lack information about any nearby village, so the geographical co-ordinates can only be estimated: 11°37' E and 00°54' N. We cannot give the height above sea level.

To the south of Avoum, there are two tributaries of the Ebo, which flows from east to west directly into the Okano. Surprisingly this is yet another stream in which only *Aphyosemion cameronense* was found.

"GWW 86/24" is a stream two kilometres from Sam in the direction of Médouneu. Sam itself has the following geographical co-ordinates: 11°16' E and 00°59' N at 561 metres above sea level. To the west of Sam lie two small villages (Nkan and Adzabilon: 11°14' E and 00°59' N). The road is crossed by some streams of the Afoum system. This river flows into the Nkam, which is an easterly tributary of the Abanga.

Aphyosemion cameronense was the only killifish species.

"GWW 86/25" lies 23 kilometres west of Sam on the Médouneu road. On our maps several small streams are marked here as crossing the road. For example, near the village of Bendolo (11°5' E and 00°58' N at 510 metres above sea level) we find the 'Bendolo' of the same name. This stream runs into the Mbomo just a few kilometres to the east. The Mbomo itself flows south-west into the Abanga.

Once again the only killie found was *Aphyosemion cameronense*.

"GWW 86/26" lies nine kilometres west of the previous finding place, that is to say 32 kilometres from Sam in the direction of Médouneu. This should be a stream in the vicinity of the village of Afaf Zok (11°01' E and 00°57' N at 468 metres above sea level), which lies in the drainage area of the Bolo. The Bolo flows south into the Mbomo. Apart from *Aphyosemion cameronense*, no other killie species were found by Wagner and Wendel.

"GWW 86/27" lies a further seven kilometres west of the previous finding place. The distance is given as "39 kilometres from Sam to Médouneu". The geographical co-ordinates cannot be given exactly. The road runs along the area of the source of the Abanga, so it is crossed by the following streams and small rivers: Ngougoun, Abanga, Bikoumeu and Mvé.

We cannot say to which of the bodies of water mentioned the stream under discussion belongs. In any case - as was the case with the many previous localities - *Aphyosemion cameronense* was the only killifish species.

"GWW 86/28" was determined by WAGNER and WENDEL as "15 kilometres before Médouneu". Our findings suggest this is a small stream in the vicinity of Nkoumadza (10°55' E and 01°00' N at about 450 metres above sea level), which flows into the Mvé, which runs into the upper Abanga.

Once again *Aphyosemion cameronense* was the only killie to be found.

"GWW 86/29" lies ten kilometres east of Médouneu, so we imagine this finding place to be in the neighbourhood of the villages of Efôt and Elim (10°54' E and 01°01' N) near the source of the Mvé. The collectors mention *Aphyosemion cameronense* but no other fish. For a long time this locality was the most westerly location of *Aphyosemion cameronense* on the frontier between Gabon and Equatorial Guinea. Then PASSARO and EBERL found this species some kilometres further in the direction of Médouneu (see "PEG 94/42").

"GBHL 86/1" is the first finding place of the February 1986 trip, when BARDIN, HOUDU and LOMBARD fished intensively the north of Gabon for the second time. Unfortunately, after this collecting trip, they seem to have lost interest in the maintenance and breeding of killifish, so none of these populations have remained in the hobby.

The three Frenchmen began travelling in the north of the country starting from Oyém. At a point 6.5 kilometres west of this town they fished by the side of a minor road, which runs parallel to the main road from Oyém to Mongomo. (On our maps the place is spelt "Mongono". This is the border town in Equatorial Guinea.) They found *Aphyosemion cameronense* and *Aphyosemion herzogi.*

We do not know the name of the stream or of a village in the neighbourhood, so we have to estimate the geographical co-ordinates: this locality could be near Ekoné (11°32' E and 01°38' N). In the vicinity of this village the Nyé rises and then flows north into the Ntem.

The following map shows the large number of main and side roads around Oyém:

"GBHL 86/2" lies ten kilometres north-west of Oyém on the same road. The geographical co-ordinates of the village of Yaffa are 11°30' E and 01°38' N. In another spring of the Nyé BARDIN, HOUDU and LOMBARD found *Aphyosemion cameronense* and called these fish "blue, yellow phase".

We have no further information on the appearance of adult males from this area, but our own experiences (PASSARO and EBERL in August 1994) showed that it was a population of *Aphyosemion cameronense*, the males of which had an above average proportion of yellow markings on the unpaired fins.

Similar cases are known from other localities: Madang I, "LEC 93/3" and others.

"GBHL 86/3" is another locality near Oyém. Its position is described as "16 kilometres from Oyém on the Oyém-Mongomo road". Here too we have no information as to the name of the stream or a village in the neighbourhood.

According to our maps it should be a stream near the villages of Mivdé and Ingassé (11°28' E and 01°37' N), which flows either into the Mila or the Miang. Both of these rivers are tributaries of the Kyé, which runs north into the Ntem.

BARDIN, HOUDU and LOMBARD report a "blue" population of *Aphyosemion cameronense* with a "red anal fin".

"GBHL 86/4" is the most easterly locality of this trip from Oyém. The trip ended near Eboubo, from where the distances were measured. Two kilometres west of Eboubo in the direction of Oyém a stream with *Aphyosemion cameronense* was found. We determined the geographical co-ordinates of Eboubo as follows: 11°59' E and 01°35' N.

Interestingly enough the road runs along the watershed between two hydrographic systems: the streams south of Eboubo and Tourounéssol (the neighbouring village to the west) flow into the Ntié, a tributary of the Okano, which runs south into the Ivindo. The streams to the north form small tributaries of the Sô, which flows north into the Nyé, which itself runs into the Ntem.

Closer investigations in this area and a comparison of the different populations of *Aphyosemion cameronense* could provide valuable findings on the variability of this species. So it is all the more regrettable that this strain is no longer available.

"GBHL 86/5" lies ten kilometres from Eboubo. The collectors describe the colouration of the male *Aphyosemion cameronense* as "green and yellow"! This could indicate that this finding place belongs to another hydrographic system and the population to a different phenotype from locality "GBHL 86/4".

The maps we have suggest that this stream must be situated in the vicinity of the villages of Nkoum (11°54' E and 01°34' N) and Sém, (11°53' E and 01°33' N). And these streams lie near the source of the Woleu.

In a very small area one could therefore find populations of *Aphyosemion cameronense* which belong to the three hydrographic systems of the Ntem, Woleu and Okano/ Ivindo!

"GBHL 86/6" is a stream 35 kilometres west of Eboubo on the road to Oyém (at a guess 11°46' E and 01°33' N; the height above sea level cannot be given precisely here either), where *Aphyosemion cameronense* with the usual body colouration was again found. This could be a stream in the drainage area of the Samkar, which flows via the Dziri into the Woleu.

As already mentioned, the finding place "GBL 85/30" is also in this area, but lack of information prevents us from being able to say where the streams lie in relation to each other or how far apart they are.

"GBHL 86/8" is a locality 110 kilometres north-east of Oyém on the Minvoul road. These two towns are 115 kilometres apart, so this stream can only be five kilometres south-west of Minvoul. The geographical co-ordinates are 12°05' E and 02°09' N at 591 metres above sea level. Near the villages of Medjong and Mbas there are some small streams, which are only a few kilometres long and flow directly south into the Ntem.

BARDIN, HOUDU and LOMBARD report the presence of a "blue" population of *Aphyosemion cameronense* together with *Aphyosemion exiguum*. These collectors were the first to find a representative of the subgenus *Kathetys* (here in the form of *Aphyosemion exiguum*) on Gabonense territory, something which RADDA and PÜRZL had predicted.

Using BARDIN, HOUDU and LOMBARD's data, PASSARO and EBERL were able to visit this locality in August 1994. However, they only managed to find two young *Aphyosemion exiguum*; *Aphyosemion cameronense* was not to be found (see also under "PEG 94/23").

"GBHL 86/10" refers to the locality 27.5 kilometres south-east of Makokou on the road to Okondja mentioned on page 258. We know nothing about the appearance of the adult males nor do we know enough about the precise location of this stream to be able to give the geographical co-ordinates accurately. But it is worth mentioning here that the streams in question can only belong to the Aboy (north of the road) or to the Mounianguié (south of the road). Both streams flow into the Ivindo near Makokou.

BARDIN, HOUDU and LOMBARD found *Aphyosemion cameronense* ("blue"?), *Aphyosemion kunzi*, *Diapteron cyanostictum* and *Epiplatys neumanni*.

"GBHL 86/12" has already been discussed on page 257. This stream is said to be 38.8 kilometres north-east of Makokou on the road to Mékambo. At this place *Aphyosemion cameronense* ("blue, yellow phase"?), *Aphyosemion punctatum* and *Epiplatys neumanni* were found.

The geographical co-ordinates for the village of Ibenga, which in fact no longer exists, are 13°03' E and 00°41' N at about 530 metres above sea level. To the north of the road several small streams run into the Békoubékou, which flows directly into the Ivindo. To the south of the road rises the Bengadi, which drains into the Liboumba and then into the Ivindo.

"GBHL 86/14" refers to a finding place 13 kilometres west of Makokou (where this measurement was taken from is unknown). The collectors described this population as "green", but they state that it is definitely *Aphyosemion cameronense.* Also found in this locality were *Diapteron cyanostictum* and *Epiplatys neumanni.*

In theory this could be the Mènyigu stream, which has already been dealt with under the discussion of locality "GWW 86/3". On the other hand, this hypothesis is countered by the different killifish fauna: Wagner and Wendel had found *Aphyosemion cameronense*, *Aphyosemion punctatum*, *Diapteron georgiae* and *Epiplatys neumanni* in January 1986, but one month later, Bardin, Houdu and Lombard found *Aphyosemion cameronense*, *Diapteron cyanostictum* and *Epiplatys neumanni*.

Even if there are two different streams, they must be very close to each other (12 or 13 kilometres west of Makokou). Of interest here would be an investigation of the relationship between the two *Diapteron* species. Are the two streams connected? How strong would the competition then be between *Diapteron georgiae* and *Diapteron cyanostictum*?

"GBHL 86/16" refers to a stream 70 kilometres west of Makokou. The collectors report the presence of *Aphyosemion cameronense* ("blue" = the usual phenotype), *Diapteron georgiae* and *Epiplatys neumanni*. Due to insufficient details we cannot give the geographical co-ordinates accurately enough.

Measurements taken by Passaro and Eberl in August 1994 showed the village of Agnang to be some 73 kilometres west of the end of the asphalt in Makokou. We would therefore place locality "GBHL 86/16" in the vicinity of this village. Further details on Agnang are given under locality "PEG 94/10".

"GBHL 86/17" is a stream to the west of Ovan on the road to Koumaméyong. Bardin, Houdu and Lombard found *Aphyosemion cameronense*, *Diapteron cyanostictum*, *Diapteron georgiae* (!) and *Epiplatys neumanni*.

Although no stream or village name is known in this instance either, we can give the geographical co-ordinates as 12°08' E and 00°20' N at approximately 470 metres above sea level.

To the west of Ovan lies the road between Ayol Mebang and Ebé, which is parallel to a stream, whose name we are unable to ascertain. This stream flows from west to north and after a few kilometres flows into the Mvoung near Ovan, after having crossed the road several times. Probably this is the stream fished at that time.

"C 89/39" is the code for a finding place discovered by Bas Vlijm on the Lolodorf-Ebolowa road on 24.7.1989. The geographical co-ordinates are 10°55' E and 03°00' N at approximately 650 metres above sea level.

The streams around Efoulan join the Medoumbou, a tributary of the Nyabitende, which flows into the Tchangué and then into the Lokoundjé.

The other fish species found was *Barbus jae.* Unfortunately this strain too is no longer available in the hobby.

"EMS 90/3" is one of the two populations of *Aphyosemion cameronense* imported by Eberl and others from south Cameroon in August 1990. The third locality lies near the village of Mebandé on the Lolodorf-Ebolowa road: 10°51' E and 03°07' N at 591 metres above sea level. The 'Mebandé' stream, which crosses the road, flows into the Djongo, a tributary of the Melangué, which runs into the Lokoundjé. No other killie species was caught, just one small barb species. None of the fish of this strain survived the trip, so this finding place was visited again by GRELL and EBERL in 1991. They managed to bring live specimens back to Germany. This strain is available in the hobby.

The position of this locality is shown on the following map:

"EMS 90/4" is the next finding place of this trip. It is three kilometres south-east of Nsessoum. The position of this stream has already been discussed on page 265 under AMIET's locality "Nsessoum".

EBERL and others then tried to find and import the Nsessoum forms illustrated by AMIET, 1987 and which differ so markedly from each other. In the village there were a few inhabitants who could clearly remember a scientist camping there for three days several years earlier, in order to observe and catch insects, fish and other creatures.

The collectors were immediately taken to a stream about three kilometres from Nsessoum in the direction of Ambam. The stream is some 200 metres into the forest on the left of the road. It flows from left to right. The only other fish found besides *Aphyosemion cameronense* was a barb species. This strain too is distributed in the hobby.

The next locality fished was "EMS 90/5", which is in the immediate vicinity of Nsessoum and represents AMIET's Phenotype 2. This population will therefore be dealt with in the discussion of this phenotype on pp 376 to 384.

"GAB 10/90" is a narrow stream, which Barbara and Allan BROWN discovered in July 1990 in north Gabon, 38.7 kilometres south of Mitzic on the road to Lalara. According to our maps this is one of the small streams that cross the road between Zomoko and Minzi from west to east. After a few kilometres they run into the Lara, which in turn flows via the Okano into the Ivindo. The locality is a washing place directly on the road. A plant resembling grass and also a *Crinum* species grew in the water. Together with *Aphyosemion cameronense* a form of the "*herzogi*"-group was also found.

We are not able to give a precise location for this finding place, which is why we have to give estimated geographical co-ordinates: 11°28' E and 00°33' N at about 300 metres above sea level.

This strain arrived in Germany from Great Britain, since when it has been maintained in the hobby.

"GAB 15/90" lies 19.3 kilometres south of Oyém on the road to Mitzic. According to the information given by the collectors, *Aphyosemion cameronense* was caught by the bridge over the "River Woleu", which crosses the road from east to west. In our opinion it is astonishing for an *Aphyosemion* to occur in a river of this size, which must surely be an exception. The geographical co-ordinates are 11°36' E and 01°27' N at 638 metres above sea level. Unfortunately this strain has disappeared from the hobby, as attempts to breed and distribute it were unsuccessful.

"CGE 91/8" is one of the 20 localities fished by Wolfgang GRELL and Wolfgang EBERL in south Cameroon and around Edéa during August 1991.

On 9.8.1991 they found near the village of Meuban I (not Mebandé, see **"EMS 90/3"**) in the 'Nkoumadjap' stream 28.8 kilometres south of Djoum on the Ovan road a population of *Aphyosemion cameronense* together with *Aphyosemion exiguum* and a male *Aphyosemion kunzi.*

As one arrives from Djoum to Meuban I, there is a path regularly used by the villagers which leads into the forest on the right-hand side. About 400 to 500 metres down this path there is a stream coming from the left.

The geographical co-ordinates can be given from the detailed records taken on site:

12°41' E and 02°27' N at 629 metres above sea level. The stream runs into the Maningombo, which flows south into the Miété and then into the Ayina. This river in turn flows south-east and into the Ivindo.

This strain was distributed widely in the hobby and is thus available at the present time.

"CGE 91/9" refers to the 'Monovonbo' stream near the village of Mébassa (Mébasa), 98.9 kilometres from Djoum on the road to Endengué. The geographical co-ordinates of this locality, which was visited on 09.08.1981, are 12°41' E and 02°27' N at 629 metres above sea level. The stream runs into the Yété, which flows south into the Kom and then into the Ntem.

Again GRELL and EBERL were taken by the villagers to a path in the forest, the approach to which was not visible from the road. At some distance outside the village in the direction of Oveng, it was first necessary to use a machete to make an opening into the thick vegetation by the side of the road, before it was possible to follow the perfectly passable footpath. After about 600 metres the Monovonbo stream was seen coming from the left. The only killifish present was *Aphyosemion cameronense*.

This population of *Aphyosemion cameronense* is also available in the hobby.

"CGE 91/11" is a stream called Abéliba'a near Nguém, seven kilometres west of Ngomedzap on the road to Mvengué: 11°06' E and 03°15' N at 712 metres above sea level. The stream runs into the Ngoulounganga, which flows into the Akono, which feeds the Bikoué. Further south this river is called the Lokoundjé.

From Nguém a path leads through the forest. After 600 to 700 metres it takes you to the stream where *Aphyosemion cameronense* and *Aphyosemion exiguum* were found on 10.08.1991. This strain is still kept in killie tanks.

"HJRK 92/6" is a finding place of the Cameroon trip undertaken by Wolfgang HERZOG, Hans-Jürgen JOCHIM and Richard ROTH in November 1992. The stream crosses the road from right to left (as seen coming from Ma'an) and lies 14 kilometres east of Ma'an in the direction of Méyo Centre. Only one other killifish species was found alongside *Aphyosemion cameronense*. We calculate the geographical co-ordinates to be approximately 10°44' E and 02°27' N at about 574 metres above sea level. It could be a stream in the vicinity of the villages Tcha'assono or Meko'omengon, which is part of the Mvi'illi or Mbano systems, two northern tributaries of the Ntem.

Unfortunately this strain did not get distributed in the hobby.

"HJRK 92/7" is near the village of Mfoumou beetween Ma'an and Méyo Centre. This village is not shown on our maps. So we cannot give with adequate accuracy either the geographical co-ordinates or the hydrographic system to which the stream belongs.

At all events this finding place is situated between the last mentioned and the next localities, which means in the region of 14 to 33 kilometres east of Ma'an. But it is certainly a northern tributary of the Ntem.

The only other species found alongside *Aphyosemion cameronense* were bush-fish of the genus *Ctenopoma*.

This strain is no longer available in the hobby.

"HJRK 92/8" is the next locality 33 kilometres east of Ma'an in the direction of Méyo Centre. This stream crosses the road from right to left, but we cannot give its precise position. Since only very small young *Aphyosemion cameronense* were to be found, none were imported into Germany.

"HJRK 92/9" is the last locality along this road. Its position is given as 38 kilometres from Ma'an in the direction of Méyo Centre. Again *Aphyosemion cameronense* was the only killie species to be found. This strain is no longer distributed in the hobby.

"HJRK 92/11" refers to a finding place 32 kilometres west of Ebolowa on the road to Akom II and Kribi. The stream crosses the road from right to left (as seen coming from Ebolowa). *Aphyosemion cameronense* was the only killifish species. The exact geographical co-ordinates cannot be given.

This strain has been bred successfully and so is widely distributed in the hobby.

"Bibouleman" is the name given to a strain imported into Germany from south Cameroon in the early nineties. It is still available in the hobby. On our maps we have been able to find a village called "Biboulémam" on the road from Ebolowa to Kribi. It lies between Mefo and Akom II and has the geographical co-ordinates 10°39' E and 02°48' N at about 600 metres above sea-level. In the neighbourhood of Biboulémam there are many unnamed streams that run into the Biwomé. This river flows south into the Ntem.

We have no precise information on whether it is actually this village, when or where the fish of this strain were caught, who imported them or what other fish were to be found with them in the biotope.

"LEC 93/1" was the first finding place of the trip to north Gabon made by Olivier LEGROS, André CERFONTAINE and Wolfgang EBERL in January 1993. Coming from Libreville and Ndjolé they reached the village of Laboka II about 12 kilometres east of Lalara on the road to Ovan and Makokou. The geographical co-ordinates are 11°32' E and 00°19' N at 347 metres above sea level. On 07.01.1993 they were taken by the villagers to a stream 2.8 kilometres west of the village, which was reached by going along a path for about a kilometre through the forest. The stream was about 30 centimetres wide and between 5 and 20 centimetres deep. According to the villagers it did not have a name. In it were found a large number of *Aphyosemion cameronense* of different sizes and one male *Aphyosemion herzogi*. The specimens of *Aphyosemion cameronense* collected did not survive the rest of the trip, so it was not possible to bring this strain back to Europe.

"LEC 93/3" is a stream to the north-east of Ebé, a small village 48 kilometres east of Koumaméyong and 8 kilometres west of Ovan. "In the rainforest of north Gabon we found *Aphyosemion maculatum* near the village of Ebé" is the caption to a photograph by Jan PAP in WILDEKAMP (1981, page 22). The collectors tried to find this *Aphyosemion* in Ebé. The village itself has the following geographical co-ordinates: 12°07' E and 00°20' N at an estimated 450 metres above sea level.

The inhabitants of the village showed them the Nkogh'essy stream, which is about 200 metres north-east of the village and belongs to a small system of streams which drains eastwards into the Mvoung, which lies only a few kilometres away.

But instead of *Aphyosemion maculatum* the only killifish present was *Aphyosemion cameronense*. It was found in surprising numbers and in all sizes. Could it have been a mistake? Was there another village with the same name? Had *Aphyosemion maculatum* been displaced by *Aphyosemion cameronense* since 1980?

These questions were answered when, with the help of the villagers, another stream to the west of Ebé was found by the roadside half an hour later. In this stream lives *Aphyosemion maculatum*: see under ***Aphyosemion maculatum***, where on page 350 locality "LEC 93/4" is discussed.

Since its import *Aphyosemion cameronense* "LEC 93/3" has been bred with great success and distributed among enthusiasts for the small *Aphyosemion* species. So it is still represented in killie tanks.

The following map shows the location of both finding places in the immediate vicinity of Ebé:

"LEC 93/5" is the Manzalé stream near the village of Ebéssi (Ebèssi) 14 kilometres west of the end of the asphalt near Makokou on the Ovan road: 12°45' E and 00°35' N at approximately 480 metres above sea level. The stream runs into the Mènyigu, which flows south into the Nyabaré and then into the Ivindo.

Besides *Aphyosemion cameronense*, the following fish were found: *Diapteron cyanostictum* and *Epiplatys neumanni*, as well as *Ctenopoma spec*. and a *Mormyridae* species. The usual water insects, shrimps and tadpoles were also present. A detailed description of this finding place and a photograph of the biotope were published in NEUMANN (1994) on pp 17 to 22.

This strain of *Aphyosemion cameronense* has been successfully distributed in the hobby.

"LEC 93/8" lies near the village of Bissobilam, 55 kilometres west of the end of the asphalt in Makokou. According to the villagers this is "PK 54 Makokou" (= point de kilomètre 54). The geographical co-ordinates are 12°24' E and 00°30' N at about 470 metres above sea level.

The Mevomé stream belongs to the Dzoué head-waters. This river flows west into the Mvoung. On 10.1.1993 *Aphyosemion cameronense* (more females than males) and *Aphyosemion punctatum* (more numerous) were found in the clear, very small and shallow stream with a muddy bottom. There was no *Diapteron* species present, even though the biotope appeared to provide suitable conditions. This population of *Aphyosemion cameronense* was not distributed in the hobby.

"LEC 93/9" is a stream of unknown name east of the village of Afoumadzo 60 kilometres from the end of the asphalt in Makokou. We estimate the geographical co-ordinates to be 12°26' E and 00°28' N at 457 metres above sea level. This stream lies in the area of the source of the Dzoué and belongs to the Mvoung system.

Together with *Aphyosemion cameronense* the collectors found *Diapteron fulgens* and *Epiplatys neumanni*. This population was not brought back to Europe.

"LEC 93/10" is the next locality in a westerly direction 64 kilometres from the end of the asphalt in Makokou. The geographical co-ordinates are similar to those of the previous finding place. In the stream, whose name is not known, were found a large number of *Epiplatys neumanni* as well as *Diapteron georgiae* and one male *Aphyosemion cameronense*. This population could not therefore be introduced.

"LEC 93/11" refers to the eleventh locality of this trip, which was also fished on 10.1.1993. It is the Méyang stream near the village of Ayol five kilometres west of the bridge over the Mvoung in Ovan: 12°19' E and 00°20' N at 440 metres above sea level. The stream belongs to the same small system as that mentioned under locality "LEC 93/3". It therefore also flows east into the Mvoung.

Diapteron cyanostictum was found here but in very small numbers - just three males and one female. This population of *Aphyosemion cameronense* has been bred successfully and is thus available in the hobby.

"LEC 93/13" is a small tributary of the Tô near Oveng, the so-called "Chantier forestier" of the French timber export firm belonging to Gérard LEBRUN, north-west of Zomoko. The geographical co-ordinates are 11°16' E and 00°39' N at an estimated 460 metres above sea level. The Tô itself flows west into the Nkam, which further south-west

Aphyosemion cameronense "Melen" from south Cameroon

Aphyosemion cameronense "CGE 91/11" from Nguém between Ngomedzap and Mvengué

Aphyosemion cameronense "EMS 90/3" from Mebandé

This head study of a male *Aphyosemion cameronense* "CGE 91/9" shows that even the pectoral fins of these killies can be beautifully coloured runs into the Abanga. In January 1993, with the help of Gérard LEBRUN, the three collectors LEGROS, CERFONTAINE and EBERL had tried to find the old locality of *Aphyosemion haasi*. Before actually looking for this fish, they fished close to Oveng. In the worker settlement "Economa" about a kilometre west of Oveng (the centre of the Chantier forestier), they were led by the very friendly inhabitants to a channel some 50 centimetres wide and just a few centimetres deep. After about twenty metres it runs into the Tô. *Aphyosemion cameronense* was very numerous here and could be found in all sizes. As this population differed only slightly from the others in this region, fish from this locality were not taken back to Europe.

"LEC 93/15" refers to a stream that crosses the road 48 kilometres west of the outskirts of Mitzic in the direction of Sam. The distance between the two places amounts to 56 kilometres, so this stream must lie about six kilometres east of Sam near Nzèk (11°17' E and 00°57' N) or Mengong (11°16' E and 00°57' N). We cannot easily give the height above sea level, but we would estimate it to be about 540 metres. The road runs parallel to the Afoum, which after a few kilometres flows into the upper Nkam, which is an easterly tributary of the Abanga.

Besides *Aphyosemion cameronense* - the only killie - there were plenty of barbs, characins and shrimps. This strain is to be found in aquaria.

"LEC 93/16" lies some 500 metres west of the customs house at Sam, where foreign travellers are checked thoroughly and with great patience, even if they are just tourists passing through. Sam itself lies right on the border with Equatorial Guinea, and it has the following geographical co-ordinates: 11°16' E and 01°00' N at 561 metres above sea level. Pressure of time prevented the collectors from finding out the name of the stream. It was more important to leave the immediate vicinity of Sam as quickly as possible. Nevertheless one wanted to introduce a population of *Aphyosemion cameronense* from Sam.

The streams around Sam flow into the Mvong, which to the south of the town joins the Afoum and then runs into the Nkam and subsequently the Abanga. The "LEC 93/16" strain of *Aphyosemion cameronense* (the only killie species present there) is available in the hobby at the present time.

"LEC 93/17" is the last locality of this species to be discovered during the trip in January 1993. It is a stream that crosses the road from Sam to Médouneu 51 kilometres west of Sam. It lies between the villages of Afak Zok (11°01' E and 00°57' N at 468 metres above sea level) and Oboui (10°58' E and 00°59' N). The streams there may belong to the Bolo, which flows into the Mbomo and then into the Abanga, or else to the Ngougoun or Bikoumeu, which are both eastern tributaries of the Abanga. This population of *Aphyosemion cameronense* was distributed in the hobby and should still be available.

"PEG 93/16" is the sixteenth finding place of the July 1993 trip undertaken by Guido Passaro and Wolfgang Eberl. During the second attempt to re-introduce *Aphyosemion haasi* they spent the night in Zomoko. The plan was to follow the old forest road on foot, with the help of a villager. Further details will be given under this taxon (see page 334).

On 14.7.1993 at about 8.00 a.m., after a walk of several kilometres, a small stream was found, in which "only" *Aphyosemion cameronense* was found instead of *Aphyosemion haasi*.

The drawing at the bottom of page 337 in the chapter ***Aphyosemion haasi*** **Radda & Pürzl, 1976** shows the location of the finding place, whose geographical co-ordinates cannot be given exactly, as we lack accurate maps.

But the crucial thing is that this stream definitely belongs to the Amvéné system (flowing in the west of Zomoko).

The only other fish present were small barbs. The usual shrimps and tadpoles were present in large numbers.

This strain is distributed in the hobby.

"PEG 93/17" is a stream 52.2 kilometres east of Lalara on the Koumaméyong road between Lolo and Djidji. The geographical co-ordinates cannot be determined. The height above sea level is approximately 400 metres.

The streams in this area run into the Fieng, which flows south and joins the Ogooué a few kilometres west of Booué. The collectors did not take fish from this locality, as only four males and one female *Aphyosemion cameronense* were found. However, the more numerous *Diapteron georgiae* was collected and has been distributed in the hobby.

"PEG 94/7" is the seventh of a total of 51 finding places of the second Gabon trip undertaken by Guido Passaro and Wolfgang Eberl in August 1994. The locality is 56 kilometres from the end of the asphalt in Makokou. After one passes through the village of Bissobilam, a stream crosses from left to right the road to Ovan and Koumaméyong. The geographical co-ordinates are the same as those given for locality "LEC 93/8".

Besides *Aphyosemion cameronense*, *Epiplatys neumanni* and *Diapteron fulgens* were present, as well as barbs, characins, a catfish species and a *Ctenopoma* species.

It was possible to bring back adequate wild stock from this finding place, so that it is quite possible that this population will be permanently and widely kept in the hobby.

"PEG 94/8" lies 60 kilometres from the end of the asphalt in Makokou. The stream crosses the road from south to north. Here too the three killie species *Aphyosemion cameronense*, *Epiplatys neumanni* and *Diapteron fulgens* were found, but specimens from this population were not brought back to Europe.

For one thing, the killies here were very few in number, and lack of time prevented the collecting of a sufficient number of adult specimens.

"PEG 94/10" is the 'Bibolé' stream near Agnang, 73 kilometres west of the end of the asphalt in Makokou. The geographical co-ordinates were determined as follows: 12°18' E and 00°25' N, at 486 metres above sea level.

The stream is situated to the north of the village and drains into the Métak Menzom, which flows north into the Mvoung.

Apart from the very large number of adult specimens of *Aphyosemion cameronense*, numerous *Epiplatys neumanni* were found, as well as a young male *Diapteron georgiae*. No fish from this locality were brought back to Europe.

The following map shows both the position of Agnang on the Makokou to Ovan road and the streams and rivers of this region:

"PEG 94/11" is a stream, name unknown, which is situated eight kilometres west of the bridge over the Mvoung in Ovan, between Ayol Allar (12°09' E and 00°20' N at 440 metres above sea level) and Ebé (see under **"LEC 93/3"**). The geographical co-ordinates cannot be given exactly. The height above sea level should be 445 metres.

The stream that crosses the Ovan-Koumaméyong road from left to right (south to north) belongs to the small hydrographic system already mentioned under "LEC 93/3".

As well as *Aphyosemion cameronense*, *Epiplatys neumanni* was found; neither species was imported live.

"PEG 94/16" is a small stream between the districts "Djidji I" and "Djidji II" seven kilometres west of Koumaméyong on the Lalara road. The geographical co-ordinates are 11°47' E and 00°13' N at 400 metres above sea level. The stream - name unknown - flows into the Fieng and then into the Ogooué.

The stream was almost dried up. Despite intensive efforts, all that was found was a single male *Aphyosemion cameronense* (in fact without the "Yellow Blotch" of the nearby Phenotype 5) and two specimens of *Epiplatys neumanni*.

As there were not enough fish to make possible the distribution of this strain in the hobby, none was brought back to Germany.

"PEG 94/18" is a stream that crosses the Oyém road 51 kilometres north of Mitzic from left to right. The stream is situated between the villages of Nkey and Ongongo, and the villagers called it 'Otong Babossol'. The geographical co-ordinates are 11°42' E and 01°09' N; this stream lies in the area of the source of the Afia, which flows into the Avoumé Orientale (= French for "eastern Avoumé"). The Avoumé itself runs into the Okano.

Aphyosemion cameronense was found, and also *Aphyosemion herzogi*, a barb and a *Ctenopoma* species. Live specimens were not imported.

"PEG 94/19" refers to the 'Mfanyé' near the village of Essoné, 64 kilometres north-east of Oyém on the Minvoul road: 11°58' E and 01°57' N. At this locality too the height above sea level cannot be determined. The streams around this place run into the Méssa, which joins the Ottondan, which then flows north into the Sossolo and then into the Ntem. *Aphyosemion herzogi* was found together with *Aphyosemion cameronense*; neither strain was distributed in the hobby. Also present were one barb and one *Ctenopoma* species.

"PEG 94/22" is a stream of unknown name near Mebolo (Mébolo), 75 kilometres northeast of Oyém on the road to Minvoul: 11°58' E and 1°57' N, in this case the elevation above sealevel can not be detected.

The flowing waters in the surroundings of this village form the Méssa which unites with the Ottondan in order to flow northwards into the Sossolo and thus into the River Ntem.

Besides *Aphyosemion cameronense*, here also *Aphyosemion herzogi* could be found; both populations were not distributed in the hobby. Other fish species were a Barbus and a *Ctenompoma* species.

"PEG 94/22" is the 'Melow' stream near Medjong III, seven kilometres south-west of Minvoul on the road to Oyém: 12°05' E and 02°08' N at 591 metres above sea level. As the road runs just a few kilometres north of the Ntem, all the streams flow directly into this river. *Aphyosemion cameronense* was the only fish species to be found, specimens from this locality were not brought back to Europe.

"PEG 94/29" is most probably a stream which had already been investigated by BARDIN and LOMBARD in February 1985 (see page 325 under **"GBL 85/19"** and ***Aphyosemion halleri***).

PASSARO and EBERL had come from the direction of Minvoul. At the crossroads on Nkolmengboua they started measuring the distance of 6.5 kilometres in the direction of the border with Cameroon. True to the information given by the two Frenchmen, they came to the Tara stream, which crosses the road from west to east.

They had very much hoped to find *Aphyosemion halleri* with the distinctive orange-yellow caudal peduncle, which had been expressly mentioned by BARDIN and LOMBARD. In the event they found "only" two males and one female *Aphyosemion cameronense*; the body colouration showed no significant differences from previous or subsequent populations of this species.

"PEG 94/33" is a stream near Tchimazok ("PK 68 Oyém"), ten kilometres south of Bitam on the Oyém road: 11°33' E and 02°00' N at about 615 metres above sea level. The streams around Tchimazok flow into the Ntan, which runs into the Mvézé. Near Ebébiyin this river flows into the Kyé and then into the Ntem.

On 17.8.1994, at about 5 p.m., PASSARO and EBERL had arrived in the village, to spend the night outside Bitam. They were shown a spring and a small stream to the west of the road, where washing was done and manioc soaked. They managed to find only a few adult specimens of *Aphyosemion cameronense*, so it was not possible to bring this population back with them.

"PEG 94/34" is the next finding place, which was fished on the other side of the road on the morning of 18.8.1994. According to the villagers, the stream is called the 'Bibawé'. The distance between this and the previous locality amounts to two kilometres as the crow flies. So the geographical co-ordinates and hydrographic factors will be the same as for locality "PEG 94/33".

However, in addition to *Aphyosemion cameronense*, a form of the "*herzogi*"-group was found, which is very close to *Aphyosemion bochtleri*. It would be worth investigating more closely the occurrence of fish with this colouration in the north of Gabon around Bitam and also the genetic relationship of the populations with each other.

Sufficient specimens of both species were brought back to Germany, so it should be possible for them to be distributed within the hobby.

"PEG 94/35" is a stream from a spring one kilometre west of the turning off the road to Ebek and Alen Essèng. It is not at all easy to find. It lies about 500 metres north of the village of Akam Effak. The villagers gave the position of Akam Effak as "PK 25 Bitam and PK 50 Oyém". The geographical co-ordinates of this finding place were determined from the maps available to us as follows: 11°34' E and 01°55' N. The height above sea level cannot be given.

The stream runs into the Mvémeu, which is an eastern tributary of the Mvézeu. Further north this river is called the Mvézé and flows into the Kyé near Ebébiyin.

The following sketch represents the location of this finding place of *Aphyosemion cameronense* and a form of the "*herzogi*"-group, which cannot be placed within any hitherto described species.

Adult specimens of both *Aphyosemion* were collected, so the distribution of these strains in the hobby should be assured.

"PEG 94/36" is the 'Mbolo' stream near Mbomo, about 20 kilometres north-west of Oyém. The geographical co-ordinates of this village are 11°30' E and 01°51' N. Here too it is impossible to give the height above sea level.

Mbomo itself lies in the area of the source of the Mvézeu, which has been mentioned several times. The only killie species was *Aphyosemion cameronense*; no live specimens were imported into Germany.

"PEG 94/37" is a small stream in the area of the source of a small eastern tributary of the Kyé between Yoss and Mékoga north-west of Oyém. The geographical co-ordinates are 11°28' E and 01°49' N.

Passaro and Eberl found as well as *Aphyosemion cameronense* a form of the "*herzogi*"-group which it is difficult to classify. Neither population was taken back to Germany.

"PEG 94/38" refers to the 'Mfémé' stream near Adzap, 31 kilometres north-west of Oyém. The geographical co-ordinates are 11°26' E and 01°46' N. The streams around Adzap belong to an eastern tributary of the Kyé. Its name is unknown to us. *Aphyosemion cameronense* was found here, as was a form of the "*herzogi*"-group which is difficult to define. Live specimens of the former species were brought back to Europe.

"PEG 94/39" is the code for the finding place "GWW 86/20", which PASSARO and EBERL reached on 18.8.1994 at about 9 a.m. The search for *Episemion callipteron* at the terra typica was fruitless, as the stream by the roadside had become choked and turned into a marshy area, which in the meantime had been used as a dump.

Collecting efforts in the area of the stream further up the road failed owing to the muddy base of the standing water. On the other side of the road impenetrable undergrowth prevented the collectors from getting far enough into the forest to catch *Episemion callipteron* there. The only three *Aphyosemion cameronense* caught - an adult male and two young fish - were not retained.

"PEG 94/41" is a spring and stream near the village of Ndonglo II, whose location was given by the villagers as "PK 82 Oyém and PK 26 Sam". The geographical co-ordinates are 11°25' E and 01°03' N. After a few kilometres the streams around this village run into the Lara, which flows south into the Okano.

This population of *Aphyosemion cameronense* was not brought back to Germany.

"PEG 94/42" refers to the 'Ndzembo' stream near the village of Egnieng Melen, whose precise location was explained on page 259 (see also the map on page 259). The geographical co-ordinates are 10°51' E and 01°01' N. The height above sea level cannot be given. Once again a representative of the "*herzogi*"-group was found together with *Aphyosemion cameronense*.

This population of *Aphyosemion cameronense* was brought back live, so it should now be distributed within the hobby.

Syntopic Killifish

Aphyosemion batesii
Aphyosemion bochtleri
Aphyosemion exiguum
Aphyosemion herzogi
Aphyosemion spec. aff. herzogi
Aphyosemion kunzi
Aphyosemion punctatum
Diapteron cyanostictum
Diapteron fulgens
Diapteron georgiae
Epiplatys neumanni
Epiplatys sangmelinensis
Hylopanchax silvestris

Owing to the enormous distribution area of this species, it is perfectly possible that other killifish have been found syntopically with *Aphyosemion cameronense* in the past, but details of which are not available to us. It is equally possible that in the future more syntopic killies will be found during the course of collecting trips.

Description

The definition of the "*cameronense*"-group came in the detailed description of the colouration pattern of *Aphyosemion cameronense*. We would refer readers to pp 19 to 27, where this will be found.

The numerous colour pictures of adult males show on the one hand the variability of this species throughout the whole distribution area; and on the other hand the typical colouration characteristics that are common to all these populations are made clear.

The following drawing also shows in comprehensive and schematic fashion the significant features of the body colouration of adult male *Aphyosemion cameronense*:

Relationships

Aphyosemion cameronense does not have the feature of the Yellow Blotch, so we can call this species one of the "blue" forms of this species group, as are also *Aphyosemion obscurum*, *Aphyosemion haasi*, *Aphyosemion mimbon*, *Aphyosemion maculatum* and Phenotypes 1, 2, 6, 7 and 8.

The red colouration features on the flanks make it particularly close to Phenotype 2, from which it differs in essence only in the colouration of the anal fin.

Aphyosemion obscurum and Phenotype 1 have a much higher proportion of red colouration on the flanks. The numerous red spots form several parallel rows or lines.

The medio-ventral band and the zig-zag band of *Aphyosemion haasi* are similar in form and position to those on *Aphyosemion cameronense*, but on the few specimens known to date from the terra typica both bands differ in being broader and the anal fin has completely different markings.

Aphyosemion mimbon and *Aphyosemion maculatum* differ from *Aphyosemion cameronense* in the pattern of red spots on the flanks and the absence of both bands.

Phenotype 6 again has a thick and irregular pattern of red spots on the flanks. The two bands are only hinted at.

Phenotype 7 differs from *Aphyosemion cameronense* in the broad medio-ventral band and the absence of the zig-zag band, whereas Phenotype 8 lacks both features and the red spots are few and arranged irregularly.

It is noteworthy that *Aphyosemion amoenum* and Phenotype 3 have the body markings of *Aphyosemion cameronense*, but in addition they show clearly the Yellow Blotch and so can be placed with the "yellow" group. This striking criterion is virtually the only distinguishing feature between these three forms.

Diagnosis

On page 254 we mentioned some localities of *Aphyosemion cameronense* and their distances from each other, in order to demonstrate the size of the distribution area. It is worth noting, for example, that Mebandé in Cameroon ("EMS 90/3") and Laboka II in Gabon ("LEC 93/1") are 420 kilometres apart as the crow flies; Mebandé is 440 kilometres from locality "GBHL 86/10" and 460 kilometres from locality "GBHL 86/12".

If one also considers the Diang population as belonging to *Aphyosemion cameronense*, then the maximum distance is the 570 kilometres from Diang to Laboka II.

Despite these great distances and their occurrence in different areas, we consider the populations mentioned in this chapter as belonging to a single species: *Aphyosemion cameronense*. This is a very widely distributed species, which occurs in different hydrographic systems and occupies a - pretty roughly - roundish distribution area.

It is remarkable that frequently on the frontier of the distribution area other representatives of this species group have been found. Some have been described as valid species or subspecies. Others, however, with a disregard for important characteristics on adult males (and similar criteria were used in the description of the earlier mentioned forms) have been considered as belonging to "*Aphyosemion cameronense*".

However, it is worth noting that in Cameroon and Gabon one can cover hundreds of kilometres and find exclusively the pure blue form we call *Aphyosemion cameronense* BOULENGER, 1903.

But when one gets to certain areas, after collecting intensively and systematically, one finds forms differing from *Aphyosemion cameronense* which have their own (even if much smaller) distribution areas.

These divergent forms (called "phenotypes" in this book) do not occur in one stream but are separate species or subspecies.

Discussion

The placing together of such distant populations from widely differing hydrographic systems just on the grounds of common colour characteristics of the adult males does not take into account the possibility of genetic separation between different locality variants. This could provide interesting possibilities for aquarists and scientists who are prepared to experiment. Their work would certainly be very informative.

On the other hand, in our list of localities of *Aphyosemion cameronense* known to date, we have included those populations which, because of a relatively uniform colouration pattern can be comprised in a distinctly uniform (homogeneous) group of fish.

There are enough examples of two populations of members of the "*cameronense*"-group which have been found just a few kilometres apart from each other and yet which differ markedly in colouration and at the same time are stable populations. In both streams all the males show the distinguishing features of their species or phenotype. Transitional forms or individual specimens displaying a mixture of these features do not occur. We are convinced that with a planned programme of collecting, especially in the frontier areas between *Aphyosemion cameronense* and the neighbouring representatives of this species group, further examples will become known of species living next to each other. How do these observations in the wild influence our opinion regarding the validity of the species *Aphyosemion cameronense* (and the other species so far described)? What conclusions can be drawn for the divergent forms which we call phenotypes?

We suggest that the following points should be carefully considered and discussed objectively:

- As at the present time we do not know whether there are genetic barriers between populations living far apart and from differing hydrographic systems, we are here limiting ourselves just to the externally recognisable characteristics of adult males.
- The species of the "*cameronense*"-group with the biggest distribution is a homogeneous group of populations with stable colouration from different river systems. We call this species *Aphyosemion cameronense* BOULENGER, 1903.
- It is possible, at the frontiers of the distribution area, to find species and phenotypes of this species group, which are equally homogeneous and stable in their colour patterns and which have a definable distribution area with clear frontiers.
- Attempts should be made to estimate the relative age of *Aphyosemion cameronense* in comparison with the species so far described and the phenotypes defined in AMIET 1987 and by us in this work. This would teach us more about the possible dynamics of the various representatives of the "*cameronense*"-group.
- What influence is exerted by the *Aphyosemion* species which replace *Aphyosemion cameronense* on its distribution frontiers on the body colouration of the males and also on the existence of differing forms of the species group?
- Targeted collecting work in the future in the frontier regions of *Aphyosemion cameronense* may produce further cases of divergent phenotypes being direct neighbours.

Aphyosemion obscurum AHL, 1924

Aphyosemion obscurum "EMS 90/13"

History

Aphyosemion obscurum is the second oldest species of the "*cameronense*"-group. It was brought to Berlin in the form of a single specimen by G. ZENKER from "Jaunde, Kamerun" on the occasion of a trip to Cameroon. This preserved fish of just 28 millimetres was then examined by Ernst AHL, and the species "*Panchax obscurus*" was described in 1924.

The ichthyologist Ernst AHL was born in Berlin in 1898. In 1921 he came to the Zoologisches Museum in Berlin as an assistant and worked there as a voluntary assistant and from 1924 as senior assistant. He was called up in 1941 and was killed in the Second World War.

AHL realised the fish was related to the *Aphyosemion cameronense* which had been described 21 years earlier. As far as we know, at that time specimens of this species were not available to him. It seems much more likely that AHL had used solely the morphomeristic data to place both forms close to each other.

Six years after the first description HOLLY (1930, page 214) examined the preserved specimen and made some corrections to the measurements taken by AHL (see **Meristics**).

It was not until the sixties that SCHEEL (1968, pp 325-328) was able to bring back to Europe and examine live material of this form. However, he was not sure about the status of the taxon *Aphyosemion obscurum* (synonym of *Aphyosemion cameronense* or subspecies or separate species).

In 1974 (pp 30 and 113) SCHEEL used the term "subphenotype", in order to describe the position of both forms in relation to each other. In due course this resulted in authors later giving the taxon described as "*Panchax obscurus*" the name "*Aphyosemion cameronense obscurum*", in other words they gave it the status of a subspecies of *Aphyosemion cameronense*.

The population imported early in 1979 by HEINEMANN and LENZ was subsequently called by BERKENKAMP *Aphyosemion obscurum*. In the mid eighties there followed a few imports of various populations, but these were not successfully distributed in the hobby.

AMIET (1987) used material he had himself collected and with the help of comparisons established that *Aphyosemion obscurum* should be regarded as a separate species (a view we share!).

SEEGERS (1988, page 10) writes that AHL's colour data, together with the general impression gained from the type specimen, point to a young male.

In 1989 Bas VLIJM managed to import two strains from the area around Matomb. Unfortunately they did not get distributed in the hobby. So it was not until August 1990 that EBERL and others were able to get this species permanently established in the hobby with the strain "EMS 90/13".

As far as we know, no other collecting work has been carried out since in the distribution area of *Aphyosemion obscurum.* So no new population has been imported since 1990.

First Description

Ernst AHL: "Zur Systematik der altweltlichen Zahnkarpfen der Unterfamilie *Fundulinae*". Zoologischer Anzeiger 60 (1/2), 1924, page 55. The taxon used in the original description was *Panchax obscurus*.

Meaning of the Specific Name

In the first description AHL mentions the uniformly dark colouring on the body and fins. SEEGERS (1988, page 10) points out that this is still visible. He says the method of fixing is the reason for this appearance.

The Latin word "obscurus, obscura, obscurum" means dark, concealed. AHL referred to the dark colouration of the type specimen as being the reason for the choice of the specific name "*obscurus*".

Interestingly enough, *Aphyosemion obscurum* is the representative of the "*cameronense*"-group with the largest preponderance of red in the body colouration and on the fins. The red spots lie close to each other and actually give the impression of a "dark" fish.

Terra typica

"Jaunde, Kamerun". This information provided by ZENKER shows that at that time the old spelling for the capital of Cameroon was used.

Until the end of the First World War this country had been a German colony. It was then divided into a western British and an eastern French sector. The present official spelling of the capital of Cameroon is "Yaoundé".

The geographical co-ordinates of the city itself can be given as 11°31' E and 3°52' at about 769 metres above sea level. SCHEEL (1990, page 292) gives the readings 11°30' E and 3°52' N.

We do not know exactly whether ZENKER had fished in the immediate vicinity of the city or actually inside the city itself. In the early twenties Yaoundé must have been considerably smaller than the present day city of over a million inhabitants. So it is perfectly possible that a suitable stream existed within the city for ZENKER to have caught fish in.

This possibility is supported by the fact that no distances are given. The growth of the city of Yaoundé, together with the location "Jaunde", which from our present day viewpoint is no longer verifiable, makes us think there is no chance of finding ZENKER's original finding place.

Synonyms

Aphyosemion cameronense
Aphyosemion cameronense obscurum

The different views of the experts regarding the validity of this form led to the use of these two names, depending on whether the taxon "*obscurum*" was considered to be a synonym of *Aphyosemion cameronense* or a subspecies of this species.

The names "*Panchax microstomus*", "*Panchax bellicauda*" and "*Fundulus beauforti*" were mentioned earlier under *Aphyosemion cameronense*, of which species we called them synonyms. The type localities "Nkianga Lokundje" and "Sangmelima" and our present state of knowledge exclude the possibility of *Aphyosemion obscurum* being connected with these taxa.

Meristics

Unfortunately the number of fin rays and detailed information on the scalation are not to be found in the literature available to us.

In the first description AHL gives the following counts for the single preserved specimens:

D = 12
A = 16
Sq.l. = 29

HOLLY (1930, page 214) examined the holotype and changed the figures as follows:

D = 11
A = 15
Sq.l. = 31

These variations cannot be explained fully today. It is conceivable that AHL had not used correct working methods and that HOLLY (using the same method of counting?) corrected AHL's readings. It is equally possible that the two men had different ideas regarding the counting of meristics.

This problem would be clarified if new meristic figures were taken from wild fish, both from the vicinity of Yaoundé and from the rest of the distribution area.

Karyotype

SCHEEL (1990, page 292) gives the following figures, without commenting on them:

n = 17, 22 arms
SL = 35 mm

We know of no other work done in this context.

Geographical Distribution

Aphyosemion obscurum has a very small distribution area on the northern edge of the "*cameronense*"-group in south Cameroon. Along the Edéa-Yaoundé road to the east it borders on the habitat of *Aphyosemion raddai*.

The distribution area as known today is enclosed by a line joining Matomb, Yaoundé, Bikok and Makak. This makes an area of about 1500 square kilometres.

According to AMIET (1987) this species can be found in large numbers in the small streams that flow from the Yaoundé hills to the south and west. However, it is absent from the area north and east of this city.

The southern distribution frontier lies near Bikok, 24 kilometres from Yaoundé as the crow flies. Going westwards we find *Aphyosemion obscurum* as far as Matomb, about 50 kilometres from Yaoundé. In the direction of Makak, to the southwest, the distribution frontier is not yet known exactly and needs further investigation.

The distribution areas of *Aphyosemion cameronense* and *Aphyosemion obscurum* border each other: AMIET (1987 page 111 and page 235) was able to observe this in the vicinity of Bikok, where the two species were found only four kilometres apart as the crow flies, in two different hydrographic systems. In his opinion *Aphyosemion obscurum* inhabits the upper tributaries of the Akono and the Mefou, which rise in the so-called "Yaoundé Massif", whereas the small streams that run directly into the Nyong belong to the distribution area of *Aphyosemion cameronense*. The two species can therefore occur very close to each other, but there are no signs of transitional forms or hybridisation!

The following map shows the small distribution area of *Aphyosemion obscurum* in the northern region of the "*cameronense*"-group; below it is a detailed map, on a larger scale, of the localities known at the present time:

Known Localities

"Matomb" is a locality name for *Aphyosemion obscurum* used repeatedly in the seventies and eighties. We have no information on the exact location of the stream, so we can only give the geographical co-ordinates of Matomb itself: 11°04' E and 03°49' N at 548 metres above sea level.

The streams around Matomb flow into the Manyai, a northern tributary of the upper Késllé which runs south-west into the Nyong.

As *Aphyosemion obscurum* was no longer available in the hobby after the mid eighties, we think it highly unlikely that this strain still exists in the hobby today.

"Binguéla II" is the name of a strain of this species, which in the eighties was distributed and bred at least in Germany, where this name was met with a few times in killifish literature. Unfortunately we do not know who imported this population of *Aphyosemion obscurum* or whether there were any other killifish species at this finding place.

The geographical co-ordinates are 11°24' E and 03°44' N at 683 metres above sea level. In the neighbourhood of Binguéla rise the Nsié and the Djalon, both tributaries in the area of the Akono, which flows south into the Nyong.

"CCMP 85/15" is the code for a strain which CHAUCHE, MARSAN and POLIAK imported from Kala in 1985. This was the fifteenth locality of this Cameroon trip.

We have determined the geographical co-ordinates of this village as follows: 11°22' E and 03°51' N at 738 metres above sea level! Close to the village flows the 'Niobo' stream, which further south is called the 'Djobo'. It flows into the Akono and then into the Nyong.

Unfortunately it was not possible to distribute this strain in the hobby after its import into France. So it is probably no longer available.

"Kala" is the caption to the colour pictures 87 to 89 on plate 57 in AMIET (1987). He had caught the males in the photographs in July 1974, March 1979 and December 1980. As Prof AMIET was working and teaching at the University of Yaoundé until 1994, no live specimens from this locality were brought to Europe. His information may well have helped CHAUCHE, MARSAN and POLIAK to find this superb *Aphyosemion* and bring it back in 1985. If this is so, the locality designations "CCMP 85/15" and "Kala" would be the same.

"Bikok" is another finding place mentioned in AMIET (1987, pages 111 and 235), but no precise details are given. The only data on the exact location of this village is "24 km as the crow flies". AMIET means by this the distance from Yaoundé to Bikok. The geographical co-ordinates are 11°28'E and 03°38' N at 731 metres above sea level.

Near Bikok there is the Negbé, a small tributary of the Akono. Just a few kilometres to the east of the Yaoundé-Mbalmayo road rises the Ossoé Mvelé, a tributary of the Mefou. This is where the frontier with *Aphyosemion cameronense* mentioned by AMIET could lie.

"W Yaunde, E Cameroon" is the caption in SCHEEL (1990, top of page 292) to a picture which shows a male *Aphyosemion obscurum* caught and photographed by him.

We are unable to get more detailed information on where this population came from, but we assume that SCHEEL's locality lies west of Yaoundé (= W Yaunde) on the "route ancienne". The present day "Axe lourd" did not yet exist then. At that time he considered this area of Cameroon as the east of the country, which is why he used the term "E Cameroon" (= eastern or east Cameroon).

Lack of accurate data on the location of this finding place prevents us from giving either the geographical co-ordinates, the height above sea level or the river or stream system it belongs to.

This strain was probably bred by SCHEEL and possibly also distributed, but it is no longer available to aquarists.

"Ototomo" is also a locality mentioned in AMIET (1987, pp 111 and 235). Its position is given as "34 km from Yaoundé in a direct line". We found the geographical co-ordinates to be 11°29' E and 03°40' N at about 700 metres above sea level.

This village lies on the Mbankomo-Ngoumou road just a few kilometres from Akono.

Live specimens from this finding place have never been imported into Europe.

"K9" is the code for the ninth locality of the Cameroon trip undertaken by HEINEMANN and LENZ at the end of 1978 and the beginning of 1979. The stream is on the "route ancienne" from Yaoundé in the direction of Eséka (and Edéa). Its position is given as 46 kilometres west of Yaoundé between Ngoulémakong and Matomb.

Unfortunately it is not possible to give here the precise geographical co-ordinates.

Barbs and catfish were found, but no other killies. This strain is no longer available in the hobby.

"Fast flowing stream near Ngoulmekong" is the caption to a picture of a male *Aphyosemion obscurum* in RADDA & PÜRZL (1976, page 131). This locality is said to be west of Yaoundé on the Edéa road. We do not have any further details.

We have determined from our maps the geographical co-ordinates of Ngoulmekong on the "route ancienne" from Yaoundé to Edéa as follows: 11°12' E and 03°49' N at 718 metres above sea level.

It is interesting to note that the road used at that time ran on a watershed. The streams north of Ngoulmekong run into the Mpang, which further north joins with the Nkadip to flow into the Lobo, a southern tributary of the Sanaga. On the other hand, to the south of the village, rises the Liboo, which is called the Lomo further south. This river runs into the Liégué, which flows south near Makak into the Nyong.

As this strain no longer exists in the aquarium, it would be worthwhile, particularly in view of the hydrographic situation, for someone to collect representatives of the "*cameronense*"-group (*Aphyosemion obscurum* or *Aphyosemion cameronense*?) in and around Ngoulmekong.

"7 km east of Matomb" is another finding place, mentioned in the caption to a picture on page 135 in RADDA & PÜRZL (1976). The geographical co-ordinates cannot be determined accurately enough, but the locality must be a stream near the source of the Kéllé. This stream lies on the old road from Yaoundé to Edéa.

Like the previous strain, this population does not exist in the hobby.

"C 89/42" is the code for the locality discovered by Bas VLIJM on 26.7.1989, at about 10.30 a.m. It is situated near Matomb II, 7.8 kilometres north-east of the turning off the "Axe lourd" to Matomb.

At an air temperature of 24°C and a water temperature of 23°C, the stream was 40 centimetres deep and 1.5 metres wide. Also in the water were barbs and *Mormyridae*. The pH of the fast flowing water was 6.5 and the total hardness 0° dGH.

This strain did not get distributed in the hobby.

"C 89/43" is the next finding place near Matomb III, where one hour later Bas VLIJM again found *Aphyosemion obscurum*. It was the only fish species found. This population is not in the hobby.

"EMS 90/13" is the locality which EBERL and others found near the eastern outskirts of Matomb. Coming from the "Axe lourd" they had travelled a few kilometres on the "route ancienne" and reached the first buildings in Matomb, where they were shown a small stream with *Aphyosemion obscurum*.

On 21.8.1990 at 12 noon, this stream was only about ten centimetres deep and 40 centimetres wide. The water flowed slowly and was clear and slightly brownish. The air temperature was 26°C and the water temperature around 23°C. A definite reading of the geographical co-ordinates is not possible, but we guess they are about 11°5' E and 03°49' N. The "EMS 90/13" strain is in the hobby, even if in limited numbers.

Syntopic Killifish

Till now no killifish have been found to be syntopic with *Aphyosemion obscurum*. But we suspect that in the Bikok-Mbalmayo area *Aphyosemion exiguum* could be found to be syntopic, as it is known from Mbalmayo itself. Also, in this area, *Aphyosemion cameronense* and *Aphyosemion obscurum* occur very close to each other, and both species (belonging to one and the same species group!) favour identical biotopes.

The only conditions necessary for *Aphyosemion obscurum* to occur syntopically with *Aphyosemion exiguum* is for this latter species to penetrate into the hydrographic system of the former.

Aphyosemion batesii, a semi-annual species of the subgenus *Raddaella* might also be found to the south of Yaoundé with *Aphyosemion obscurum*.

In our view, intensive collecting work in the distribution area of this species ought to result in at least one of them being found to be a syntopic *Aphyosemion*.

Description

Aphyosemion obscurum can be considered as being one of the so called "blue" forms of the "*cameronense*"-group, since the Yellow Blotch is not present. On the other hand we find there is a surprisingly high proportion of red spots on the flanks, which give the impression of rows of spots running parallel to each other.

This characteristic gives this fish a certain similarity with *Aphyosemion striatum* from the coastal plain in Gabon. SCHEEL (1990, page 292) puts it this way: "OBS (*Aphyosemion obscurum*) resembles STR (*Aphyosemion striatum*), but karyotypic evidence does not indicate any close relationship".

Both the medio-ventral band and the zig-zag band are clearly recognisable and of the same form as found typically on *Aphyosemion cameronense*. The rows of spots on the front part of the body do not stop but continue through the middle of the body to the caudal peduncle. Specimens occur on which the rear part of the flanks have two rows of spots which come together to form a single row. On others, two parallel rows of red dots run between the medio-ventral band and the zig-zag band, giving the impression of four parallel lines.

The dorsal and anal fins are heavily spotted red. The anal has a white, light blue or slightly yellowish band and also a red submarginal border.

The colouration of the caudal does not differ from the pattern thought of as typical for *Aphyosemion cameronense*.

The following drawing is intended to show in simplified form the basic colouration characteristics of *Aphyosemion obscurum*:

At locality "EMS 90/13" one of the authors took these photographs, which at first sight seem to show just some moss on a tree-trunk...

...but on closer examination one finds a perfectly camouflaged insect!

Relationships

The striking feature of the parallel rows of spots is also found on Phenotypes 1 from Mvilé, 4 from Bélinga and 9 from Ngoyang. These forms are geographically separated from *Aphyosemion obscurum* by the following distances:

- -Phenotype 1 90 kilometres from Makak to Mvilé (west of Lolodorf).
- -Phenotype 4 345 kilometres from Bikok to Bélinga (north of Makokou).
- -Phenotype 9 40 kilometres from Makak to Ngoyang (north of Lolodorf).

Although the last mentioned distance between Makak and Ngoyang is not all that great, colour characteristics also make it possible to distinguish between all the four regularly marked forms of the "*cameronense*"-group.

- -Phenotypes 4 and 9, in all known populations, and also in both wild and tank bred males, have the Yellow Blotch, which has so far never been observed on *Aphyosemion obscurum*.
- -Phenotype 1 resembles *Aphyosemion obscurum* at first glance. But the spot pattern on Phenotype 1 is less dense and appears to consist of individual spots, whereas those on *Aphyosemion obscurum* tend to come together to form real lines.

Finally, when these forms are being differentiated, it should be borne in mind that for instance *Aphyosemion cameronense* has been found in the immediate vicinity of Lolodorf, between *Aphyosemion obscurum* and Phenotype 9. So these two forms are separated by a species which has been recognised up to the present day.

A comparison of *Aphyosemion obscurum* with the members of the "*cameronense*"-group which do not have a "regular pattern of spots" immediately shows its special position within the species group.

Diagnosis

Aphyosemion obscurum occurs in the northern border area of the "*cameronense*"-group. It has a very small distribution area, but it is well defined, thanks to numerous finding places.

In this species we find the striking characteristic of the dense pattern of spots on the flanks, which is present in similar form on *Aphyosemion raddai*, its neighbour to the west (but definitely not in the same species group), and also on the three phenotypes of the "*cameronense*"-group mentioned above from Cameroon and Gabon.

Only four kilometres away from an *Aphyosemion obscurum* locality near Bikok, AMIET found a stream containing *Aphyosemion cameronense* with the typical body colouration. So there do not seem to be any transitional forms between the two species.

The constant body colouration and the resulting uniform appearance of *Aphyosemion obscurum*, together with a clear distribution frontier with *Aphyosemion cameronense*, support the case for the validity of this taxon created by AHL.

Discussion

The independent status of the taxon "*Panchax obscurus*" can be convincingly argued for on the basis of the following: the localities known to date, as well as Amiet's (1987) classification of *Aphyosemion obscurum* based on his own findings in the distribution area and its frontiers demonstrate that this form has a self-contained and homogeneous distribution.

Scheel writes in 1990 on page 292: "OBS is very similar to CAM in phenotype and karyotype, but I think that it differs sufficiently from CAM (s.s.) by the much more numerous red spots on the posterior most part of the side". By "OBS" and "CAM" he refers to *Aphyosemion obscurum* and *Aphyosemion cameronense* respectively, and the latter sensu stricto ("s.s").

We understand this statement to mean that he sees "*Panchax obscurus*" clearly as a representative of the "*cameronense*"-group (= CAM according to Scheel). At the same time he recognises the distinctive spot pattern as a distinguishing feature of the form, which Boulenger had mentioned in the first description (for this Scheel uses the term "CAM s.s").

This would support the separation of "*obscurum*" as a distinct species or at least as a subspecies of *Aphyosemion cameronense*.

In his publication Scheel did not go as far as Amiet. However, his thinking may have prepared the way for Amiet's decision to consider the taxon "*obscurum*" as a separate species in 1987, on pp 110 and 235: "Now that its distribution is better known and its morphological peculiarities are shown to be constant and clearly discriminatory, we shall consider it here as a full species."

Finally it can be said that Amiet's collecting work around Yaoundé and the comparisons this made possible with the colour pattern of *Aphyosemion cameronense* have shown that it is perfectly justifiable to go along with Ahl and consider the taxon "*obscurum*" as a separate species.

We have followed Amiet's way of thinking, as we consider his arguments to be very conclusive. It would be advisable, in the course of future collecting trips to the south and west of Yaoundé, to investigate the distribution area of *Aphyosemion obscurum.* In this respect the following regions would be of special interest:

- In the streams around Bikok Amiet's findings should be confirmed; also it is still unclear how far this species spreads in a south-easterly direction.
- Near Makok the distribution frontier of *Aphyosemion obscurum* needs to be determined clearly; and we need to know which *Aphyosemion* replaces this species.
- What *Aphyosemion* exists to the east and north-west of Yaoundé?

Aphyosemion amoenum Radda & Pürzl, 1976

Aphyosemion amoenum "EMS 90/8"

History

We know of no reference to this species being ever caught or imported prior to its discovery by Radda & Pürzl on 04.12.1975. Admittedly the distribution area lies on the most important road in Cameroon, from Douala to Yaoundé via Edéa, but on the other hand this area is very small and we must assume that *Aphyosemion amoenum* was not known before 1975.

After the first introduction to Europe, this species was imported on many occasions by various collectors, but these strains were not kept for long. Until the late eighties the only known strain was the so-called aquarium strain, which was distributed with the name "Sonbo". There then followed in July 1989 the import by Legros, Vlijm and Eberl of the "C 89/22" strain from Nkonga. This was followed by subsequent collections in 1990 by EBERL and others ("EMS 90/..") and at almost the same time by Vlijm and others ("cxc..") and in 1991 by Grell and Eberl ("CGE 91/..").

This collecting work increased considerably our knowledge of the variability and distribution of this species, so that we can now consider it to be one of the best researched forms of the "*cameronense*" group.

First Description

Dr Alfred C. RADDA & Eduard PÜRZL: "Der *Aphyosemion cameronense*-Komplex", DKG-Journal 8, 1976, pp 134 to 138.

Meaning of the Specific Name

The Latin word "amoenus, amoena, amoenum" means charming, delightful, beautiful (information provided by Dr RADDA on 29.07.1991).

The authors intended to refer to the colouration of male *Aphyosemion amoenum*. As the generic name *Aphyosemion* is neuter, the system of nomenclature required that the neuter form "*amoenum*" be chosen for the specific name.

Terra typica

"...collected on 04.12.1975 at 9.10 a.m. at locality no K 24/75, a stream in the rainforest 3.5 km NNE of the turning from Sonbo to Bibang on the Edea-Yaoundé stretch of the road, Ndoupé, tributary of the Kellé, Nyong system."

This information is very precise and leaves no doubt as to the type locality. The data we have indicate that this is the road which at that time turned off from the main road from Edéa to Yaoundé which went from west to east. The turning was near Song Mbong (= Sonbo) and went north towards Dibang (= Bibang).

The "Edea-Yaoundé stretch of road" mentioned by RADDA & PÜRZL was not made up. Since the construction of the asphalted "Axe lourd" in 1988 and 1989, it has been used less and less, which is why it has been given its present name "route ancienne" (French for old or former road). Today many parts of it will no longer be passable (ascertained in the field by EBERL and others in August 1990). Consequently further collecting work at the type locality is not possible. The spellings of the place names in the first description (Sonbo - Song Mbong and Bibang - Dibang) differ from the information we have. This may have been the result of using different maps.

Ndoupé is a village a few kilometres west of Song Mbong, which at that time may have been administratively responsible for the latter. The mention of Ndoupé would have helped the authors of the first description to define the position of "Sonbo".

With the maps available to us we calculate the geographical co-ordinates of the terra typica of *Aphyosemion amoenum* to be 10°43' E and 03°55' N. We reckon the height above sea level to be about 200 metres.

In the neighbourhood of this point there are numerous small streams that belong to the Mbila system. Near the Song Mbong crossroads the Mbila flows into the Kéllé, which itself flows south-west and runs into the Nyong.

In the first description, on pp 137 and 138, RADDA & PÜRZL give the following data on the ecology of the finding place:

> "The terra typica is a stream in the rainforest near Sonbo (200 m above sea level), about 1 to 5 m wide. The water level on 04.12. at 9.10 a.m. came to a depth of about 10 to 30 cm. The air temperature was 27.6°C and the relative humidity 90%. The water temperature was 23.2°C, the pH 6.0, the total hardness 0.75° DH or 10 ppm Ca CO_3. The concentration of dissolved oxygen amounted to 6.8 mg/l."

Essentially these data correspond to the readings which have been reported (even if in not such detail!) by other collectors in the biotopes of *Aphyosemion amoenum*.

Synonyms

The species was discovered relatively recently, and the first description contains both precise data on the location of the terra typica and a very telling colour picture. These factors have meant that to date *Aphyosemion amoenum* had not been imported under a synonym or mentioned in the literature under any other name.

Meristics

RADDA & PÜRZL deposited a holotype, an allotype as well as several paratypes from the terra typica. From these they took the following morphometric figures:

D = 11 (Holotype), 12 (Holotype), 11 (Paratype 1), 12 (Paratype 2)
A = 17 (Holotype), 16 (Allotype), 17 (Paratype 1), 17 (Paratype 2)
Sq.l. = 33 + 1 (Holotype), 32 + 1 (Allotype), 32 + 2 (Paratype 1), 32 + 1 (Paratype 2).
D/A = 1/10 (Holotype), 1/9 to 10 (Allotype), 1/9 to 10 (Paratype 1), 1/9 to 10 (Paratype 2)

Karyotype

Not known or rather not investigated.

Geographical Distribution

Aphyosemion amoenum is the most north-westerly representative of the "*cameronense*"-group. Its distribution area lies on the western edge of the inland plateau (and partly in the region of the lowlands!) of south Cameroon. The distribution frontiers as known to date are formed by a line joining Pouma, Sakbayémé, Ngong Mkak, Dibang and Mbanga. We estimate the size of this area to be from 1000 to 1500 square kilometres.

The following general map shows the relationship of *Aphyosemion amoenum* with the distribution area of the "*cameronense*"-group on its north-westerly edge:

At present the greatest distance known between two localities of this species is represented by the 32 kilometres between Ngong Mkak and Mbanga.

When new roads are built in this region and organised collecting work carried out, there is a distinct possibility that as a result new localities will be discovered and the distribution area as we know it will have to be extended.

All the localities lie in the drainage area of the northern tributaries of the Kéllé (Lépso, Mandjobé, Ndoupé, Njoya, Mbila, Mbango and Ngopi) and of the southern tributaries of the Sanaga (Lépahé, Noga, Ndimahé, Ngouti and Mam) or else near Ngong Mkak north of the Sanaga in the streams of the Mougué and Ngogon.

Aphyosemion amoenum thus occurs quite obviously in two different hydrographic systems in Cameroon: the streams of the southern localities flow into the Kéllé and then into the Nyong, whereas after a few kilometres the northern streams run into the Sanaga.

We are not aware of any explanation for this kind of distribution, but there are two possible ways of interpreting the situation:

- Either *Aphyosemion amoenum* is a dynamic species, which is extending its distribution area to the north-west towards *Aphyosemion edeanum* and *Aphyosemion spec. aff. bualanum* Phenotype G.
- Or it is a relict species which used to have a larger distribution in both hydrographic systems and is now being driven back by the two species mentioned, which are competing from north and west.

Compared to the other representatives of the "*cameronense*"-group, *Aphyosemion amoenum* inhabits low altitudes (see **Known Localities**). This means that, as far as we know at the present time, it is the only representative which has left the inland plateau and moved in a westerly direction.

Comparative studies of the karyotypes of populations from the edges of the distribution area of *Aphyosemion amoenum*, together with corresponding crossing experiments, could provide valuable information regarding the possible dynamics of this species!

Known Localities

"Sonbo" is the name given to the oldest strain existing in the hobby. We suggest that it is the population imported by RADDA and PÜRZL from the terra typica. In this case the code "K 24/75" would also be appropriate.

"Dibang" is the name given to another strain; this one was kept in the hobby in the eighties. This is a fairly large place in the drainage of the Lépahé, which lies only about six kilometres south of the Sanaga (10°43' E and 04°00' N). We do not have more details regarding the precise finding place, the date of import or the names of the collectors. At the present time this strain is available in the hobby.

"Pouma" is the name of a small town on the "Axe lourd" itself, about 52 kilometres east of Edéa and 127 kilometres west of Yaoundé. The geographical co-ordinates are 10°31' E and 03°51' N at 154 metres above sea level. We do not know when, from where or by whom this population was imported. Among killifish keepers this is one of the most widely distributed populations of *Aphyosemion amoenum*. Unfortunately the locality of this strain is often wrongly given as "Puma".

"C 89/22" is the code for the population that was caught on 12.07.1989 at 12 noon, by Olivier LEGROS, Bas VLIJM and Wolfgang EBERL in the village of 'Nkonga' - six kilometres north of Pouma - on the road to Sakbayémé. The geographical co-ordinates are 10°34' E and 03°54' N; the height above sea level is 250 metres.

The air temperature was 25°C, the water temperature about 23°C; the stream was about 20 centimetres deep and the width varied from one to two metres. There was a current of average strength in the clear water, which had readings of pH 7.0 and 0° dGH total hardness. Accompanying fish found were *Aphyosemion loennbergii*, a few small barb species and some cichlids.

"C 89/46" refers to the finding place 'Biang' ('Bihiang') on the Pouma-Sakbayémé road, where the species was caught by Bas VLIJM on 26.07.1989, at 2.30 p.m. Both water and air temperature were 25°C, the pH was 6.0 and the total hardness 1° dGH. The stream was 25 centimetres deep and 75 centimetres wide. The only accompanying fish was *Aphyosemion loennbergii*. This strain no longer seems to be available in the hobby.

"Log Bako'o" is a locality code mentioned in AMIET (1987). This village lies about five kilometres east of Pouma on the "Axe lourd" (10°35' E and 03°51' N, 205 metres above sea level). We do not know an exact location for this finding place. This strain was never brought back to Europe.

"EMS 90/8" is the 'Lababaga' stream near the village of 'Son Mayo' south of Sakbayémé (10°36' E and 04°00', about 400 metres above sea level). On 19.8.1990 at about 11 a.m., EBERL and others found the air temperature 25°C, the water temperature 23°C, the water 20 to 50 centimetres deep and the stream 60 centimetres wide on average.

The relatively slow flowing water was clear and slightly brownish. Also present were *Aphyosemion loennbergii*, *Epiplatys sexfasciatus*, barb species and cichlids. This strain is fairly common in the hobby.

"EMS 90/9" refers to a locality near the village of Log Bako'o, about five kilometres east of Pouma on the "Axe lourd".

On 19.08.1990, Eberl and others had tried to go to Amiet's locality, but they were unable to find anyone who could remember this scientist fishing. After leaving the "Axe lourd" in a southerly direction, they then found the stream, name unknown, which is shown on the following locality sketch:

In this stream *Aphyosemion amoenum* and *Aphyosemion raddai* were found together for the first time (see also page 91). Other fish present were *Aphyosemion loennbergii*, *Epiplatys sexfasciatus* and a small barb species.

The streams around Log Bako'o belong to a small river of unknown name, which runs into the Kéllé, a few kilometres to the south.

The only fish caught were a few male *Aphyosemion amoenum* and two half grown male *Aphyosemion raddai*. Not a single female of either species was found. So at that point in time no fish from locality "EMS 90/9" were brought back to Europe.

However, a year later, in August 1991, Wolfgang Grell and Wolfgang Eberl visited this locality again and managed to bring back a satisfactory number of *Aphyosemion amoenum* of both sexes. But again only a few male *Aphyosemion raddai* were found. This population is distributed in the hobby as *Aphyosemion amoenum* "Log Bako'o".

"EMS 90/10" is a small stream near the village of Ndoupé. On 19.08.1990 EBERL and others had left the "Axe lourd" near Pouma, in order to drive eastwards in the direction of Yaoundé on the "route ancienne", which runs parallel to the new road.

After about 12 kilometres on the very poor road they reached the village mentioned in the description of the terra typica of *Aphyosemion amoenum*. The geographical co-ordinates are 10°41' E and 03°52' N at 215 metres above sea level.

The region around Ndoupé is interlaced with many small streams, which belong to a water system of the same name, which flows south into the nearby Késllé.

The distance from the terra typica is about four kilometres as the crow flies. Further progress to the turning to Dibang was not possible, owing to a collapsed bridge. The stream there was too wide to be a biotope of *Aphyosemion amoenum*.

About 100 metres south of the "route ancienne", the very friendly villagers showed the collectors a stream 20 centimetres deep and 50 centimetres wide, in which *Aphyosemion amoenum* was present with *Aphyosemion loennbergii* and a barb species.

At about 1 p.m. the air temperature was about 25°C, the water temperature around 23°C, and the slow flowing water was clear and slightly brownish.

At the point where the path from the village reached the stream, the water had been dammed, in order to make it deep enough for bathing. Both in this part of the stream and in the undisturbed tributary to the bathing place, the killies were present in large numbers and in all sizes.

The population "EMS 90/10" is also widely kept in the hobby under the name "Ndoupé".

"CGE 91/13" is the code for a stream of unknown name near the village of 'Ngong Mkak' on the Sakbayémé-Kahn road, about six kilometres east of the bridge over the Sanaga.

The precise geographical co-ordinates are not known, as the village of Ngong Mkak is not marked on the maps available to us; but we think they must be 10°37' E and 04°04' N. The locality is only a few kilometres north of the Sanaga, at an estimated 290 metres above sea level.

Placing the stream in a small hydrographic system is not appropriate, as all the streams in the vicinity of Ngong Mkak flow virtually directly into the Sanaga.

On 11.08.1991, at about 10 a.m., GRELL and EBERL found the air temperature to be approximately 24°C and the water temperature 22°C. The only other fish found to be present were barbs and cichlids. *Aphyosemion amoenum* was surprisingly rare and thus very difficult to catch. According to the villagers the "Mangélé", which is what they call *Aphyosemion*, are to be found in considerably greater numbers during the rainy season.

There is much more red in the body colouration of the males, and the Yellow Blotch is smaller than on the other strains of *Aphyosemion amoenum* south of the Sanaga. We nevertheless place this population in this species.

The colour picture at the bottom of page 317 shows an adult male "CGE 91/13".

Syntopic Killifish

Aphyosemion loennbergii
Aphyosemion raddai
Epiplatys sexfasciatus

Description

Aphyosemion amoenum has the most clearly visible "Yellow Blotch" on the caudal peduncle of all the forms in the "*cameronense*"-group. It was this striking feature that caused it to be described scientifically in the first place.

The body ground colour corresponds to the metallic blue-green which is common to the males of the genus *Aphyosemion*. On the flanks, roughly half way along the dorsal and anal fins, there begins a yellow-orange coloured area, which stretches to the caudal through almost the whole height of the caudal peduncle. The size of this Yellow Blotch varies from population to population as well as from individual to individual.

Both the medio-ventral band and the upper zig-zag band are well defined and present on all populations and individuals. In the anterior area of the body individual red spots are recognisable. In places they join to become interrupted parallel rows of spots. Around the middle of the body they break up and revert to a zig-zag band.

The dorsal fin's ground colour is frequently yellow. It has some red spots and/or short interradial streaks.

The basic colour of the anal fin varies from light blue to yellowish. The red patterning is irregular and can consist of individual spots and streaks. On individual fish the red part is so dense that the impression arises of red mottling with a tendency for a red marginal border to form. A narrow marginal band, either whitish or light blue, is present.

The caudal fin has the typical "*cameronense*"-group colour pattern. The central area is light blue to light green with irregular red blotches, which converge in the direction of the fin rays. In the central part of the fin in particular, the red parts can become so dense, that the blue-green ground colour is only visible in the form of narrow stripes leading out to the fin rays.

This part of the fin is bordered above and below by a red submarginal band.

These two bands can be thought of as continuations of the lower medio-ventral band or of the zig-zag band. The upper and lower band in the caudal can be yellow, light blue or whitish in colour. All manner of combinations can be seen within one population or one aquarium bred generation: yellow above and below, bluish above and below, yellow above and bluish below and the other way round.

AMIET (1987, pp 113 and 237) calls the two marginal bands of the caudal fin "wide and very symmetrical".

Schematic drawing of a male *Aphyosemion amoenum*

Aphyosemion amoenum "CGE 91/13" from Ngong Mkak north of the Sanaga

Relationships

The Yellow Blotch gives the impression of a connection between *Aphyosemion amoenum* and the other species and phenotypes which have this characteristic. However, *Aphyosemion amoenum* is separated geographically from these forms by the distances given below of the shortest distances between them as the crow flies, as known at present.

The measurements are in every case taken from Mbanga, which is the most south-easterly known locality of *Aphyosemion amoenum*:

-from *Aphyosemion halleri* 186 kilometres to Bikong.

-from Phenotype 3 258 kilometres to Efoulan (east of Djoum).

-from Phenotype 4 390 kilometres to Bélinga.

-from Phenotype 5 410 kilometres to Koumaméyong.

-from Phenotype 9 42 kilometres to Mentanyé.

The typically pronounced red elements on the flanks (medio-ventral band, zig-zag band and the spots on the front part of the body), together with the colouration of the caudal fin, are reminiscent of *Aphyosemion cameronense*. In the same way there is a similarity with Phenotype 3, which can be distinguished by the markings on the unpaired fins of *Aphyosemion amoenum*.

Aphyosemion amoenum can be separated from Phenotypes 4 and 9 by the dense and regular pattern of spots on their flanks, which corresponds rather to the pattern of markings on*Aphyosemion obscurum*. Phenotype 5 is found at the greatest distance from *Aphyosemion cameronense* and differs from this species in the unique colouration of the caudal fin (spotted!) and the only slightly developed zig-zag band, together with the small number of red spots on the front part of the body.

Diagnosis

Aphyosemion amoenum is one of the forms that occur on the distribution frontier of the "*cameronense*"-group. The distribution area is very small and relatively well known, thanks to numerous finding places. This species is extremely variable from locality to locality

The uniqueness of *Aphyosemion amoenum* within the "*cameronense*"-group is due to its special distribution area on the edge of the inland plateau or even the beginning of the coastal plain, and also to its being syntopic with *Aphyosemion loennbergii* (a species of the coastal subgenus *Chromaphyosemion*) and *Epiplatys sexfasciatus* (also a species of the coastal plain).

Discussion

Although the species is very variable, the facts pointed out in the diagnosis seem to us sufficient arguments for regarding *Aphyosemion amoenum* as a homogeneous form and thus a valid species within the "*cameronense*"-group. This is also in line with the views of the other authors who have dealt with this taxon.

Aphyosemion raddai used to be thought of as closely related to *Aphyosemion amoenum* by various authors. It is, however, easily distinguished from this species and does not even belong to this species group. So it cannot be regarded as a subspecies of *Aphyosemion amoenum* or the other way round ("*Aphyosemion raddai amoenum*").

Admittedly there is the very attractive suggestion that *Aphyosemion raddai* occurs as a further species on the northern edge of the "*cameronense*"-group, precisely between *Aphyosemion cameronense* and *Aphyosemion obscurum*. In fact, however, it is a species from another species group, which has a similar choice of biotope and is probably "pressurised" by the neighbouring representatives of the "*cameronense*"-group.

The special position of *Aphyosemion amoenum* requires further collecting work, in order to find out more information on the distribution frontiers of this species and with it of the "*cameronense*"-group in the following areas:

- West of Pouma (from Song Woga to around Mapubi), to find the frontier with *Aphyosemion edeanum* and any possible direct competition in the same biotope.
- North-west of Pouma near Log Sanho and Hegba Pouma.
- North of the Sanaga around Ngong Mkak, to the east in the direction of Kahn and further on towards Ibaïkak, in order to investigate the relationship with *Aphyosemion spec. aff. bualanum* Phenotype G.
- Along the road which leads south from the "Axe lourd" in the direction of Eséka, to investigate the southern tributaries of the Kéllé for representatives of the "*cameronense*"-group. Is the Kéllé the southern distribution frontier of *Aphyosemion amoenum*? To what species or phenotype do the members of this group belong, which live between the Kéllé and the Nyong?
- To the east of Boumnyébél to as far as Matomb (position vis-à-vis *Aphyosemion raddai* and *Aphyosemion obscurum*), the existing gaps should be filled as far as possible.
- In the north-east of the distribution area of *Aphyosemion amoenum* known today (between Dibang and Dingombi and near Ngog Mapubi and Bot Makak) further localities of this species may be found and information obtained on its position with regard to other *Aphyosemion.*

In addition systematic crossing experiments should be carried out, to investigate the relationship with *Aphyosemion cameronense* and the other representatives of the "*cameronense*"-group which have the Yellow Blotch.

The first described and best known species with the Yellow Blotch would make a good starting point from which to make a thorough study and revision of this species group.

Let the reader compare the colour pictures, colour descriptions and distribution maps of *Aphyosemion halleri* and Phenotypes 3, 4, 5 and 9 with *Aphyosemion amoenum*. Why should the last mentioned form be a separate species, the taxon "*halleri*" only a subspecies of *Aphyosemion cameronense* and the phenotypes mentioned be identical with *Aphyosemion cameronense*?

Aphyosemion halleri RADDA & PÜRZL, 1976

Aphyosemion halleri "EMS 90/7"

History

It was during RADDA and PÜRZL's collecting trip in December 1975 that a divergent form of *Aphyosemion cameronense* was found near Ambam in south Cameroon which had not previously been known to science.

Ernst HALLER from Stuttgart had flown to Cameroon as well, to make the third member of the party. The plan was to hire a car, drive from Ebolowa via Ambam into Gabon, where they would investigate the north of this country. The Ntem is the border between Cameroon and Gabon, but the ferry across it had broken down, so they were forced to leave Ernst HALLER behind in Ambam in charge of the car. On 07.12.1975 HALLER, initially on his own, but then with RADDA and PÜRZL, caught a representative of the "*cameronense*"-group near the Ambam Catholic Mission. Having the Yellow Blotch made this form differ from the blue specimens of *Aphyosemion cameronense* which they had previously found further to the north. Subsequently specimens were brought back and bred and photographed by HALLER. One of these pictures was published in the first description (RADDA & PÜRZL, 1976, page 139).

This form was named in honour of the companion and first collector Ernst HALLER as a subspecies of *Aphyosemion cameronense*.

On the same day RADDA and PÜRZL found another locality of *Aphyosemion halleri* between Ambam and the ferry across the Ntem.

Unfortunately the efforts to establish these strains in the hobby proved unsuccessful. For almost ten years all that existed in Europe of this form were the preserved type specimens, a few colour pictures and the written data concerning their provenance.

In February 1985 the Frenchmen BARDIN and LOMBARD visited the north of Gabon, where they managed to discover several finding places for *Aphyosemion halleri* in the vicinity of Bitam. Their population "GBL 85/21" is still kept in the hobby.

In the meantime AMIET (1987) had investigated the distribution of *Aphyosemion halleri* to the north of the type locality. He found this species near Bikon.

In August 1990 EBERL and others managed to achieve one of the main purposes of their collecting trip when they got to the Ambam Catholic Mission and most probably visited the terra typica. This population is today still distributed among aquarists as a pure strain ("EMS 90/7"). It was also possible to find AMIET's locality "Bikon" ("Bikong") north of Ambam and make a second strain from south Cameroon available for keepers of killifish.

In August 1994 Guido PASSARO and Wolfgang EBERL succeeded in collecting the species around Bitam in north Gabon. Thus they were able to confirm BARDIN and LOMBARD's findings and also bring back live fish of this population to Europe.

First Description

Dr Alfred C. RADDA & Eduard PÜRZL: "Der *Aphyosemion cameronense*-Komplex", DKG-Journal 8, 1976, pp 138 to 140.

Meaning of the Specific Name

The authors of the first description dedicated this form to their friend who accompanied them on the collecting trip, Ernst HALLER, who for many years had been very involved with killifish.

Terra typica

"...collected by E. HALLER on 7.12.1975 from the spring that feeds the water supply for the Catholic Mission in Ambam, Cameroon".

Ambam is the Cameroon frontier town on the border with Gabon. It lies about 10 kilometres north of the Ntem. The distance from Ebolowa in the north comes to 91 kilometres and from Bitam in north Gabon it is 57 kilometres by road.

The geographical co-ordinates of the Ambam Catholic Mission are, according to the maps available to us, 11°16' E and 02°23' N at 560 metres above sea level. SCHEEL (1990, page 241) gives for the town of Ambam the co-ordinates 11°17' E and 02°23' N.

The area around the Ambam Catholic Mission is drained by a stream called the 'Bitutui'. This stream flows south into the Menyoo, which in turn runs into the Ntem after a few kilometres.

Synonyms

The first description is of relatively recent date, an exact type locality was given and clear colour photographs were published. Consequently there have been no cases in the past of this form being wrongly named.

There are just different views on the validity of the taxon "*halleri*". This has led to the naming of the form as *Aphyosemion cameronense halleri* (RADDA & PÜRZL, WILDEKAMP, SEEGERS, SCHEEL) or *Aphyosemion halleri* (AMIET, HUBER).

In this work we agree with AMIET and HUBER's viewpoint.

Meristics

D = 12
A = 16
D/A = 1/7
Sq.l. = 32 + 2

These figures derive from the first description and were taken from the holotype from the terra typica and also from one allotype and one paratype (both from the locality "Bac Eking").

Karyotype

Not known or rather not investigated.

Geographical Distribution

Aphyosemion halleri is a small species whose distribution area has not yet been investigated adequately. The extreme points known to date are Bikong in the north, the ferry near Eking in the east and the Billy area near Bitam in the south.

Unfortunately it has not yet been possible to find out how far the distribution area extends to the west and south-west in the territory of Equatorial Guinea.

Aphyosemion halleri's distribution area is divided from east to west by the Ntem. It stretches over the area where the three countries of Cameroon, Gabon and Equatorial Guinea meet. Ebébiyin is the central point.

Bearing in mind the hydrographic conditions in the extreme north-east of Equatorial Guinea, we estimate that *Aphyosemion halleri* inhabits an area of 1000 square kilometres.

This general map shows the position of the distribution area of *Aphyosemion halleri* in the area where the three countries of Cameroon, Gabon and Equatorial Guinea meet:

As information on how far west this species extends is lacking, only the extreme points Bikong and Billy are known. These places are 42 kilometres from each other as the crow flies.

As soon as someone manages to fish in Equatorial Guinea in the vicinity of Ebébiyin, we can expect further findings on the occurrence of this species west of the Kyé (for example in the tributaries of the Mbaca and the Ntomo to the south-west of Ebébiyin).

The presence of *Aphyosemion cameronense* north-west of Ambam along the Méyo Centre-Ma'an-Nyabéssan road suggests that this species has also spread south of this area and thus occurs west of *Aphyosemion halleri*. This situation is shown on the next map.

Known Localities

The type locality is a small stream which can be reached by taking a footpath from the Ambam Catholic Mission Church and walking about 400 metres south. The permanent stream is used as a source of drinking water by the inhabitants of the mission and the people working in the immediate neighbourhood.

In the first description RADDA & PÜRZL mention that HALLER was also able to find *Aphyosemion halleri* "in three smallish to middling size streams in the immediate neighbourhood of Ambam". Unfortunately we do not have further information on these finding places.

"Bac Eking" in RADDA & PÜRZL, 1976 is the ferry (= French: "le bac") which crosses the Ntem, and which one has to take to get from Cameroon to Gabon (as in fact there is no bridge!). The information "in a stream between Ambam and Bac Eking" is not very precise, given the distance of approximately 29 kilometres by road between Ambam and the ferry.

We do not know if the stream is situated close to the ferry crossing point or some kilometres away from it. So we are unable to give either precise data on the position of this locality or the geographical co-ordinates. This strain does not exist in the hobby.

"Bikon" is the name in AMIET (1987) for the finding place where he was able to find *Aphyosemion halleri*. It is a small village only about three kilometres north of Ambam on the road to Ebolowa. The maps we have give the spelling of this place as "Bikong".

We calculate the geographical co-ordinates to be 11°16' E and 02°24' N at 610 metres above sea level. The streams around Bikong belong to the same system as the type locality near Ambam.

"GBL 85/17" is a stream five kilometres north of the "Ferme Agricole" at Bitam on the road to Eboro and the Gabon-Cameroon frontier. The geographical co-ordinates are 11°30' E and 02°09' N at 773 metres above sea level.

The streams in this area run into the Ekapan, which flows north-east into the Ngan, a tributary of the Ntem.

The Frenchmen BARDIN and LOMBARD found an *Aphyosemion* there, which, in view of the colour description, we place in *Aphyosemion halleri*. The *Epiplatys* form which they did not identify was most probably *Epiplatys neumanni*.

This strain did not get distributed in the hobby.

"GBL 85/18" is only 1.5 kilometres north of the intersection of the Bitam-Eboro and Bitam-Minvoul roads on the road to Eboro and the Cameroon border. The geographical co-ordinates are 11°29' E and 02°16' N at 556 metres above sea level.

PASSARO and EBERL found this crossroads coming from Minvoul (east) and drove the distance mentioned in the direction of Eboro. This locality is described in more detail on page 290 under **"PEG 94/29"**.

"GBL 85/21" lies near the village of "Billy" ("Biyi"), about a kilometre west of the turning to Ebébiyin off the Bitam-Eboro road. The geographical co-ordinates are 11°28 E and 02°7' N at 600 metres above sea level. This was the only population of this trip to be distributed. In the hobby it is known as the "Billy" strain.

PASSARO and EBERL also fished in this locality (see **"PEG 94/31"**).

"GBL 85/22", **"GBL 85/23"**, **"GBL 85/24"** and **"GBL 85/25"** are the other localities, which are situated two and a half, seven and a half, nine and a half and eleven kilometres west of the crossroads referred to in the direction of Ebébiyin. At all of these localities *Aphyosemion halleri* was found, but none of these strains found their way into the hobby.

"EMS 90/6" is the finding place near Bikong that EBERL and others stopped at on 17.08.1990 at about 3 p.m. The stream of unknown name was about 50 centimetres wide and 20 centimetres deep. Apart from *Aphyosemion halleri* a few small specimens were also found of a form belonging to the "*Aphyosemion herzogi*"-group. Both the air temperature and water temperature were around 24°C. The slow flowing water was clear and the stream bottom muddy.

"EMS 90/7" is the code for the stream about 400 metres south of the Ambam Catholic Mission, which we regard as the terra typica. This locality was visited by EBERL and others on 17.08.1990 at about 12 noon.

The stream was only about 20 centimetres deep and roughly a metre wide. In it were numerous half grown fish, with the young males already showing the typical Yellow Blotch. *Aphyosemion halleri* was the only fish present.

This finding place can be seen at the top of page 328.

Both the "EMS 90" strains are kept by many killifish enthusiasts. They are also known as "Bikong" and "Ambam".

"PEG 94/31" refers to the 31st locality of PASSARO and EBERL's Gabon trip. It was fished on 16.08.1994 at about 1 p.m. Using BARDIN and LOMBARD's information it was not difficult to find this stream where it crossed the road. At the washing area itself no killies were found, but some 500 metres upstream *Aphyosemion halleri* was present in large numbers together with small barbs and a *Ctenopoma* species.

The locality photograph on the top of page 329 shows a section of the stream; at this place *Aphyosemion halleri* was very easy to catch.

Live specimens from this locality were brought back without any problems, so we have this pure strain for future comparisons and possibly crossing experiments.

"PEG 94/32" is the next locality near the village of Oveng Mélén, nine kilometres west of the turning to Ebébiyin in Billy. The geographical co-ordinates are 11°25' E and 02°7' N. The height above sea level cannot be given accurately.

The very friendly villagers call the stream in the forest south of the road the 'Mvézé'. This is the name of a small river which runs in this area parallel to the Billy-Ebébiyin road in a north-westerly direction. It then flows into the Kyé. But the stream investigated by the collectors is only a small tributary of the Mvézé.

It was surprising that the biotope was so shallow (August = dry season). The water did not flow any more but collected in individual pools and puddles, between which it trickled slowly downstream through the mud. Nevertheless *Aphyosemion halleri* was present in large numbers. None of the adult or half grown specimens looked anything but well nourished and in the best of health. No live fish were brought back from this locality.

Syntopic Killifish

Aphyosemion spec. aff. herzogi
Epiplatys neumanni (?)

Despite the numerous known localities, *Aphyosemion halleri* has only ever been found with one other *Aphyosemion*, which showed features of *Aphyosemion herzogi*, but which differs considerably in colouration from that species ("EMS 90/6").

Intensive collecting work in the presumed distribution area of *Aphyosemion halleri* would surely result in more information on syntopic killifish.

Description

The clearly recognisable Yellow Blotch makes *Aphyosemion halleri* one of the forms within the "*cameronense*"-group which share this feature. This makes simpler a separation from the so called "blue" representatives of the species group, which are listed on page 293 in the discussion of the relationships involving *Aphyosemion cameronense*.

Depending on how the light falls on the fish, the front part of the body of the adult males is light blue to metallic green. From about the middle of the dorsal and anal to the root of the caudal fin, the caudal peduncle is coloured orange-yellow from top to bottom. This produces a striking contrast between the anterior and posterior parts of the body.

The red spots, the medio-ventral band and the zig-zag band correspond totally to the known pattern. The spots lie in parallel rows, but they show no pronounced tendency to merge with each other. They converge in irregular fashion into short rows of two to a maximum of six or seven spots.

Individual fish may occur in which the two red bands join at the root of the caudal fin, giving the impression of a bow (AMIET, 1987, pp 111 and 236: "At the end of the peduncle, it (= the medio-ventral line) tends to turn upwards and to rejoin the latero-dorsal line, sketching an arc at the base of the caudal").

The ground colour of the fins is a strong pale blue, which is strongly contrasted by the pattern of glowing red markings. The dorsal fin is sometimes edged yellow in the outer area and has individual red spots or interradial streaks, which can be so close to each other, that the whole fin almost seems to be red.

The amount of red on the anal fin can vary considerably, so that one can occasionally find almost blue fins, in contrast to those predominantly covered with red blotches and streaks. AMIET (1987) stresses the fact that the outer area of this fin never has a white, light blue or yellowish marginal band. On the other hand there is sometimes a narrow red marginal band.

Both the male illustrated in RADDA & PÜRZL's first description and the specimens illustrated in colour by AMIET (1987) have caudal fins with colouration that differs clearly from that of *Aphyosemion cameronense*. The same is true of the fish caught by one of the authors near Ambam and Bikong.

Over a pale blue base there are the red blotches and streaks already mentioned; these form a "marbled" pattern.

Aphyosemion halleri differs from *Aphyosemion amoenum* in not having the upper and lower marginal band. Only in the lower part of the caudal fin can one see a marginal band, which is of the same ground colour as the whole fin, but never whitish or yellowish!

Locality "EMS 90/7" of *Aphyosemion halleri* near the Ambam Catholic Mission; this is probably the terra typica of this species

Schematic drawing of a male *Aphyosemion halleri*

The biotope of *Aphyosemion halleri* near Billy in north Gabon, "PEG 94/31". Picture taken 16.08.1994, 1.00 p.m.

Male *Aphyosemion halleri* "PEG 94/31"; note the large amount of yellow and the absence of red markings in the unpaired fins

As can be clearly seen from the male of the "PEG 94/31" strain from Billy, which is depicted at the bottom of page 329, the populations of *Aphyosemion halleri* in the vicinity of Bitam differ recognisably from the fish from south Cameroon.

Maurice Chauche photographed a male shortly after the import of this strain. He kindly placed a colour slide at our disposal, so that we could use it for comparison purposes. The wild fish photographed does not vary significantly from the body colouration of the fish which were kept by us at the beginning of the nineties with the name "Billy". This strain should have been kept pure over the years and still be maintained and bred by aquarists.

Passaro and Eberl's experiences in the vicinity of Billy ("PEG 94/31" and "PEG 94/32") show quite clearly that this is the true body colouration in this area, and that it is not a question of individual fish being especially divergent in colouration.

A particularly striking feature is the absence of red spots on both the dorsal and anal fins, whilst the ground colour of these fins corresponds to the colouring of the Yellow Blotch.

The caudal fin and front part of the body have the same colouration as on the males from the area around Ambam.

The medio-ventral band has the markings typical of most representatives of the "*cameronense*"-group. The zig-zag band is rather narrower and gradually breaks up into individual red spots.

Relationships

Aphyosemion halleri belongs to the "yellow group" which has already been explained on page 318. We think it is also appropriate for this species to show with a few examples how it is geographically separated from the other forms with the Yellow Blotch. The measurements are taken from the furthest locations where *Aphyosemion halleri* is now known to be found:

-from *Aphyosemion amoenum* 186 kilometres from Bikong to Mbanga.
-from Phenotype 3 146 kilometres from Eking to Efoulan (east of Djoum).
-from Phenotype 4 225 kilometres from Billy to Bélinga.
-from Phenotype 5 215 kilometres from Billy to Koumaméyong.
-from Phenotype 9 129 kilometres from Bikong to Ngoyang.

Both the medio-ventral band and the zig-zag band are very reminiscent of *Aphyosemion amoenum* and Phenotype 3, but *Aphyosemion halleri* can be distinguished from these two forms by the colouration of the caudal and anal fins.

This species differs from Phenotypes 4 and 9 by just the regular and much denser pattern of spots on the flanks, whereas Phenotype 5, in contrast with the other forms of the "yellow" group, has a weakly developed pattern of spots and completely different markings on the caudal fin.

Diagnosis

Aphyosemion halleri represents the only form of the "*cameronense*"-group with the Yellow Blotch which most probably does not live on the group's distribution frontier. For this fact to be finally established, however, more investigation is needed in Equatorial Guinea.

The distribution area of this species is also relatively small. The greatest distance between two localities known at present is that between Bikong and Billy, which is 40 kilometres as the crow flies. The Ntem divides this area. Even so, all streams found so far that contain *Aphyosemion halleri* belong to the immediate drainage area of the Ntem.

The populations from the "Bikong" and "Ambam" localities have similar colouration patterns. In addition one should mention three other streams with *Aphyosemion halleri* around Ambam, where E. HALLER fished. According to RADDA & PÜRZL (1976, page 140) the males from these streams are the same as those caught at the terra typica.

Since 1985 this species has also been known from north Gabon, thanks to the collecting work by BARDIN and LOMBARD, even if the males caught around Billy in the Bitam area have divergent markings on the dorsal and anal fins. But these fish have both the same colour pattern on the caudal and the orange-yellow caudal peduncle as the Ambam specimens. This points to it being the same species. This opinion has not been questioned to date.

The specific status of *Aphyosemion halleri* is doubted by many authors. AMIET, however, collected intensively only six kilometres north of 'Bikon' (Bikong) and was able to find a population which he calls "relatively close to the "true" *cameronense* phenotype". PASSARO and EBERL found *Aphyosemion cameronense* about twelve kilometres south of Billy ("PEG 94/33", Tchimazok).

This would mean that there are two further precisely defined distribution frontiers between the two forms of the "*cameronense*"-group. One of them has the Yellow Blotch, whilst the other one funnily enough has not (further examples are Djoum-Efoulan, Ebé-PK 26 West Ovan and Koumaméyong-Djidji).

The presence of *Aphyosemion halleri* with *Aphyosemion cameronense* in the same hydrographic system without there seeming to be an intermediate form is, together with the clearly differing body colouration, an important argument, according to AMIET, for considering this form as a distinct species.

Discussion

Aphyosemion halleri has like *Aphyosemion amoenum* the stable characteristic of the Yellow Blotch, but in the same publication it was described as "only" a subspecies of *Aphyosemion cameronense*. We do not understand fully the reasons of the authors of the first description. Both AMIET and PASSARO & EBERL have shown that *Aphyosemion halleri* lives in close proximity to *Aphyosemion cameronense*. This could support even further the form's elevation to separate species.

Aphyosemion haasi RADDA & PÜRZL, 1976

Aphyosemion haasi, drawn from a colour picture of the holotype by Eduard PÜRZL

History

In their introduction to their publication "Der *Aphyosemion cameronense*-Komplex" (DKG Journal 8, 1976) RADDA & PÜRZL report in detail on page 134 on the discovery of this form, whose first description follows on pp 140 to 143.

Karl-Heinz HAAS, the cichlid specialist from Stuttgart, together with three companions, had visited the north of Gabon in January 1974. Their plan was to investigate in particular the areas around Mitzic, Zomoko, Lalara, Ovan and Makokou. During their stay near Zomoko the collectors met Gérard LEBRUN, a French expert in the export of tropical timber. Through him they received a great deal of support and were thus able to fish in the area worked by Mr LEBRUN north-west of Zomoko, an area which is closed to the public.

While they were there, they found an extremely colourful form from the "*cameronense*"-group, which was subsequently imported by RADDA & PÜRZL in December 1975, and again by Franz BOCHTLER and Wolfgang GASPERS in January 1976.

The specimens collected by RADDA & PÜRZL were used in 1976 for the description of *Aphyosemion cameronense haasi*, a subspecies of *Aphyosemion cameronense* dedicated to Mr Karl-Heinz HAAS.

Unfortunately attempts to establish the imported strains in the aquarium failed. All we now have are the superb colour photographs which Eduard PÜRZL was able to take of a male from the type locality.

In July 1992, in the course of his trip to the north of Gabon, GRELL tried to find this form but did not even manage to get to the terra typica.

Despite the practical help and support of Mr LEBRUN, a further attempt in January 1993 by LEGROS, CERFONTAINE and EBERL failed, because the road used in the seventies is no longer passable.

In July 1993 there followed another attempt by PASSARO and EBERL, yet despite their earnest endeavours, they were not able to find an *Aphyosemion* with the appearance of the specimen photographed by PÜRZL (see also **Discussion**!).

First Description

Dr Alfred C. RADDA & Eduard PÜRZL: "Der *Aphyosemion cameronense*"-Komplex", DKG-Journal 8, 1976, pp 140 to 143.

The taxon used in the first description is "*Aphyosemion cameronense haasi*".

Meaning of the Specific Name

The authors of the first description dedicated this form to their old friend Karl-Heinz HAAS from Stuttgart, who with his collecting trips in the mid seventies made important contributions to the study of the fish of Gabon.

Terra typica

"...collected ...from a hill stream about 27 km NW Zomoko; Amvené tributary north of Lalara, north Gabon".

The exact position of this stream is not shown on the maps available to us. If one measures the distance of 27 kilometres from Zomoko in a north-westerly direction, one finds a point which, according to the maps, is a long way from any road. This imaginary finding place would then have the geographical co-ordinates 11°17' E and 00°43' N at a height of 610 metres above sea level.

The facts we learnt in January and July 1993 in Oveng, near Zomoko, lead us to suppose that the type locality is a stream that crosses one of the numerous roads in the area of Mr LEBRUN's timber export firm.

An exact reconstruction of the site of the type locality is today impossible (see also under **Distribution**), as the roads used at that point in time have since been closed.

The rainforest returns and overgrows the roads day by day, so that the chances of collecting in the same place become more and more unlikely.

Synonyms

So far only very little has been published on this form, which is why no real synonyms have been used. Just a few authors place it in *Aphyosemion cameronense*, the most common name is "*Aphyosemion cameronense haasi*".

Should the validity of the taxon "*haasi*" ever be proved scientifically, then the name "*Aphyosemion cameronense*" used for this form would be considered as a synonym of *Aphyosemion haasi*.

Meristics

D = 13 and 12
A = 17 and 16
D/A = 1/7 to 1/8
Sq.l. = 31 + 2

These figures derive from the first description and were taken from the holotype (a male) and an allotype (a female), both of which come from the terra typica.

Karyotype

Not known or rather not investigated, owing to lack of material.

Geographical Distribution

Zomoko lies on the road from Lalara to Mitzic in north Gabon. The area to the north-west of this village is used by a French firm for the commercial export of timber.

In order to obtain high quality tree trunks, the area of forest is subdivided into squares and roads built into the forest, with geological factors being taken into account. When all the usable trees of a certain area have been felled and these roads are no longer needed, earth movers are used near where these roads cross to build up a mound of earth. As a result these private roads can no longer be used.

The vegetation grows fast and the condition of the road surface deteriorates rapidly. In July 1993, with the help of Gérard LEBRUN, PASSARO and EBERL managed to find again the road originally used when *Aphyosemion haasi* was caught. But it was impossible to drive on it, as can be clearly seen from the picture at the top of page 336.

PASSARO and EBERL were suitably prepared for this situation. They carried in a rucksack all the equipment necessary for catching killies, photographic gear and provisions for a good long walk through the rainforest.

Gérard LEBRUN had placed at their disposal a reliable worker who had a good knowledge of the area which had been open to vehicles in the seventies and eighties. After walking for about six kilometres along the old forest road, the collectors were shown a stream on the left hand side of the road, which appeared to be a suitable biotope for members of the "*cameronense*"-group.

The stream was about 50 centimetres wide and only 20 centimetres deep. On 14.07.1993 at about 8 a.m. the population "PEG 93/16" was caught. We must unequivocally regard it as *Aphyosemion cameronense.*

The local guide asserted more than once that this stream flows into the Amvéné (RADDA & PÜRZL: "Amvené"). It thus belongs to the same hydrographic sub-system as the terra typica of *Aphyosemion haasi*.

This is confirmed by comparing the maps available to us and also by the course taken by the streams in the area fished!

On the following map the position of the terra typica of *Aphyosemion haasi* in the distribution area of the "*cameronense*"-group can be seen.

The map at the bottom of page 337 then shows the finding places of killifish in the vicinity of Zomoko and Oveng, as they have been known up to the present day.

Known Localities

Till now the only known localities are the terra typica ("27 kilometres north-west of Zomoko") and those already mentioned ("These striking fish from Zomoko..."), which were caught by different collectors in the mid seventies.

Unfortunately we do not have more precise information on the latter localities.

This road was driven on several times a day by heavy timber lorries, right up to the early nineties. Since its closure, the African rainforest has been winning the narrow band back

An adult wild male of strain "PEG 93/16"

The search for *Aphyosemion haasi* meant that the items needed for the collecting of killies had to be carried in a rucksack

Syntopic Killifish

In the first description, RADDA and PÜRZL mention that they found *Aphyosemion herzogi* in a stream 4.5 kilometres away from the terra typica. They stress that these two species are therefore sympatric (in the same region) but not syntopic (in the same biotope).

In July 1993, in a small tributary of the Amvéné about 500 metres above the road connecting Zomoko and Oveng, PASSARO and EBERL found some young *Aphyosemion herzogi* but no representative of the "*cameronense*"-group (and unfortunately not a trace of *Aphyosemion haasi*!).

We do not think that *Aphyosemion haasi* and *Aphyosemion herzogi* inhabit such different biotopes, especially since in January 1993 LEGROS, CERFONTAINE and EBERL were able to show that *Aphyosemion cameronense* and *Aphyosemion herzogi* (or *Aphyosemion spec. aff. herzogi*) are syntopic near Laboka II. PASSARO and EBERL found the same to be true near Tchimazok in August 1994.

If someone managed to fish more intensively the distribution area north-west of Zomoko, we would learn more about the existence of *Aphyosemion haasi* and of any killies which happened to be syntopic with it.

Description

Aphyosemion haasi is a blue representative of the "*cameronense*"-group, without the Yellow Blotch, but with both the medio-ventral band and the zig-zag band. The fish has an extremely high proportion of red in its colouration.

The deciding criterion which led RADDA & PÜRZL to describe it as a subspecies was the extreme width of the two bands. Their shape corresponds basically to the normal form to be seen in *Aphyosemion cameronense*, but both bands are three to four times broader than is usual with the other members of the "*cameronense*"-group.

In addition they merge as they pass from caudal peduncle to the caudal fin, as well as at several places between the beginning of the dorsal and the end of the anal fin. This is a colouration feature that is otherwise unknown in the "*cameronense*"-group.

The red spots on the front part of the body form a relatively coarse and irregular pattern. On the single specimen photographed one can see no clear tendency for long rows of spots to form.

The dorsal fin has very large red blotches, which can assume a slightly longish shape in the direction of the fin rays.

The caudal fin corresponds in essence to the usual colour pattern; the longish streaks are very broad.

The anal fin pattern is unusual. The basal area is dark red, there then follows a pale blue area, and after that comes a broad sub-marginal red border and a pale marginal band.

This colour pattern can be regarded as unique for the "*Aphyosemion cameronense*"-group as known today.

Relationships

As the several attempts to find this form again and import it alive have failed, we can only go on the colouration of the single photographed male. The colour pattern of this specimen leads us to place it close to *Aphyosemion cameronense*.

The only distinguishing characteristic that separates the two forms is the width of the red colouration features on the flanks and fins, and also the "percentage" of red colouration.

Aphyosemion haasi can be easily distinguished from *Aphyosemion mimbon* and *Aphyosemion maculatum*, since these two species lack both the medio-ventral and the upper zig-zag band, as has been mentioned earlier. Despite the short geographical distances between these species, we do not think it possible that *Aphyosemion haasi* could be a population of *Aphyosemion maculatum* with particularly bright colouration.

Separation from the other three "blue" forms presents no problems:

- -*Aphyosemion obscurum* from the area around Yaoundé and Phenotype 1 from Mvilé (also Cameroon) have the two red bands of normal width on the flanks. Between them there are numerous red spots that form longitudinal rows.
- -Phenotypes 6 and 8 have no red bands but the body markings differ considerably from the usual colour pattern.
- -Phnenotype 7 has a strikingly broad medio-ventral band, but the zig-zag band is virtually nonexistent.

Diagnosis

Judging from the pictures in the first description, *Aphyosemion haasi* represents a divergent form with the typical colour pattern of *Aphyosemion cameronense.* The width of the two bands on the rear part of the body, which in places merge with each other, together with the generally extremely high proportion of red, especially on the anal fin, make it possible to distinguish it from *Aphyosemion cameronense*.

When one examines the only photographed male, one can see striking differences, that are as important as the features that have led to the description of other species (or subspecies) of the "*cameronense*"-group in the past.

If there were several males with this striking colouration - this characteristic of the broad bands and the coarse patterns on the fins would in this case prove to be constant to some extent - there would, in our opinion, be no doubt that the taxon "*haasi*" would have to be considered valid.

On the other hand, with just a single specimen, there is always the possibility that it is just one particularly red fish with exceptionally divergent colouring. In this case the description of a subspecies or even separate species would not be justified.

The type locality and other localities for *Aphyosemion haasi*, for which we have no more information, belong to the drainage area of the Amvéné, which is a tributary of the Okano.

Collecting work near the terra typica in streams which also belong to the Amvéné system has only produced *Aphyosemion cameronense* with the body colouration typical of north Gabon.

A precise analysis of this taxon is not possible at present, as live material is not available.

Discussion

Regrettably we do not have any information on how many specimens were caught during the three collecting trips in the mid seventies, whether they came from the same stream, what their colouration was and to what extent individual males showed variability.

It would be especially interesting to know if there were males with narrower or broader medio-ventral and zig-zag bands, and also how common fish with this colouration were.

If it were possible to compare wild fish, then the validity of this taxon could be decided within a few hours. The same would be possible if fish could be collected at the actual terra typica or in the immediate vicinity.

In the latter case one would be able to say with greater certainty than now what the representatives of the "*cameronense*"-group in the distribution area of *Aphyosemion haasi* look like.

The three vain attempts by GRELL, LEGROS, CERFONTAINE, PASSARO and EBERL in recent years show that this undertaking would have to be much better prepared. It is impossible to cover 27 kilometres on a road impassable to cars. Moreover it would be hardly possible to say when one has covered these 27 kilometres.

The condition of the closed road is getting worse by the day, but it is conceivable that it could be ridden on by cross-country motor-cycles. But who is in the position to plan, finance and even carry out such an undertaking?

We assume that it will be extremely difficult to collect there in the near future. And, as time goes by, the likelihood of anyone being able to collect there will diminish even further. It will probably be impossible now to check positively the validity of *Aphyosemion haasi*.

So we can only express surmises and speculation on this fish. These are based on the study of the literature, the experience gained in the field and lastly on our personal opinion:

> The finding in the wild of such divergent males from the "*cameronense*"-group excludes the possibility of it being an artificially produced hybrid. If there were several specimens of this appearance and also several biotopes not connected to each other, this would point to the required stability of the colouration characteristics, as can be seen on all the other representatives of the "*cameronense*"-group. Then the taxon "*haasi*" would have to be regarded as valid. This would mean confirmation of the first description by RADDA and PÜRZL.

Aphyosemion haasi RADDA & PÜRZL, 1976

> Were it to be just a single fish, elevation to the status of subspecies or distinct species would not be justified. Then it would be necessary to investigate the other specimens from the same biotope and then establish what species the fish belonged to. In this case the taxon "*haasi*" would prove to be a junior synonym of another species (*Aphyosemion cameronense*) and would have to be rejected.

The present situation does not permit us to make a final judgement. It seems rather that the "*haasi* riddle" will remain unsolved.

However, the presence of *Aphyosemion cameronense* "PEG 93/16" in an Amvéné tributary on the right-hand side poses some questions:

- -Why does such a typically standard coloured population of *Aphyosemion cameronense* exist in a lower tributary of this system, only about 20 kilometres from the terra typica of so divergent a fish as *Aphyosemion haasi*?
- -Has it been able to stray across the Amvéné itself to the north and north-west, to come close to the terra typica of *Aphyosemion haasi* and encroach into its biotopes?
- -How close do the two forms actually come to each other? This question could only be settled by intensive collecting efforts along the old road.
- -Is it conceivable that *Aphyosemion haasi* is a relict form in the upper part of the Amvéné, which flows south, and that it is slowly being ousted by the dynamic *Aphyosemion cameronense*?
- -Which of the two forms would be the older one? Is it possible that the younger *Aphyosemion haasi* has developed as a marginal form of *Aphyosemion cameronense* (similar colour pattern on the flanks)?
- -Was the holotype of *Aphyosemion haasi* just a single fish, a "mutant" so to speak? Then *Aphyosemion cameronense* would exist in the whole Amvéné area and *Aphyosemion haasi* would be a junior synonym of *Aphyosemion cameronense*.

In fact we do know of one case in which a divergent form of the "*cameronense*"-group is known only from two localities very close to each other: AMIET's Phenotype 1. But in contrast to *Aphyosemion haasi*, the "Mvilé" locality can be fished at present, and there is in the hobby a pure population ("CGE 91/12").

Moreover there are examples of two different representatives of the "*cameronense*"-group coming very close to each other: Bikok to the south of Yaoundé (*Aphyosemion obscurum* and *Aphyosemion cameronense* in AMIET, 1987) and Nsessoum between Ambam and Ebolowa (Phenotype 2 and *Aphyosemion cameronense* in AMIET, 1987).

Lack of detailed information and live and photographic material means we cannot be sure of the validity of this taxon. This is all the more regrettable as this fish could be one of the most beautiful representatives of the "*cameronense*"-group.

This alone would be ample reason, despite the problems described, for looking for *Aphyosemion haasi* in its habitat!

Aphyosemion maculatum RADDA & PÜRZL, 1977

Aphyosemion maculatum "LEC 93/4"

History

In December 1975 RADDA and PÜRZL drove through Oyém and Mitzic to travel in the north of Gabon. On the N4 between Koumaméyong and Ovan they found some males of an *Aphyosemion* form which had a particularly striking colouration pattern. Closer investigation showed that meristic figures made it a member of the "*cameronense*"-group. Its divergent body markings justified its elevation to the status of distinct species.

Subsequently it proved impossible to establish this strain brought back by RADDA and PÜRZL in the hobby. The Dutchman Jan PAP on his collecting trip found a new finding place of *Aphyosemion maculatum* near Ebé to the west of Ovan. But this strain did not last for long in the hobby either. Sporadic imports in subsequent years (for example in February 1986 by BARDIN, LOMBARD and HOUDU, "GBHL 86/18") also failed to get this species established in the hobby for any length of time.

It was not until 1990 that Barbara and Allan BROWN managed to fish the terra typica of *Aphyosemion maculatum* during their Gabon trip. They used RADDA and PÜRZL's data to find the locality, and they were able to bring back this species with the locality code "GAB 19/90".

From the time of the import of the type specimens, this *Aphyosemion* was reckoned to be a very difficult species, which it was supposed could only be bred in small quantities.

Keith FODEN from Manchester managed to get going a stable strain from Allan BROWN's F_1 fish. He had no problems at all in breeding the fish! So it was that fish of the F_2 generation arrived in Germany and the "GAB 19/90" strain has since been bred regularly.

In July 1992 GRELL succeeded in bringing back a strain of *Aphyosemion maculatum* from Matora between Lalara and Koumaméyong. This strain had striking yellow fins.

In January of the following year LEGROS, CERFONTAINE and EBERL brought back the "LEC 93/3" population, which, like the "GAB" strain, quickly became established among keepers of killies.

Six months later PASSARO and EBERL brought back to Germany from the vicinity of Matora another strain with the code "PEG 93/14". This strain of *Aphyosemion maculatum* has yellow fins and its position in the hobby also seems to be assured.

Another collecting trip by these two aquarists in August 1994 resulted in many new findings on this species and its distribution. *Aphyosemion maculatum* was found in every stream fished to the west of Ebé, so in the wild it is a common species. In addition a third locality for the "yellow" form of *Aphyosemion maculatum* was found in the village of Lolo I ("PEG 94/17").

First Description

Dr Alfred RADDA & Eduard PÜRZL: "*Cyprinodontiden*-Studien in Gabun, II. Nord-gabun", Aquaria, 24, 1977, pp 21-31.

Meaning of the Specific Name

Wishing to emphasize the striking characteristic of the pattern of blotches on the males, the authors of the first description based the specific name on the Latin word "maculatus, maculata, maculatum", which can be translated as "spotted, blotched".

For the generic name *Aphyosemion* the neuter form "*maculatum*" had to be used.

Terra typica

"...collected on 11.12.1975 at 16.20 in a stream in the rainforest on the National Road No 4 from Koumaméyong to Ovan, 33 km E Koumaméyong and 20 km W Ovan, fixed on 18.09.1976 after being kept in the aquarium."

This too is a case of extremely precise data on the type locality. The National Road No 4 (N4 for short) leads from the crossroads near Lalara via Koumaméyong, Ovan and Makokou to the east. The distance from Koumaméyong to Ovan comes to 52 to 53 kilometres. RADDA and PÜRZL had come from Mitzic and Lalara and discovered the 36th locality of this collecting trip (code "G 75/36") 33 kilometres east of Koumaméyong.

In the first description RADDA and PÜRZL mention the presence of *Diapteron georgiae* and a *Clarias* species. On page 26 they give, along with some other localities of this trip, a table with the following readings for the terra typica of *Aphyosemion maculatum*: pH 6.4; electrical conductivity 20µS; 0.5°dGH; 1.6 mg Ca^{2+}/1; 1.2 mg Mg^{2+}/1. In addition further chemical characteristics of the water were given, such as the iron content, the use of potassium permanganate and the concentration of various substances.

Synonyms

The relatively recent discovery of this species, together with its very clear definition, has meant that to our knowledge no synonyms have been used to date.

Meristics

RADDA and PÜRZL deposited a holotype (adult male), an allotype (female) and seven paratypes from the terra typica. They found the following data:

D = 13
A = 16
D/A = 1/7 to 1/8
Sq.l. = 30+2

The authors of the first description were able to find slight variations: the number of dorsal rays came to 13 on four fish and 12 on four others. One specimen had 17 rays on the anal fin, whereas the other seven specimens had 16. The number of scales in a longitudinal series was even found to be 32+2 on some specimens.

Karyotype

Not known or rather not investigated.

Geographical Distribution

Aphyosemion maculatum inhabits a very small distribution area in north Gabon on the southern distribution frontier of the "*cameronense*"-group. Its frontiers can only be given as along the Lalara-Ovan road. To the north there are no passable roads and along the Koumaméyong-Booué road there are scarcely any suitable streams.

It is interesting that *Aphyosemion maculatum* is replaced to the west (Lalara) and also to the east (Ebé) by *Aphyosemion cameronense*, but within this area Phenotype 5 is found. One has the impression that this representative of the "*cameronense*"-group (at least along the N4) separates the classic form and the form with the yellow fins (Matora and Lolo I).

With the following map we wish to show that *Aphyosemion maculatum* has a very small distribution area on the southern edge of the "*cameronense*"-group:

For a long time the known localities led people to suppose that *Aphyosemion maculatum* and the "normal *Aphyosemion cameronense*" alternated or replaced each other repeatedly but without any real regularity along the Lalara-Koumaméyong-Ovan road.

It was not until the last few years that collectors discovered that the *Aphyosemion maculatum* populations in the west (i.e. in the Lalara direction) differ from those in the east (in the Ovan direction), and the populations of the "*cameronense*"-group between these two "colour forms" were wrongly (or for the sake of convenience?) called *Aphyosemion cameronense* (see also "Phenotype 5 from Koumaméyong").

The map on the following page shows the distribution of *Aphyosemion maculatum* as it is known today.

According to Radda & Pürzl (1985, page 30), the most westerly locality of *Aphyosemion maculatum* lies "10 kilometres west of Lalara on the road to Ovan". In fact, however, Ovan is situated to the east of Lalara, so there is probably some mistake here.

Unfortunately it is not said whether this locality lies ten kilometres to the west of Lalara on the road to Ndjolé (in a lower tributary of the Amvéné?) or whether it is ten kilometres east of Lalara near Laboka or Yen.

The most easterly locality known to date was discovered by Legros, Cerfontaine and Eberl just a few hundred metres from the western outskirts of Ebé near Ovan. This population has the code "LEC 93/4".

It is not possible to establish the distribution frontiers to the north and south of the N4 at present, as there are no passable roads into the forest there. The localities in the west lie in the drainage area of the Mendoué, which runs north-west into the Okano. The eastern localities belong to the Mva, which flows south-east into the Mvoung. So we have here two systems separated from each other.

Known Localities

"GBHL 86/18" refers to the one locality of Bardin, Houdu and Lombard's trip, whose position is given as "14 kilometres west of Ovan on the road to Koumaméyong". In February 1986 *Aphyosemion maculatum* was discovered along with *Aphyosemion punctatum*, *Diapteron georgiae* and *Epiplatys neumanni* - four killifish species in one biotope.

We do not know from where in Ovan the distance was measured from, and there is also a lack of further information, so we cannot give accurately the geographical co-ordinates. After its import this strain did not last long in the hobby.

In this stream about 500 metres north of the village of Matora the male shown below was found

An adult wild *Aphyosemion maculatum* "PEG 93/14"

"GAB 19/90" is a locality on the Koumaméyong-Ovan road, which, according to BROWN (pers. comm. September 1992), ought to be the actual terra typica. Coming from Koumaméyong, the collectors had travelled 33 kilometres east when they came across a stream with *Aphyosemion maculatum*. We can only estimate the geographical co-ordinates. On several occasions PASSARO and EBERL were able to find *Aphyosemion maculatum* to the east of the terra typica (see also **"PEG 94/13"** and **"PEG 94/14"**). We therefore consider the 'Yélélé' stream between Mélané and Souganlam to be the terra typica: 12°01' E and 00°19' N at 453 metres above sea level. This strain is well distributed in the hobby.

"GBG 92/23" is the code for the population that was discovered in July 1992 by GRELL in a stream which crosses the Lalara-Koumaméyong road in the village of 'Matora' (11°42' E and 00°17' N, at about 500 metres above sea level). *Diapteron georgiae* was found as well as *Aphyosemion maculatum.*

We do not know if this strain is still in the hobby.

"Ebé" is a locality mentioned by WILDEKAMP (1981: 22), the caption to the picture says: "In the rainforest of north Gabon *Aphyosemion maculatum* is found near the village of Ebé". Jan PAP's photograph shows a sluggish stream and a small log canoe.

Presumably this is the locality that PAP found during his Gabon trip in 1980 ("GJP 80"). We have no further information about this locality or the distribution of this population. There is now no "GJP 80" strain of *Aphyosemion maculatum* in the hobby.

"LEC 93/4" is a finding place near Ebé twelve kilometres from Ovan on the road to Koumaméyong. After catching *Aphyosemion cameronense* in Ebé itself, LEGROS, CERFONTAINE and EBERL tried to find Jan PAP's old locality. In this they were helped by the villagers, who showed them a stream not more than about 400 metres west of the end of the village. This stream crosses the road from north to south (see also the map on page 282). We calculate the geographical co-ordinates of the village of "Ebé" to be 12°06' E and 00°20' N. We cannot give the height above sea level accurately. The stream fished at that time belongs to the system of the Mva, which runs south-east into the Mvoung and then into the Ivindo.

Aphyosemion maculatum was the only species of killifish. Also to be found in large numbers were barbs, small characins, tadpoles, shrimps and water insects. This strain came to be fairly widely distributed in the hobby.

"PEG 93/14" refers to the fourteenth locality of PASSARO and EBERL's July 1993 trip to Gabon, which has already been mentioned several times. The locality is in Mato-ra, 18 kilometres west of the crossroads in Koumaméyong. Coming from the Booué (and thus also from the Koumaméong) direction, they wanted to try to confirm the presence of *Aphyosemion maculatum* with yellow fin margins (see also **"GBG 92/23"**).

In Matora the villagers could not remember GRELL being there or his locality on the road. So the collectors were shown a stream to the north of the village, where *Aphyosemion maculatum* was to be found in large numbers. *Diapteron georgiae* was also found to be present, but there were only a few specimens.

The name of the stream visited at that time is not known, but the locality lies in the drainage area of the Mendoué, which runs north-west into the Okano.

This strain has since been bred and distributed among aquarists who are keen on the small *Aphyosemion* species.

"PEG 94/13" is a stream 15 kilometres west of the bridge in Ovan near the village of Messé (11°5' E and 00°20' N), which crosses the road from north to south. The stream is a small tributary of the Mva, which itself is about three metres wide. *Aphyosemion maculatum* was found together with *Diapteron georgiae*. No specimens of this population were brought back.

"PEG 94/14" refers to the next finding place 18 kilometres west of the bridge in Ovan. The 'Messé' stream crosses the road between the villages of Messé and Mélané from north to south and belongs to the same system as the previous locality.

The geographical co-ordinates are 12°3' and 00°20' N. We have not been able to determine the height above sea level.

This strain of *Aphyosemion maculatum* was brought back, so it ought to be available to the enthusiast.

Syntopic Killifish

Aphyosemion punctatum
Diapteron georgiae
Epiplatys neumanni

The western distribution area of *Aphyosemion maculatum* between Lalara and Lolo has not been adequately investigated. In theory new findings on syntopic killies might be expected.

The only known species there to date is *Aphyosemion cameronense*; these species tend to replace each other rather than occur in the same stream.

At the present time there are no reports of a semi-annual species from the subgenus *Raddaella* occurring here. In the past it has only been found to the east of Ovan.

Description

Both the external appearance and the meristics suggest that *Aphyosemion maculatum* should be placed in the "*cameronense*"-group, even if some important features of the body colouration are absent.

We can recognise two "colour forms", which we have said are separated from each other.

In both the eastern and western forms the basic colour corresponds to the metallic blue-green which is usual for this species group. On the anterior half of the body we find the pattern of red spots developed as in the other forms.

On the rear part of the body there are a large number of dark red blotches, which partially merge into each other and can form vertical bands.

The dorsal fin is a shimmering metallic blue-green and has numerous dark red spots and interradial streaks.

The anal fin has a very narrow white or pale blue marginal band, joined by a red sub-marginal band. The inner part of the fin is covered with large irregular red blotches, which spread into the sub-marginal border.

The markings on the caudal fin correspond basically to the usual pattern found in the other representatives of the "*cameronense*"-group. The only difference is that in the central area we find quite large spots to irregular blotches which on occasions tend to assume an extended shape in the direction of the fin rays. The two marginal bands of this fin are whitish to pale blue, but on the eastern forms they are never yellowish.

On the other hand the western form has a constantly high proportion of yellow in the unpaired fins. The body markings correspond in all important respects to the pattern of the populations around the terra typica.

The dorsal and anal fins have a yellow marginal band. The upper and lower bands of the caudal have the same colouration.

As the upper and lower area of the caudal differ markedly from the ground colour of the fin, one has the impression of extended points to the fins. However, it is in fact only the anal fin that has a long extension at the posterior end.

The following drawings represent schematically the colouration patterns of the eastern and western populations:

A male of the "LEC 93/4" strain, with relatively few red blotches

Relationships

The absence of the Yellow Blotch prevents this species from being placed in the "yellow" group. So we can immediately place it with the "blue" forms.

However the blotch markings ("*maculatum*" = blotched!) justify the setting up of a separate group, in which we could also include *Aphyosemion mimbon*.

Aphyosemion maculatum needs to be differentiated only from *Aphyosemion mimbon* from the 'Monts de Cristal'. The localities situated closest to each other are Matora and Médouneu, which are 135 kilometres apart as the crow flies. Until now the only member of the group found along the Lalara-Mitzic-Sam-Médouneu road have been *Aphyosemion cameronense* or Phenotype 8 in a small area to the west of Mitzic. Essentially therefore it is the species *Aphyosemion cameronense* which separates the only two blotched representatives.

Both species have in common the large red blotches on the flanks, but the unpaired fins of *Aphyosemion mimbon* have a completely different colouration:

- The dorsal has a yellowish ground colour and in many populations has a red mottling pattern; but there are also strains with a uniformly yellow dorsal fin.
- The anal fin is extremely variable; it can be pale blue with red dots or it can have a bright yellow marginal and red sub-marginal band; in addition specimens have been found with a completely yellow anal fin.
- The caudal fin always has an upper and lower yellow marginal band; the central area is dark red with blue dots.

Diagnosis

Aphyosemion maculatum is another "small" species on the southern edge of the "*cameronense*"-group, into which it must definitely be placed despite the divergent markings (RADDA & PÜRZL in the first description and all subsequent authors).

This well defined species can be split into two colour forms in different hydrographic systems (Okano-Ivindo and Mvoung-Ivindo). The populations in the vicinity of the terra typica between the 'Yélélé' stream and Ebé are called blue-red. The three populations known to date near Matora and Lolo have yellow margins in the unpaired fins.

Between the two colour forms there is a gap of 34 kilometres as the crow flies (Lolo-Yélélé). In this area *Aphyosemion cameronense* (Djidji) and Phenotype 5 have been found.

Both to the west (Lalara, reported by HUBER) and to the east (Ebé, "LEC 93/3"), *Aphyosemion maculatum* is replaced by *Aphyosemion cameronense*. This situation is shown in more detail on the two maps on page 355.

Aphyosemion maculatum is separated geographically from the similarly coloured species *mimbon* (near the source of the Komo) as both species occur in different hydrographic systems. In addition there are clear differences in the colouration of the unpaired fins. The two species were described at about the same time, and any theoretically conceivable synonymy would be impossible to support with any logical argument.

Discussion

In our treatment of *Aphyosemion maculatum* we have seen that this is a distinctly divergent species with a small distribution area in the southern frontier region of the "*cameronense*"-group.

Between Lalara and Ovan we find three forms in a very small area - *Aphyosemion cameronense*, *Aphyosemion maculatum* and Phenotype 5. To date no transitional forms or natural hybrids have been observed.

In our opinion this supports the theory which considers this species group as highly polymorphic and makes a clear distinction between the individual forms (here phenotypes).

More work needs to be done on the distribution area of *Aphyosemion maculatum* and its relationship with that of these three forms. This could result in an increase in our knowledge of the dynamics of the "*cameronense*"-group and in speciation.

Crossing experiments with geographically close populations of the three neighbouring forms would help to find further barriers. This could not only confirm the already accepted specific status of *Aphyosemion maculatum*; in addition it might provide arguments for separating the form we call here Phenotype 5 from *Aphyosemion cameronense* (and all other representatives of the "*cameronense*"-group). Finally this would lead to Phenotype 5 being raised to the level of species (as has already happened with *Aphyosemion amoenum* and *Aphyosemion halleri*).

Aphyosemion mimbon HUBER, 1977

Aphyosemion mimbon "LEC 93/18"

History

During several collecting trips in the seventies, German and Austrian aquarists travelled from Libreville to the transitional area between the coastal plain and the 'Monts de Cristal' in north Gabon. But at that time the only fish brought back were species like *Aphyosemion striatum* and *Aphyosemion microphtalmum* (*Aphyosemion escherichi*?) from the area around Song and "Atogafina".

It was not until August 1977 that Jean Henri HUBER penetrated further into the so-called Crystal Mountains, where he found a very divergent form from the "*cameronense*"-group. This fish was found near Akoga, in a stream 16 kilometres west of Médouneu and also near the Médouneu Catholic Mission. After doing research on these fish HUBER described this new species as *Aphyosemion mimbon.*

Some of the wild fish were successfully used for breeding by Maurice CHAUCHE. However these strains did not get distributed among aquarists and so were subsequently lost to the hobby.

For a long time this species was not seen in the aquarium until January 1986, when, as already mentioned on page 241, the species was successfully reintroduced by WAGNER and WENDEL.

In July 1992 GRELL succeeded in bringing back to Europe two strains of *Aphyosemion mimbon* from the area to the west of Médouneu.

In January of the following year LEGROS, CERFONTAINE and EBERL passed through Médouneu on their way from Sam and were also able to bring back two strains of this species and subsequently distribute them among aquarists.

Towards the end of their stay in Gabon in February 1994 ("GEB 94"), Thomas BLUM and Wolfgang EBERL went on a two day trip into the Monts de Cristal, getting as far as Edoum. They discovered further localities of *Aphyosemion mimbon*, and again live fish were brought back.

Finally, in August of the same year, PASSARO and EBERL were able to do likewise and at the end of the "PEG 94" trip investigate more closely the distribution area of this species. They too managed to bring back live specimens.

At the same time the distribution frontiers of *Aphyosemion mimbon* were determined both to the north-east (with *Aphyosemion cameronense*) and to the south-west (with Phenotype 6).

First Description

Jean Henri HUBER: "Une chaîne de deux *Aphyosemion* sympatriques dans les monts de Cristal, Gabon, avec description d'une espèce nouvelle: *A. mimbon* n. sp.", Revue française d'Aquariologie 1, 15th June 1977, pages 3-10.

Meaning of the Specific Name

In selecting a name for this species, HUBER chose the word used by the inhabitants of north Gabon in their language for all small fish in the rainforest streams, which we class as killifish.

He recounts this in the first description of *Aphyosemion mimbon* as follows: "**Signification du nom d'espèce.** *Mimbon* est le nom vernaculaire donné aux Poissons du genre *Aphyosemion* par le peuple Fang qui a colonisé le nord et le nord-ouest (région de l'estuaire) du Gabon. Le singulier étant "m'bon", il faut prononcer le nouveau nom en plaçant l'accent tonique sur la deuxième syllabe".

This can be translated as follows: "**Meaning of the specific name.** *Mimbon* is the local name given to the fish of the genus *Aphyosemion* by the Fang people, who have settled in the north and north-west (estuary region) of Gabon. The singular is "m'bon". The new name should be pronounced with the stress on the second syllable".

In fact one of the authors, during several trips to Gabon, has found that the word "m'bon" is used from Makokou through Mitzic and Oyém to the frontier and on into Cameroon, and also around Sam and Médouneu to the coastal plain. The word is used to differentiate the killies found in the streams from the other fish present. For the Fang people the term includes not just the *Aphyosemion* mentioned by HUBER but also the *Diapteron*, *Epiplatys*, *Raddaella* and the lamp-eyes as well.

Terra typica

"Localité n° 54". This is the 54th locality of J.H. HUBER's Gabon trip, which he stopped at on 29.08.1976.

On page 4 of the publication there follows a description of this locality in French: "Village de Akoga, à environ 55 km de Médouneu. Petit ruisseau assez courant en arrière des cases, qui se jette dans la Mvé, 150 m plus loin."

This could be translated as: "The village of Akoga, about 55 kilometres from Médouneu. A small, fairly fast flowing stream behind the huts, which 150 metres further on flows into the Mvé." Thus the type locality is very accurately described. We make the geographical co-ordinates to be 10°29' E and 00°52' N at an estimated 530 metres above sea level. The map on this page shows the position of Akoga.

In this area the road runs near the Mvé (Mveng), which after a few kilometres runs into the Mbé, which flows to the south-west and joins the Komo.

HUBER then gives a comprehensive description of this finding place: "Végétation dense sur les bords, fond sableux avec des zones à forte concentration de feuille, eau légèrement brune. Caractéristiques le 29 août à 9 heures: température de l'eau 20.8°C, de l'air 22°C, pH 6.4, DH 0.2. Avec une espèce de Barbus et des Grenouilles, deux *Aphyosemion* sont à nouveau sympatriques. La forme "bleue" est moins abondante que la forme "jaune".

This is a translation of the quotation: "Dense vegetation on the banks, a sandy base with parts having a heavy concentration of leaves, water slightly brown. Readings on 29th August at 9 a.m.: water temperature 20.8°C, air temperature 22°C, air temperature 22°C, pH 6.4, 0.2 dGH. Along with a barb species and some frogs, two *Aphyosemion* are again sympatric. The "blue" form is less numerous than the "yellow form".

HUBER describes *Aphyosemion mimbon* in his publication from page 8 onwards. It is *Aphyosemion mimbon* which he calls the "blue" form, while the "yellow" form is a representative of the "*herzogi*"-group, but not *Aphyosemion herzogi* itself.

Synonyms

Like the *Aphyosemion* species described earlier, *Aphyosemion mimbon* was discovered relatively recently. This fact, together with the precise description of this species, means that to date no synonyms have been used.

Meristics

HUBER deposited a holotype (a male) and 23 paratypes (males and females) from the terra typica and from localities 52 and 53. He used a total of nine specimens to provide the following figures:

D = 13-14
A = 16-17
D/A = 1/7 (once) to 1/8 (1/9 once)
Sq.l. = 30-32 + 2

According to HUBER's data, 15 other specimens preserved at the time of the first description were not examined.

Karyotype

Not known or not investigated. *Aphyosemion mimbon* inhabits quite a large distribution area in north Gabon compared to the other representatives of the "*cameronense*"-group (except for *Aphyosemion cameronense*, of course).

It is interesting that this is very unlikely to be a species at the edge of this group. What can be said is that *Aphyosemion mimbon* is replaced by *Aphyosemion cameronense* in the west and north-west and by Phenotype 6 in the south-west. In addition we suspect that there is another representative of the "*cameronense*"-group in Equatorial Guinea which takes over from this species to the north and north-west.

Future collecting work in the south of Equatorial Guinea could provide more information in this respect.

Aphyosemion mimbon exists in the hydrographic systems of the Komo and the Mvé (Mveng) in the west of the 'Monts de Cristal'.

The localities known to date lie exclusively along the road from Médouneu to the west. If more roads were to become passable, then our knowledge of the distribution area of this species, especially to the south-east and the north-west could be extended quite considerably.

The most south-westerly locality found has been near the village of Ntom two kilometres south of Akoga ("GEB 94/27"). The most north-westerly lies near the Médouneu Catholic Mission (J.H. HUBER's locality No. 52).

On the following map we intend to show the distribution area of *Aphyosemion mimbon*, as it is known at present, in relation to that of the whole "*cameronense*"-group.

It should be borne in mind that so far no collecting work has been possible to the north-west of the Akoga-Médouneu road.

The map on the following page is meant to show in enlarged form the area between Médouneu and Ntom. At the same time, we have included the localities known to date of the neighbouring representatives of the "*cameronense*"-group. which are to be found on the frontiers of *Aphyosemion mimbon*'s distribution area.

As can be seen on the map, *Aphyosemion mimbon* and *Aphyosemion cameronense* (upper tributaries of the Abanaga) and Phenotype 6 (area near the source of the Song) can come very close to each other, even if they inhabit different hydrographic systems.

Known Localities

"JH 52" is the code used by HUBER (1994, page 228) for the first of a total of three localities of *Aphyosemion mimbon* from his trip in August 1976.

On 28.08.1976, in the vicinity of the Catholic Mission of Médouneu ("en contrebas de la mission catholique"), he had found a small marshy stream with very clear water. The stream belongs to the system of the Mvo, a tributary of the Abanga ("Petit marigot à eau très claire de la rivière Mvo, affluent de l'Abangha").

The geographical co-ordinates of this locality are given by HUBER (op. cit., as quoted above) using a different method of measuring (!) as "10.79 E and 01.02 N". On our maps we read the position as 10°46' E and 01°01' N.

The stream HUBER calls the 'Mvo' could be the one marked as 'Nyo' on our maps. The Nyo is a stream that feeds the Komo. We do not think it possible that it could belong to the upper Abanga (Abangha); see also page 259, **"PEG 94/42"**!

As well as *Aphyosemion mimbon*, HUBER found *Aphyosemion spec. aff. herzogi* and also *Ctenopoma spec.*, *Clarias spec*. and *Barbus spec*.

He says this biotope is "très favorable aux *Aphyosemion*", or, in English, "very favourable for *Aphyosemion*". Accordingly these killies were very numerous ("ils sont abondants").

Fish of this strain were brought back alive and then photographed by Maurice CHAUCHE (a picture is published on page 6 of the first description), but they did not survive for long in the aquarium.

"JH 53" is the next locality, which HUBER discovered 16 kilometres west of Médouneu on the road to the coastal plain and Libreville: "A 16 km de Médouneu, sur la route de Libreville, mare marécageuse à courant très lent, située 100 m après la rivière Mva et à 500 de Nkinnen".

This says that it is a body of sluggish, almost standing water near the village of "Nkinnen", whose geographical co-ordinates we make to be 10°41' E and 00°58' N. On our maps the spelling is "Nkinèn". The reasonably large stream is only 100 metres from the village, and HUBER calls it the "Mja" (Mia); it flows into the Komo.

The water was noted for its high temperature (23°C), the muddy base and the strong smell of decay, which can be attributed to the storage of manioc in the river.

Aphyosemion mimbon was the only killifish, but a *Ctenopoma* species and a characin were found to be present.

This strain too has disappeared from the aquarium.

"JH 54" finally is the terra typica near Akoga. Its location has already been explained in detail on page 358. HUBER (1994) gives the geographical co-ordinates he took as "10.48 E and 00.82 N". Like the two other strains, this one is also no longer available in the hobby.

"GWW 86/30" is the *Aphyosemion mimbon* locality that Peter WAGNER and Roland WENDEL discovered "three kilometres from Médouneu" on 10.01.1986. As we do not know where they took their measurement from in Médouneu, we cannot say where this stream is exactly. We take the geographical co-ordinates to be 10°44' E and 01°01' N. The stream could be a small tributary of the Komo near Etsameyong.

Aphyosemion mimbon was the only killifish present.

This strain is still widely distributed among killifish enthusiasts - not least because of its beauty and thanks to the efforts of WAGNER and WENDEL.

"GBG 92/35" and **"GBG 92/36"** in GRELL (1993b, pp 2 and 3) refer to two localities west of Médouneu visited by GRELL in July 1992. We know nothing about the precise location of these finding places nor if the populations are distributed among aquarists. At the second locality the second killifish species present was *Episemion spec.*

"LEC 93/18" was stopped at by LEGROS, CERFONTAINE and EBERL on 12.1.1994 at 5 p.m. This is HUBER's locality "JH 53". 16 years after HUBER collected there, his readings on the composition of the water were totally confirmed. LEGROS found the water temperature to be 23.2°C, the pH 5.7 (!) and the nitrite content 0.5 milligramme!

This strain has become widely distributed in the hobby.

"LEC 93/19" refers to the 'Fini' stream near Avang, 35 kilometres west of the outskirts of Médouneu. The inhabitants themselves said the distance to this town was "PK 36 Médouneu". The geographical co-ordinates are 10°34' E and 00°54' N at about 600 metres above sea level.

The Fini lies to the west of the village. It feeds the Ndoubou, which flows south-west into the neighbouring Mbé. On 13.01.1993 at 7 a.m., the following readings were taken: water temperature 20.9°C, air temperature 18.6°C, electrical conductivity 18 µS, pH 6.3 and total hardness 0°dGH.

Alongside *Aphyosemion mimbon*, the collectors found *Aphyosemion spec. aff. herzogi*, *Barbus jae*, *Silurus spec.* and a characin species.

This strain has also been spread around the hobby.

"GEB 94/25" refers to the 'Oyab' stream about one kilometre north of Edoum, which was fished by BLUM and EBERL on 19.02.1994 at about 7 a.m. The geographical co-ordinates are 10°39' E and 00°57' N. The height above sea level cannot be given with sufficient accuracy.

The Oyab flows south into the Mia and is thus a western tributary of the Komo.

As well as a very large number of *Aphyosemion mimbon*, a few *Aphyosemion spec. aff. herzogi* were also found, together with a single specimen of *Episemion spec.* The first two species mentioned were brought back alive. The third species was not brought back until six months later (see also **"PEG 94/43"**).

"GEB 94/26" is also near Edoum, but not by the roadside. The villagers had said they would be happy to take the collectors along an approximately two kilometre walk through the forest to a stream north-west of Edoum, where *Aphyosemion mimbon* and again *Aphyosemion spec. aff. herzogi* were to be found.

These two strains were also brought back alive.

"GEB 94/27" finally refers to the third and last finding place of this trip in which *Aphyosemion mimbon* was found. On the journey back to Libreville the collectors passed through Akoga, so that they could fish two kilometres south-west near Ntom in the 'Mboum' stream, a small tributary of the Mveng. After about a kilometre the Mveng runs into the Mbé. Here too *Aphyosemion mimbon* and *Aphyosemion spec. aff. herzogi* were to be found together, but no live specimens were brought back.

"PEG 94/43" is the code for this repeat visit to the Oyab stream near Edoum; it had been visited on 20.08.1994 ("GEB 94/25"). The aim was not so much to catch *Aphyosemion mimbon* or *Aphyosemion spec. aff. herzogi,* of which only quite small specimens were present. More importantly, it was possible to catch a form of *Episemion* in greater quantity, where six months previously, despite intensive efforts, just one young fish had been found. Breeding size specimens of both sexes of this divergent form of *Episemion callipteron* were brought back successfully.

"PEG 94/44" refers to the 'Ndoubé' stream near Nzog Bour 13 kilometres south-west of Edoum and 31 kilometres from Médouneu. The geographical co-ordinates are 10°36' E and 00°54' N. The height above sea level cannot be given. This locality too lies in the drainage area of the Ndoubou and thus belongs to the eastern drainage area of the Mbé.

Aphyosemion mimbon was the only killifish species present, and live specimens were brought back, so this strain should be distributed among aquarists.

"PEG 94/45" is the 'Fsinen' stream near Avang, 18 kilometres south-west of Edoum. On 20.08.1994 *Aphyosemion mimbon* was again found to be the *Aphyosemion* species present. The geographical co-ordinates and also the data on the locality belonging to a hydrographic system correspond to the information given about locality "LEC 93/19".

Live specimens were also brought back of this strain.

"Ottomitan" is the name of a stream near Médouneu airport, where Hervé GONIN was able to find *Aphyosemion mimbon* and an *Episemion* form which cannot be identified more closely. The French killie enthusiast had spent his time in Médouneu from 3rd to 7th March 1983 investigating the streams around this town for fish.

Unfortunately this strain is no longer available in the hobby.

Syntopic Killifish

Aphyosemion spec. aff. herzogi
Episemion spec.

Over the years the distribution area of *Aphyosemion mimbon* has become relatively well known. There should not be any further syntopic killies - at least along the road from Médouneu via Akoga to the coastal plain.

Just the hope of decent roads being built in the future in the west and east, together with successful planned collecting trips in the south and south-east of Equatorial Guinea, give grounds for the supposition that further killies might be found alongside *Aphyosemion mimbon*.

The presence of lamp-eyes of the genus *Plataplochilus* on the western edge of the Monts de Cristal (Méla and Song, see also "LEC 93/22" under the section on Phenotype 6) could, purely theoretically, stretch a little further north-east to *Aphyosemion mimbon*. To date, however, no lamp-eyes of any kind have yet been found there.

Description

Aphyosemion mimbon is probably the species which differs most from the other representatives of the "*cameronense*"-group in the colour pattern of the males. As we have already seen with *Aphyosemion maculatum*, these two species lack some of the important characteristics of the body colouration of this species group.

A striking feature is that of the large dark red blotches on the flanks. Their number, size and shape vary considerably from individual to individual, as well as from population to population. As with other members of the "*cameronense*"-group, numerous red dots lie on the front part of the body. These appear to produce two to three parallel rows. As with *Aphyosemion maculatum*, one can see a tendency for blotches to be produced in vertical formation over a bluish background.

The ground colour of the dorsal fin is always yellow. Red spots or longish blotches can be present in greatly varying numbers and size. We know of specimens with completely yellow to almost red dorsal fins.

The anal fin too varies a great deal in colouration. It can be uniformly yellow, uniformly red or marked with a yellow marginal and a dark red sub-marginal band. On occasions the basal region of the fin is pale blue. Frequently within a strain males are to be seen with anal fins differing greatly from each other.

The pattern of markings on the caudal fin can be said to be typical in this species: two very broad marginal bands bound the central area, which is marked dark red with just a few pale blue spots and streaks. Occasionally specimens occur on which a narrow pale blue band runs between the bands and the central area. This narrow band is at the most a seventh or eighth of the width of the outer bands.

The following drawing represents a standardised male of *Aphyosemion mimbon* with a uniformly dark red anal fin. The lower drawing shows the other two colour patterns of this fin.

Relationships

In the earlier discussion of *Aphyosemion maculatum* it was made clear that *Aphyosemion mimbon* does not belong to the "yellow" group, but it can be placed in the "blotched" group.

The two species have already been seen on page 353 to be separated from each other both geographically and in the colour pattern of the males. Here we would like to make the further observation that the caudal fin of *Aphyosemion mimbon* is always coloured in a horizontal symmetrical fashion, whereas in the purely blue strains of *Aphyosemion maculatum* the upper marginal band is always less developed and narrower than the lower one. This is not true, however, of the western populations of *Aphyosemion maculatum* with yellow bands on the fins.

The following drawing is intended to show the differences between a typical *Aphyosemion mimbon* caudal fin and a typical caudal fin of *Aphyosemion maculatum*:

Diagnosis

In recent years *Aphyosemion mimbon* has been investigated intensively, so that its distribution frontiers and the colouration of the males are relatively well known.

Despite clearly recognisable "peculiarities", this species must be included in the "*cameronense*"-group. It is perhaps the species which fits least easily into a systematic arrangement of this species group.

It is noteworthy that in north Gabon, in the southern area of the "*cameronense*"-group, there are two forms regarded as distinct species which have irregular dark red blotches on the rear part of the flanks. Both species seem to be the representatives closest to each other both geographically and in their body colouration.

Differences however are seen in the high proportion of yellow in *Aphyosemion mimbon* and in the varying patterns of markings in the unpaired fins. Placing the two forms together in one species does not seem feasible, neither has it ever been discussed.

Discussion

When the members of the "*cameronense*"-group are compared, *Aphyosemion mimbon* strikes one as the species that differs most from the general appearance of these fish. For this reason, since the first description in 1977, its validity has never been questioned.

Due to the irregular red blotches on the flanks of the males, *Aphyosemion mimbon* is often called the "yellow" form of *Aphyosemion maculatum*. This is supposed to signify the close relationship between the two forms.

This description of the relationship can be thought of as perfectly understandable, but we do not share the view that the two species mutually replace each other. In any case the distribution areas are clearly some distance from each other, and *Aphyosemion cameronense* separates the two species.

Thought should be given rather to how two representatives of the "*cameronense*"-group were able to originate in the southern frontier area and at the same time develop such as striking feature as the "red blotches". Certainly *Aphyosemion mimbon* and *Aphyosemion maculatum* are more closely related to each other than to any other representative of this species group.

The crucial question is whether their distribution area used to be joined and the geographical separation caused by other fish, presumably by *Aphyosemion cameronense*. Climatological or geological influences could also be the cause of this phenomenon in this case.

Genetic research could indicate whether the two "blotched" species are older or younger than *Aphyosemion cameronense*. If this were to be done, all the forms around *Aphyosemion mimbon* and *Aphyosemion maculatum* would have to be compared with each other: Phenotype 6 west of *Aphyosemion mimbon*, *Aphyosemion cameronense* east of Médouneu and west of Matora, Phenotype 5 between the "blue" and the "yellow" forms of *Aphyosemion maculatum* and finally *Aphyosemion cameronense* from Ebé (and to the east of it in the direction of Ovan).

We think it conceivable that there used to exist a blotched form in north Gabon which was split into two distribution areas by the infiltration of *Aphyosemion cameronense*. The lack of interchange between the two populations groups encouraged a separate development and thus the formation of two species.

In connection with collecting work in the south of Equatorial Guinea, experiments would need to be carried out on the populations of *Aphyosemion mimbon* occurring there and the neighbouring populations of *Aphyosemion cameronense* (or another still unknown representative of the "*cameronense*"-group?) to the north and north-west. For this purpose crossing experiments would have to be carried out within a species as well as between the species (and phenotypes).

We must therefore wait until someone decides to undertake to do these crossing experiments within the framework of systematic and well prepared investigations. This work might then tell us what the genetic frontiers between the representatives of the "*cameronense*"-group are.

The Various Phenotypes in the "*cameronense*"-group

After the presentation of those representatives of this species group which have been described or else considered as species and subspecies, we would now like to look into the forms which because of the colouration of the males and their general appearance (see pp 28 to 38) also belong to the "*cameronense*"-group. Until the publication of AMIET's outstanding work (1987) these forms were all known as "*Aphyosemion cameronense*".

In addition further forms have been found in Gabon. They differ considerably from *Aphyosemion cameronense* as we define it.

A look at the historical development of this species group shows that since the mid seventies there has been no first description:

- -1903: BOULENGER describes *Aphyosemion cameronense*.
- -1924: AHL describes *Aphyosemion obscurum*.
- -1976: RADDA & PÜRZL describe *Aphyosemion amoenum*, *Aphyosemion cameronense halleri* and *Aphyosemion cameronense haasi* in a single publication.
- -1977: RADDA & PÜRZL describe *Aphyosemion maculatum* and HUBER describes *Aphyosemion mimbon*.

After a very active phase with the description of five (from the present total of seven) species or subspecies within two years (1976 and 1977), the only subsequent publication has been AMIET's work on the *Aphyosemion* of Cameroon.

This rather ignored publication contains a large amount of new information on the "*cameronense*"-group. Of critical importance is the definition in it of three "phenotypes", which are called by AMIET "phenotypes of indeterminate status close to *A. cameronense*".

To explain his definition AMIET writes on page 238: "We hesitate to take sides over the 3 following phenotypes, which could well be species but which are, however, by their morphological characteristics, less "typical" than the preceding taxa. All inhabit the same, restricted hydrographic networks as the phenotypes that conform or are in any case very similar to *A. cameronense* sensu stricto, without actually living together in the same water courses".

We will now try to present these phenotypes known to us today in a format similar to that used for the species of the "*cameronense*"-group.

Following AMIET's use of the terms Phenotypes 1, 2, and 3 we have taken the liberty of continuing with his numbering system for naming the phenotypes we consider divergent. In this way it will be possible for these forms to be distinguished from each other in a clear fashion.

We want readers to realise that *Aphyosemion spec. aff. cameronense* "LEC 91/7" does not belong to the same phenotype as, for example, *Aphyosemion spec. aff. cameronense* "GEB 94/24"!

Phenotype 1 from Mvilé

Aphyosemion spec. aff. cameronense Phenotype 1 "CGE 91/12"

History

In the seventies Scheel was able to collect populations of the "*cameronense*"-group around Lolodorf in south Cameroon and later carry out genetic research with this material. He showed that there was a particularly high variability in the karyotype (Amiet, 1987, pp 114 and 238).

It is possible that he had at that time taken specimens of this phenotype to Europe, but he could not acknowledge the differences from *Aphyosemion cameronense* sensu stricto, as at that point in time the information known about this species was still too superficial.

In March 1980 Amiet fished two streams in the vicinity of the village of Mvilé, where he discovered a form that differed from *Aphyosemion cameronense*. He then called this form "Phenotype 1".

In August 1991 Grell and Eberl decided to visit one of these streams and try to bring back a strain of this phenotype. In fact they were able to fish in one of Amiet's earliest localities and bring back from there *Aphyosemion spec. aff. cameronense* "CGE 91/12". This strain has since been spread around the hobby.

Geographical Distribution and Known Localities

The distribution area of this phenotype is not very well defined, since to date the only known localities have been the two that Amiet found. These lie in the vicinity of the village of Mvilé on the road from Lolodorf to Bipindi and Kribi.

The geographical co-ordinates are 10°36' E and 03°12' N at about 400 metres above sea level. Mvilé lies only a few hundred metres from the Mougué. This river flows from the north-east to the south-west and runs into the Lokoundjé near Bipindi.

Further collections of fish between Lolodorf and Mvilé, and also to the west of Mvilé, would be necessary to establish the distribution frontiers of this phenotype.

It is especially noteworthy that the localities known so far lie on the transition from the inland plateau (Lolodorf: *Aphyosemion cameronense*) to the coastal plain (Bipindi: *Aphyosemion loennbergii*). This means that we could have here a similar case as *Aphyosemion amoenum*.

The map on page 371 gives a general view of the position of Mvilé on the western edge of the "*cameronense*"-group. The lower map shows the area immediately to the west of Lolodorf with a few localities of *Aphyosemion cameronense*.

Unfortunately we lack precise data on Amiet's two finding places, so we can only give details of the following locality:

"CGE 91/12" is the code for the twelfth locality of Grell and Eberl's Cameroon trip. In the early afternoon of 10.08.1991 they were on their way back from Ebolowa to Edéa, which is why they had to drive through Lolodorf.

To get to Mvilé, all that was needed was a slight detour to the west. Only 14.2 kilometres west of the points where the Eséka-Kribi-Ebolowa roads cross in Lolodorf they arrived in Mvilé, where the villagers could clearly remember Amiet collecting there.

In the very narrow and shallow 'Mvilé' stream, about 200 metres south of the road, there were a large number of specimens of Phenotype 1, which could be caught easily. The water was clear and slightly brownish in colour, while the bottom was covered with leaves and red-brown mud.

The colour picture at the top of page 372 is of this biotope.

Amiet also mentions that *Aphyosemion loennbergii* was present, but no specimens of this *Chromaphyosemion* could be found at the locality we have just described. We suspect that Amiet found this species, which is typical of the coastal plain, in the second of the streams mentioned by him.

Fish from this finding place were brought back alive, and as a result this strain is now distributed in the hobby in its pure form.

Further collecting around Mvilé was not possible due to pressure of time. Consequently we still do not know exactly how far this frontier form of the "*cameronense*"-group is distributed.

Phenotype 1 from Mvilé

Locality "CGE 91/12" near Mvilé

Syntopic Killifish

Aphyosemion loennbergii

So far only one killifish species has been found in the same stream as Phenotype 1. Future collecting efforts might provide further findings, but we think that at the most *Aphyosemion exiguum* may be shown to be syntopic (in the direction of Lolodorf).

Description

The absence of the "Yellow Blotch" means that this representative of the "*cameronense*"-group can be regarded as a "blue" form. However it is notable for the large number of red spots on the flanks.

AMIET (1987, pp 113 and 238) describes the colouration of adult males as follows: The ground colour is often a copper coloured shade in the upper part of the flanks. The red spots are rounded or slightly oval, mostly well separated, and they form four relatively regular rows. In contrast to *Aphyosemion obscurum*, the upper row has no distal thickening. The red medio-ventral band is little developed, and on many specimens it is very narrow.

As a matter of fact the red spots on the flanks do not tend to converge and form parallel lines. Instead they always remain separate from each other.

The anal fin is comparable to that of *Aphyosemion obscurum*, but the marginal white band is much broader. It can cover a quarter to a third of the fin.

The caudal fin has a colour pattern that we know from *Aphyosemion cameronense*. The colouration of the marginal bands is always white or a faint pale blue. Specimens with yellowish caudal fins have not yet been observed. Amiet reports that the upper marginal band of the caudal fin is "less developed than the lower one".

The following drawing shows a schematic male of this phenotype:

Relationships

The strikingly numerous and regularly arranged spots are known from *Aphyosemion obscurum* and Phenotypes 4 from Bélinga and 9 from Ngoyang. The geographical separation from these forms can be shown using the distances between Mvilé and the localities that at present are known to be the nearest to Phenotype 1:

-from *Aphyosemion obscurum* 90 kilometres from Mvilé to Makak.
-from Phenotype 4 about 320 kilometres from Mvilé to Bélinga (north of Makokou).
-from Phenotype 9 only 40 kilometres from Mvilé to Ngoyang (north of Lolodorf).

The proximity to Phenotype 9 suggests that the two forms might be identical, but on the other hand the "Yellow Blotch" is present on Phenotype 9. This conspicuous feature also enables this phenotype to be separated easily from the Bélinga fish.

Further differentiation of the "regularly marked" forms is not necessary at this point, as this has already been done in detail during the discussion of the relationships surrounding *Aphyosemion obscurum* on page 306.

A comparison too of the various colour pictures of these forms shows that they are fish that differ clearly from each other. This can be seen particularly well on the two colour pictures in AMIET (1987, colour plate 60, pictures 97 and 98) and also on plates 9/f and 13/b!

Diagnosis

This phenotype can also be regarded as a small frontier form of the "*cameronense*"-group, since the distribution area lies on the western edge of the inland plateau in south Cameroon. Its occurrence in the wild is not adequately known, with there being only two reported localities in the vicinity of one village. Further localities of this phenotype might possibly have been discovered (by SCHEEL?), but the *Aphyosemion* found would have been identified as *Aphyosemion cameronense*.

SCHEEL's collecting work and subsequent investigation of the karyotypes of populations around Lolodorf produced a high variability in the chromosomes, which points to the possible existence of distinct (genetically separated) forms of the "*cameronense*"-group.

Of interest is the occurrence of a regular pattern of spots, which as with Phenotype 4 from Bélinga consists of individual red spots which do not merge. The two forms however live exactly opposite each other on the frontiers of the "*cameronense*"-group. In addition Phenotype 4 has a "Yellow Blotch", so the two can on no account be placed together. The regular pattern of spots combined with what AMIET called the "copper coloured" body colouration are features that separate this phenotype from all the other representatives of the "*cameronense*"-group.

It was AMIET who first recognised that the body colouration of the males differed from that of *Aphyosemion cameronense* and *Aphyosemion obscurum*. In order to separate and distinguish this form from other phenotypes of the "*cameronense*"-group, he called it "Phenotype 1".

Discussion

It is extremely difficult to define or describe a distinct species from only two localities, especially when these streams are only a few kilometres apart from each other. Moreover the distribution area of the phenotype is not known exactly; lack of further localities make it impossible to give its geographical demarcation from *Aphyosemion cameronense* in the immediate vicinity of Lolodorf nor to say how far Phenotype 1 extends west of Mvilé in the direction of the coastal plain.

The special body colouration of the males is called by AMIET a "chromatic characteristic which is not observed in any other species of the group". We interpret this as a pointer to its unique position within the "*cameronense*"-group.

Up to the present day innumerable strains of members of this species group have become known, but none of them have this shade of colouring. Our attempts to reproduce this unique colour on colour slides have been successful in only very few cases.

In fact the colouration pointed out by Amiet can be seen both on wild fish (confirmed in Mvilé by Eberl, August 1991) and on wild fish and their progeny kept in the aquarium. To be able to see the full intensity of the reflected colours, it is necessary for light to fall on the fish at the correct angle. But it is just these colour features that are so difficult to capture with a camera.

The close similarity with *Aphyosemion cameronense* may be the reason why the differences from this species have not been noticed by collectors and scientists in the past.

Following Amiet we have tried to present these criteria in word and picture.

The description of a new species with just our present knowledge would be premature. But we hope a detailed investigation of this phenotype will take place in the future. For this one would have to know exactly what streams this phenotypes occurs in and whether there is a clear distribution frontier with *Aphyosemion cameronense*. Crossing experiments between the two forms and chromosome investigations could provide information on a possible genetic separation. This would, alongside the colouration of the males, provide further arguments for regarding this phenotype as a separate species, subspecies or just a colour form of *Aphyosemion cameronense*.

The distinct colouration patterns of *Aphyosemion cameronense* and the Mvilé population in direct comparison

Phenotype 2 from Nsessoum

Aphyosemion spec. aff. cameronense Phenotype 2 "HJRK 92/10"

History

As is the case with Phenotype 1, this representative of the "*cameronense*"-group may well have been found in the past and regarded as "*Aphyosemion cameronense*". In Radda & Pürzl (1976, bottom right on page 131 and top right on page 143) two males are depicted with anal fins showing the characteristics pattern of this phenotype. As these strains are no longer available as live fish, we cannot classify them with any certainty.

In March 1985 Amiet visited the area south of Ebolowa and spent three days in Nsessoum. In one of the streams fished at that time he found a form related to *Aphyosemion cameronense*, which differs considerably from another population in the immediate neighbourhood of the village. Colour pictures of two wild specimens are to be seen in Amiet (1987, plate 60, pictures 99 and 100). In August 1990 Eberl and others managed to get to Amiet's finding places in Nsessoum and bring back both populations with the codes *Aphyosemion cameronense* "EMS 90/4" and *Aphyosemion spec. aff. cameronense* Phenotype 2 "EMS 90/5". Although the first-named strain was successfully spread around in the hobby, the (more interesting!) second population did disappear from the tanks of killifish keepers around 1992.

In November 1992 HERZOG, JOCHIM and ROTH were able to return to Nsessoum to bring back Phenotype 2 once again, along with *Aphyosemion spec. aff. herzogi*, which is also present at the same locality, "HJRK 92/10". They fished in the stream that had previously been visited by AMIET in 1985 and EBERL and others in 1990. This strain was successfully distributed in the hobby, so we have had the opportunity to breed and photograph it.

Geographical Distribution and Known Localities

In recent times no intensive collecting work has been carried out especially around Ebolowa and along the road to Ambam, so at present only one locality is known in which this phenotype has been identified.

The following general map shows the position of this locality within the total "*cameronense*"-group:

The exact position of Nsessoum between Ebolowa and Ambam can be seen on the following map:

This stream lies about 400 metres south of the Ebolowa-Ambam road in the forest near Nsessoum. As one comes from Ebolowa, there is in the village a path that leads to the right between the huts to a plantation which then turns into forest. Finally one comes to a sluggish stream about 150 centimetres wide and 20 to 40 centimetres deep, flowing from left to right. It had been dammed by the villagers in order to provide them with an all year water supply.

On 17.08.1990 at about 11.30 a.m. the air temperature was 26°C and the water temperature 22°C. The water was clear and brownish. When one stepped into it, grey mud was stirred up. The third species present was a small barb which is typical for these biotopes in south Cameroon. The usual water insects, shrimps and tadpoles were very numerous.

The distances Ebolowa - Nsessoum and Nsessoum - Ambam respectively are not known exactly. We estimate the location of this village to be 64 kilometres south of Ebolowa and 27 kilometres north of Ambam. The geographical co-ordinates are 11°07' E and 02°31' N at 595 metres above sea level. The finding place is a stream that feeds the Nto, which flows into the Mboro, a well watered northern tributary of the Ntem.

The pictures in RADDA & PÜRZL (1976) which have already been mentioned make one think that this phenotype might occur in the vicinity of Ebolowa. The streams there, however, belong to the Mvila, another important tributary of the Ntem, which is why the question as to the precise distribution will not be answered properly until more material has been collected.

Syntopic Killifish

Aphyosemion spec. aff. *herzogi*

This form from the "*herzogi*"-group was found at the locality described above in equal numbers to Phenotype 2. The colour pattern and the olive-green to brownish colouration differ distinctly from the characteristics of *Aphyosemion herzogi* from the Zomoko area in Gabon, from where this species was described.

We cannot exclude the possibility that further collecting efforts around Ebolowas may also prove *Aphyosemion exiguum* and a form of the subgenus *Raddaella* to be syntopic with this phenotype.

Description

In its ground colouration Phenotype 2 resembles *Aphyosemion cameronense*, which is why we would also place it in the "blue" group.

Amiet (1987) gives on pp 114 and 239 a very good description of the body colouration of adult males, which we would like to repeat with slight alterations:

> The body ground colour is a rather pale metallic blue. The spot pattern is composed of an upper line of spots which are slightly fused or not fused at all, starting from the head and proceeding as far as the caudal peduncle, the spots becoming larger and larger towards the rear. Below is a second line consisting of two, three or four groups of fused spots. On the flanks a small number of single or twin spots can be seen. The medio-ventral band is rather narrow and of variable length.

According to his definition, this phenotype is particularly noteworthy on account of the colouration pattern of the unpaired fins, which Amiet describes as follows:

-Anal: it is crosssed almost in the middle by a wide red band with jagged edges; the base, coloured like the body, is decorated with some small, square or rectangular, interradial marks; the very developed margin is lemon yellow washed with green and slightly translucent; it has no equivalent in the other phenotypes of the "*cameronense*"-group.

-Caudal: its upper or lower margin, or both, are also tinted with yellow; the remainder of the fin is coloured like the body with small red marks; the posterior third is very dark, blackish.

-Dorsal: finely spotted with red on a metallic turquoise or golden background, its distal edge is pale golden, not spotted, or lemon yellow.

Amiet mentions also the existence of a single specimen with a very broad marginal band on the anal fin ("...3/4 of the anal..."), on which the red submarginal band had disappeared and the two marginal bands had a strong yellow colouration.

The wild fish and progeny of the "HJRK 92/10" strain originate from the same stream as the fish Amiet used for this colour description. The only differences between his fish and those available to us lay in the yellow colouration on the caudal fin. We observed that there are also specimens with a smaller proportion of yellow and rather more red spots on the flanks.

The following drawing gives a comprehensive picture of the factors that characterise Phenotype 2. In it we have referred both to the colour pictures in Amiet (1987) and to our own findings.

Relationships

This phenotype needs only to be separated from *Aphyosemion cameronense*, actually, since the spots on the flanks are not regular as in *Aphyosemion obscurum* and Phenotypes 1, 4 and 9; nor is an irregular arrangement of red spots to be seen, as in Phenotype 8.

Accordingly we can regard *Aphyosemion cameronense* as the "most closely related form". In contrast with other cases of related species and phenotypes, there is no geographical separation over considerable distances. Amiet (1987) also names a locality of *Aphyosemion cameronense* in Nsessoum. In fact this stream lies some three kilometres away from the village in the direction of Ambam (see under "EMS 90/4", page 279).

As in the description of this phenotype we have stressed above all the markings on the unpaired fins as a feature that distinguishes it from *Aphyosemion cameronense*, we would at this point like to point out the markings on the anal fin, which in this species always has a distinctly narrower marginal white to pale blue band as well as a submarginal red band. This characteristic makes it possible for the two forms to be differentiated easily.

Phenotype 2 from Nsessoum

In order to make clear the differences between *Aphyosemion cameronense* and Phenotype 2, we have illustrated on this page, one above the other, two males of the "HJRK 92/10" and "EMS 90/4" strains.

Aphyosemion spec. aff. cameronense "HJRK 92/10"

Aphyosemion cameronense "EMS 90/4"

It should be remembered that the two localities are only about three kilometres apart. But both streams run into the Mboro, which means that they belong to the same hydrographic system.

For this reason we have tried to illustrate this situation around Nsessoum and above all show how the two streams belong to the Mboro:

Diagnosis

Today we know of only two streams from which the populations come that Amiet was able to use to define this phenotype. Only one of them is to be found at present in the hobby. Radda & Pürzl's localities "24 kilometres west of Ebolowa on the road to Kribi" and "between Mvieng and Biton on the road from Ebolowa to Kribi" represent populations with similar colouration on the anal fin, but they are not available at present.

The distribution area could therefore stretch from Nsessoum to the west of Ebolowa, even if this means there is another hydrographic system. To the south-east this form is replaced after about three kilometres by a typically coloured population of *Aphyosemion cameronense*.

The only differences from that species are to be seen in the markings on the unpaired fins. To date this is the only case of populations with such divergent patterns of fin markings being known in streams of the same system lying so close to each other.

The area between Ebolowa and Nsessoum still needs closer investigation for representatives of the "*cameronense*"-group.

Discussion

People who criticise the practice of splitting *Aphyosemion* will surely argue that it is senseless, with just two localities, to regard as a distinct phenotype a form which at first sight differs so little from *Aphyosemion cameronense*.

However we share AMIET's opinion: the presence of two constant populations so near to each other requires a close examination of the situation. Obviously more detailed investigation is necessary to find out the relationship between the populations from around Nsessoum.

Such work could provide valuable information on genetic barriers between the individual populations and thus on their validity. Ultimately it cannot be a matter of chance when in one stream males are found with broad yellow marginal borders, whilst the fish in the next or next but one stream have an anal fin which is decidedly typical of *Aphyosemion cameronense*.

Certainly the phenomenon of Phenotype 2 must not be seen in isolation, since the principles valid in this case could be applied to the other representatives of the "*cameronense*"-group. In several cases forms of this group have been in immediate proximity to each other, some in different hydrographic systems, others in the same system. Here are some examples known to date:

-*Aphyosemion cameronense* and *Aphyosemion obscurum* near Bikok.
-*Aphyosemion cameronense* and Phenotype 1 (Lolodorf-Mvilé).
-*Aphyosemion cameronense* and Phenotype 3 (Djoum-Efoulan).
-*Aphyosemion cameronense* and *Aphyosemion haasi* north-west of Zomoko.
-*Aphyosemion cameronense* and *Aphyosemion maculatum* near Ebé.
-*Aphyosemion cameronense* and *Aphyosemion mimbon* (Egnieng Melen-Médouneu).
-*Aphyosemion cameronense* and Phenotype 7 west of Makokou.
-*Aphyosemion mimbon* and Phenotype 6 (Ntom-Etsam I).

What would be ideal would be further collecting work aimed at determining exactly the distribution area of this phenotype - at least on the roads which are now well surfaced. Then it could be said whether this phenotype has a relatively small distribution area, like the other forms of this species group which are not included in *Aphyosemion cameronense* itself. One would also know if there is to the north a clear distribution frontier with *Aphyosemion cameronense*.

In this case one could not exclude the possibility of the existence of transitional forms and natural hybrids.

In this connection comparisons would have to be made between the meristics, the chromosomes and possibly even, using electrophoresis, the protein structures of the populations. In addition the results thus obtained could be confirmed or refuted by crossing experiments. Even if it came to contradictions or to this or that phenotype being made synonyms, we would have learnt something in the process. The stagnation of recent years is not desirable at all.

The western populations of *Aphyosemion maculatum* (here a wild male of the "PEG 94/17" strain) have striking yellow fin borders

This is a specimen which, like the male illustrated above, was caught near Lolo I

Phenotype 3 from Djoum-Mintom

Aphyosemion spec. aff. cameronense Phenotype 3 "CGE 91/6"

History

In the seventies RADDA and PÜRZL also fished along the road which goes from Djoum in the south-west of Cameroon through Mintom to the frontier region with the Republic of Congo (at that time still the People's Republic of Congo). During a discussion with one of the authors on the killifish of Cameroon and Gabon, PÜRZL told him that at that time only "*Aphyosemion cameronense*" was caught to the east of Djoum. On this occasion PÜRZL had a colour slide of a male caught in this area with the Yellow Blotch, which he also called *Aphyosemion cameronense.* He also said he himself had caught fish looking like the one on the slide.

We are therefore sure that this form was caught at that time and probably even brought back alive to Europe, albeit with the name "*Aphyosemion cameronense*". These strains are no longer available in the hobby, nor do we have more detailed information on the precise location of possible finding places.

In April 1975 Jean Louis AMIET visited the village of Bindom just a few kilometres to the west of Mintom in south Cameroon, where he found a form of the "*cameronense*"-group with a clearly developed Yellow Blotch on the caudal peduncle. He found the same form in the village of Avobengon and between Mintom and Alati in June 1984.

In 1987 he called this form "*A. cf. cameronense* no. 3" and thus separated it from *Aphyosemion cameronense*. On Plate 61 there are pictures of four males (two from Avobengon and one each from Bindom and Mintom-Alati).

On pp 114 and 115 and 239 and 240 Amiet gives the reasons for his separation of this phenotype and suggests an explanation for its existence (and for that of *Aphyosemion amoenum* and *Aphyosemion halleri*) on the edge of the "*cameronense*"-group.

These arguments were good enough grounds for Grell and Eberl to investigate the road from Djoum to Bindom in August 1991 and to bring back some populations of the form with the Yellow Blotch on the caudal peduncle.

The "CGE 91/6" strain was subsequently distributed successfully in the hobby. As a result colour pictures and live progeny are available.

As far as we know, no further collecting work has been done to the east of Djoum since 1991. No publications on the existence of this form have been published, so we are in a position here to present it in detail for the first time.

Geographical Distribution

From the knowledge we have, this phenotype is a frontier form of the "*cameronense*"-group in south Cameroon, whose distribution area also seems to be relatively small. As this area is of limited access, it is only possible to collect fish along the road that runs from west to east between Djoum and Mintom. The road taken by Amiet in 1985 from Mintom to the south in the direction of Alati has since then been used less and less. It has not been maintained, and so for years now it has not been usable.

The most westerly known finding place lies near the village of Efoulan, 16 kilometres east of Djoum; the most easterly is Bindom near Mintom. Both to the north and south of this road it is not possible to collect fish at the moment. We do not have more information on the precise location of the finding place on the road from Mintom to Alati, so the south-easterly distribution frontier cannot be determined.

The streams between Djoum and Mintom belong to the drainage of the Dja, whereas Amiet (1987) says the locality between Mintom and Alati is a tributary of the Ayina and thus of the Ivindo basin. We cannot verify this at present.

To the west this phenotype is replaced by *Aphyosemion cameronense*, which Grell and Eberl were able to find just 200 metres or so from the Catholic Mission in Djoum on 07.08.1991.

Amiet (1987, pp 115 and 240) reports that Phenotype 3 is replaced to the north-west, west and south-west by *Aphyosemion cameronense*, but in the east representatives of the "*wildekampi*"-group were found (see also pp 116 and 117).

This tells us that this markedly divergent form occurs at the edge of the "*cameronense*"-group, which is why we would like to show the distribution of Phenotype 3 with the general map on the following page.

The road from Djoum to Mintom is 80 kilometres long. Up until the eighties there was a road that continued from Mintom, which could be driven along for some 70 kilometres south to Alati. On one of our road maps of Cameroon there is even another road marked, which went for 75 kilometres to Mbalam on the frontier with the Republic of Congo.

In August 1991 GRELL and EBERL tried to advance from Mintom further in the direction of the Republic of Congo. However, they were informed by the sisters of the Catholic Mission, the Gendarmerie in Djoum and also by the villagers of Bindom, that the road from Mintom was no longer usable. A large number of trees had fallen across the road and needed to be cut up by chain-saw.

The following map is an attempt to show the Djoum-Mintom road and the localities known there more precisely. We have refrained from showing the area to the east of Mintom, as it is no longer possible to fish there.

Known Localities

"Avobengon" is a locality in Amiet (1987, pp 115 and 239), of which two males are shown in colour on Plate 61.

This village lies 30 kilometres east of Djoum, the geographical co-ordinates are 12°53' E and 02°40' N at 610 metres above sea level. Near the village is where the Avo rises, which flows north into the Momo, a southern tributary of the Dja.

The spelling of the name of this village is different on our maps from that given by Amiet ("Avobengono"), but it is certainly Avobengon, which was moreover confirmed by Grell and Eberl's enquiries: see also under "CGE 91/1".

Amiet took the wild fish to Yaoundé to study and photograph them there, which is why no live specimens reached Europe from this and his subsequent localities.

"Bindom" is also named by Amiet (1987) as a locality of this phenotype. This village lies only three kilometres west of Mintom. The geographical co-ordinates were read from our maps as 13°14' E and 02°41' N at 607 metres above sea level.

Near Bindom rises the Kowa, which flows twelve kilometres north as the crow flies before running into the Dja.

On pp 115 and 240 Amiet emphasises that in 1975 he was able to find in Bindom a form with a fully developed yellow caudal peduncle, whereas in 1981, only six years later, he found a "population of typical *cameronense*". When he investigated the localities for the third time in July 1984, the last named form still existed in the biotope.

The experiences of Grell and Eberl in August 1991 confirmed these changes, since they too could find "only" *Aphyosemion cameronense* (see also **"CGE 91/3"**).

The locality of *Aphyosemion spec. aff. cameronense* "CGE 91/1" near Avonbengon

"Mintom" is Amiet's designation for the third locality named by him. It is a small town, whose geographical co-ordinates we can give as follows: 13°18' E and 02°42' N at 607 metres above sea level.

Near this place rise the Kon and the Ebé, which join to the north of Mintom and after a few kilometres run into the Dja.

In order to avoid a long stop at the Gendarmerie there (the friendly conversation in Djoum had already wasted a lot of valuable time) Grell and Eberl did not look for this locality. Thus at the present time more precise information on its location and the colouration of adult males is not available to us.

"Close to the Mintom-Alati road" is the designation given to the fourth locality in Amiet (1987). The only information on its position is "...is probably part of the hydrographic network of the Ayina, a tributary of the Ivindo".

Just eight kilometres south-east of Mintom one reaches the area of the source of the Koumou, which flows south-west into the Ayina (13°19' E and 02°37' N). However, as all the streams going south-east along the road to Alati also belong to the drainage area of the Ayina, we cannot at present determine this locality of Amiet's accurately. It could be anywhere on a 60 kilometre stretch (from PK 8 Mintom to almost as far as Alati itself)!

"CGE 91/1" is the code for the first locality of Wolfgang GRELL and Wolfgang EBERL's Cameroon trip. On 08.08.1991 at about 8.30 a.m. they reached the village of Avonbengon (AMIET: Avobengon), having driven from Djoum. The inhabitants clearly remembered AMIET being there and collecting fish from a nearby stream. They took the collectors to the 'Otongbibé' stream.

Together with *Epiplatys sangmelinensis*, three different barb species, small catfish and numerous shrimps and crabs, they did in fact find a form of the "*cameronense*"-group which actually corresponded to the males illustrated in AMIET (1987).

Unfortunately it was not possible to spread this strain around the hobby.

"CGE 91/3" refers to the third locality of this trip, which was visited some three hours later near Bindom. The name of the stream previously visited by AMIET and only about a kilometre west of Bindom was reported to be the 'Sehnsimi' by the villagers.

In the very small stream which crosses the road from south to north the undergrowth gave very little room to move while catching fish. In the very shallow water a large number of fully grown specimens were caught, but in fact they corresponded more to *Aphyosemion cameronense* than to Phenotype 3. No Yellow Blotch was to be seen!

In fact this seemed to be a case of one representative of the "*cameronense*"-group being replaced by another. We will go into this phenomenon in more detail in the section Discussion.

This strain is no longer in the hobby either.

"CGE 91/4" refers to a stream of unknown name near Zo'otou (Zouatou) about six kilometres west of Bindom. The geographical co-ordinates are 13°10' E and 02°41' N at 618 metres above sea level. This village lies in the drainage area of the Memyan, which to the north joins with the Abée and flows into the Menyin, a tributary of the nearby Dja.

The stream is about a metre wide and only ten centimetres deep. In it were found a barb species and Phenotype 3. Attempts to get this strain distributed in the hobby failed.

"CGE 91/5" was visited on 08.08.1991 at about 3.30 p.m. The 'Elik' stream is about 400 metres north of the village of Alop. The geographical co-ordinates are 13°3' E and 02°43' N at 647 metres above sea level.

Near Alop rises the Mvoulou, which further north joins the Fé and then flows directly into the Dja.

The air temperature was 25°C and the water temperature 22°C. Together with Phenotype 3, *Aphyosemion exiguum* and a few barbs were present. The narrow stream was about one metre wide, extremely shallow and muddy. Poor lighting conditions made photographing the biotope an impossibility.

This strain too failed to be spread around the hobby, so there are no live specimens of this locality available.

"CGE 91/6" is the last locality of this trip where Phenotype 3 was found. The distance from the village of Efoulan has already been given on page 386. The geographical coordinates of the stream Evameka'a we determine as 12°46' E and 02°39' N at 624 metres above sea level.

The streams around Efoulan run into the Ngoundou, a tributary of the Ndamében, which flows into the Avo and then into the Momo, a southern tributary of the Dja.

In August 1991 the Evameka'a was remarkably small, being one metre wide and about 20 centimetres deep. The bottom was again covered with mud.

As well as Phenotype 3, *Aphyosemion exiguum* and *Barbus* spec. aff. *jae* were identified. This strain has been distributed in the hobby, which made possible the colour pictures published in this book.

This locality must on no account be confused with strain "C 89/39" from the village of the same name on the Lolodorf-Ebolowa road (see also page 277). In this case Efoulan is not the same Efoulan, which is a good example of the advantage of using the locality code (cf page 267).

Syntopic Killifish

Aphyosemion exiguum
Epiplatys sangmelinensis

We cannot exclude the possibility that in the course of further collecting between Djoum and Mintom a semi-annual killifish species in the form of *Aphyosemion batesii* might be found together with Phenotype 3.

Description

This phenotype differs considerably in appearance from *Aphyosemion cameronense* and what we call the "blue" group, since the Yellow Blotch is clearly visible on all the males of one population (to date only one exception has been known of, see page 395).

This means a close relationship with *Aphyosemion amoenum* and *Aphyosemion halleri*, which Amiet (1987, pp 115 and 240) expresses as follows:

> "Because of the yellow colouring of its peduncle, this *Aphyosemion* is close to *A. amoenum* and *A. halleri* but, by the rest of its other chromatic characteristics, it remains close to *A. cameronense*."

In the description of the colour pattern Amiet (1987) points out that the colouration on the anal fin strongly resembles the *Aphyosemion cameronense* populations with its marginal white and sub-marginal red band.

At the same time he calls the constant Yellow Blotch of this phenotype an "important characteristic".

Amiet (1987) on pp 115 and 239 enumerates some features which separate it from *Aphyosemion cameronense*. He calls these "less sustained" (= more subtle). The essence of his argument is as follows:

- -The marginal band on the anal and the lower band on the caudal are generally a pure white (only slightly whitish on *Aphyosemion cameronense*).
- -The red pigmentation on the caudal fin is frequently very dense; on many populations the central area of the fin seems to be almost black.
- -The end of the anal and sometimes even the corners of the caudal may on the largest males have very slight extensions.
- -The spots tend to form an arrangement in several lines in the front part of the flanks; on *Aphyosemion cameronense* they usually consist of one single line.

Our observations in the field as well as with wild fish and progeny of populations "CGE 91/6" in the aquarium only partly confirm these distinguishing characteristics, since the spots on the flanks are in fact arranged in one line as on *Aphyosemion cameronense*.

The large amount of red colour elements on the caudal fin is especially noticeable when the males are kept in dark tanks. But is difficult to capture this colouration on a photograph.

On the basis of our experience, however, we would say that the other criteria are absolutely to the point. The following drawing represents a schematised male with the special characteristics of Phenotype 3:

Phenotype 3 from Djoum-Mintom

The inhabitants of Avobengon share the collectors' joy and show with pride *Aphyosemion spec. aff. cameronense* Phenotype 3, which were caught at an old locality of AMIET's

A female of *Aphyosemion spec. aff. cameronense* Phenotype 3 "CGE 91/6"

Relationships

Being a representative of the "*cameronense*"-group with a constant and clearly developed Yellow Blotch, we place Phenotype 3 close to the species *Aphyosemion amoenum*, *Aphyosemion halleri* and Phenotypes 4, 5 and 9.

However in most cases there is a clear geographical separation from these forms. This is shown by the following distances (with the starting point for Phenotype 3 being "Efoulan"):

-From *Aphyosemion amoenum* 258 kilometres to Mbanga.
-From *Aphyosemion halleri* 146 kilometres to Eking.
-From Phenotype 4 180 kilometres to Bélinga.
-From Phenotype 5 270 kilometres to Koumaméyong.
-From Phenotype 9 254 kilometres to Ngoyang.

Between Phenotype 3 and the forms named here *Aphyosemion cameronense* has always been found, so that they are separated from each other by this species.

Only between the Djoum-Mintom road and the vicinity of Bélinga (Phenotype 4) has it so far been impossible to collect fish, owing to the lack of roads.

There is no difficulty in separating Phenotype 3 from the other "yellow" representatives of the "*cameronense*"-group using the colouration characteristics of the males:

-*Aphyosemion amoenum* has an anal fin with completely different markings; the dorsal and marginal bands of the dorsal usually have a strong yellow colouring.
-*Aphyosemion halleri* has no marginal white band on the anal fin; instead this fin is coloured red in the distal area; on many specimens a very narrow border is visible. The caudal has asymmetric markings.
-Phenotype 4 has no white marginal band on the anal fin, and on the flanks there are considerably more red spots in several parallel rows. These spots do not tend to merge with each other.
-On Phenotype 5 the zig-zag band is virtually absent and the pattern of spots on the flanks much less defined. The anal fin also lacks a marginal pure white band across its width; the caudal is spotted.
-Phenotype 9 has a smaller Yellow Blotch on the caudal peduncle, and the spots on the flanks are well developed; as in *Aphyosemion obscurum* they form regular rows consisting of red spots, which merge into each other. The pattern of markings on the anal fin is similar, but the distal area has stronger red markings.

Diagnosis

AMIET's splitting of this phenotype from *Aphyosemion cameronense* is justified because of the Yellow Blotch and the geographical distribution on the eastern edge of the "*cameronense*"-group. All the populations collected in the wild showed in every specimen a constant body colouration.

Only at locality "CGE 91/5" did GRELL and EBERL find a single male with neither the Yellow Blotch nor any form of red pigmentation on the flanks. This was probably an extremely rare occurrence of mutation.

In the western frontier with *Aphyosemion cameronense* near Djoum no transitional forms have been found so far; the smallest distance known at present between the two forms (Djoum-Efoulan) amounts to 16 kilometres.

It is interesting that as was demonstrated by AMIET and (for the third locality "CGE 91/3") conformed by GRELL and EBERL, a form with the Yellow Blotch was discovered near Mintom and Bindom, but that years later only *Aphyosemion cameronense* could be found. We know of similar observations from the area around Eboro in north Gabon, where BARDIN and LOMBARD were able to show *Aphyosemion halleri* to be syntopic with a purely blue form (*Aphyosemion cameronense*?) (see also under **"GBL 85/19"** on page 325) and PASSARO and EBERL eight years later could only find *Aphyosemion cameronense* (**"PEG 94/24"**, page 290).

AMIET also states that he was able to find this Phenotype 3 near Avobengon, but that a year later ("in the space of a single year", presumably 1985) *Aphyosemion cameronense* was present. A few years after AMIET, GRELL and EBERL found in certainly the same biotope ("CGE 91/1") only males with the Yellow Blotch, which corresponded fully to AMIET's definition of this phenotype.

These changes in the wild are difficult to explain, but it is an established fact that the "CGE 91/6" strain has kept its characteristic colouration features within AMIET's definition, with no specimens occurring without the "Yellow Blotch".

Discussion

Phenotype 3, as defined by AMIET, is probably the form in his 1987 book that differs most from *Aphyosemion cameronense*. The prominent Yellow Blotch, the distribution on the edge of the "*cameronense*"-group and the changes mentioned by AMIET in the appearance of the males within a short period make a long overdue revision of this species group all the more urgent. We are convinced that this phenotype can be described as a separate species, when the following considerations are borne in mind:

- The characteristic of the Yellow Blotch is present as a constant feature within the populations.
- The distribution area lies in the southern drainage area of the Dja; so there is no watershed between Efoulan and Djoum, where the streams belong to the Miété and then to the Ayina.
- The presence of other phenotypes in the frontier area of the "*cameronense*"-group strengthens AMIET's theory that an old form with a Yellow Blotch once existed over a large part of the distribution area of this species group and has since been put under pressure by *Aphyosemion cameronense* ("younger, more dynamic and more successful"). This led to the splitting up into several independent species (see Summing-up).

Phenotype 4 from Bélinga

Aphyosemion spec. aff. cameronense Phenotype 4 "Bélinga"

History

When in 1986 the Frenchmen LAMBERT and GÉRY looked for killies in the north of Gabon, they also got as far as Bélinga, which at that time was a flourishing town. In this region gold, diamonds, iron, nickle and uranium were mined.

Their collecting efforts led in 1968 to the first descriptions of "*Aphyosemion georgiae*" and "*Aphyosemion cyanostictum*", which we now place in the genus *Diapteron* HUBER & SEEGERS, 1977.

They fished in streams near Bélinga and the railway station being built at the time. They found an *Aphyosemion* form which did not attract any attention at the time, as it was placed in *Aphyosemion cameronense*.

In February 1987 NUMRICH and others arrived in Bélinga to investigate the type localities of the two *Diapteron* species or at least biotopes in the immediate vicinity of LAMBERT and GÉRY's finding places.

In a stream about five kilometres west of Bélinga on the road to Mayebut (Mayebout, Mayibout) they found the two *Diapteron* species, *Hylopanchax silvestris*, *Epiplatys sangmelinensis* (*Epiplatys neumanni*?) as well as *Aphyosemion punctatum* and "a variant of *Aphyosemion cameronense*" living syntopically.

The import of the last named strain was successful and in 1989 NUMRICH published in the DKG-Journal a description of the finding place: "Typuslokilität: Bélinga (Gabon)" (see also bibliography). The author of this article recognised the differences from *Aphyosemion cameronense*, which is why the caption on page 11 uses the concept "variant of *Aphyosemion cameronense*".

Over the years the "Bélinga" strain has been spread around to a few aquarists fond of the small *Aphyosemion*; hence it is still distributed in the hobby today.

During their 1990 Gabon trip, Allan and Barbara BROWN tried to drive on the road from Makokou to Bélinga, but in the intervening period the bridge over the Zadié had collapsed and been left in a state of disrepair (in the meantime Bélinga had been abandoned), so it was impossible to get there.

Following enquiries in Makokou by one of the authors in January 1993, it was learnt that the only way to get from Makokou to Mayibout was by pirogue on the Ivindo.

In August 1994 PASSARO and EBERL hired from Léon OESTREICH in Makokou a one-engined pirogue. An inhabitant familiar with the area took them from Makokou to Mayibout. It was not possible to carry out the planned walk in the direction of Bélinga (18 kilometres) owing to lack of time. Fishing near Mayibout only produced a cichlid species which could not be classified.

Geographical Distribution and Known Localities

The area around Bélinga has been fished only by LAMBERT and GÉRY and NUMRICH and others. So the only known localities in this region are the ones mentioned above. At the present time the distribution area of this phenotype can only be given as a dot, as is shown on the general map on the next page.

Collecting here is not to be expected in the near future, as Bélinga is no longer inhabited and the area around Mayibout seems to be becoming more and more isolated. With the withdrawal of the European firms from Bélinga, interest in the building of roads into this region has declined.

For years now the Mayibout-Bélinga stretch has been impassable, as there are no cars in working order in either of these places. The planned building of a railway connection with Makokou and Libreville (LAMBERT & GÉRY, 1968 in the first description of *Diapteron georgiae*: "...au futur terminus du chemin de fer..." = "at the future railway terminus") never materialised. This is another situation similar to that of *Aphyosemion haasi*.

We would like at this point to give a description of the biotope visited by NUMRICH and others, which we base on the data in the article mentioned above.

According to our maps, the stream crossing the road from north to south could be one of two streams. The points where they meet the road have the geographical co-ordinates 13°10' E and 01°07' N and 13°09' E and 01°07' N. The height above sea level cannot be determined. South of the road both streams flow to the west and after a few kilometres run into the Ivindo near Mayibout (see the map at the bottom of page 398).

Phenotype 4 from Bélinga

NUMRICH (1989, page 9) describes the locality as follows: "...small, really fast flowing stream, whose character changes dramatically every 200 to 300 metres. Some 50 metres from the road into the forest, the bottom of the stream bed is covered with large pieces of rusty iron. Only after about 150 metres does it get the appearance we know from the killifish biotopes in Gabon: almost 50 centimetre deep bog of mud and leaves, interspersed with wood and large tree roots. The stream had dug itself deep into the narrow valley, so one was forced to work upstream through the bog".

According to NUMRICH's findings, *Aphyosemion spec. aff. cameronense* lived principally "in the residual pools and dead stream arms", whereas the *Diapteron* were always to be found in the flowing water.

Syntopic Killifish

Aphyosemion punctatum
Diapteron cyanostictum
Diapteron georgiae
Epiplatys sangmelinensis/*Epiplatys neumanni* (?)
Hylopanchax silvestris

In the first descriptions of the two *Diapteron* species, *Aphyosemion splendidum* (= *batesii* or *kunzi*?), *Aphyosemion exiguum* and *Aphyosemion calliurum ahli* (= *Aphyosemion punctatum*!) were mentioned, but these were not found by NUMRICH. But we do not think it impossible for these species to occur syntopically with Phenotype 4 in the vicinity of Bélinga.

Description

Phenotype 4 obviously belongs to the "yellow" group and is its most south-easterly representative. The metallic light blue to light green ground colour of the front part of the body corresponds to the shade of colour we know from the other members of the "*cameronense*"-group. In our tank bred progeny the rear part of the body is an intense orange-red colour, which provides a slight difference from the other forms with the Yellow Blotch.

The numerous red spots on the flanks give the general impression of a reddish-orange coloured fish. There is a clear tendency for parallel lines to be formed from individual red spots (as in Phenotype 1).

The medio-ventral band and the zig-zag band are developed to an average degree with regards to width and extent.

The ground colour of the dorsal and caudal fins is light blue. They have on them a large number of roundish red blotches.

The anal fin has a whitish to pale blue marginal band, which is edged by a submarginal red border. The distal area of the fin has a similar pattern to the dorsal and caudal, but the blotches seem to be a little longer and less numerous. The drawing at the bottom of page 400 shows a schematised male of this phenotype.

Monsieur Léon Oestreich lives in Makokou and hires out small boats to tourists. He enabled us to have a really unforgettable river trip in a pirogue, which took us 80 kilometres north to Mayibout

Mayibout lies on the eastern bank of the Ivindo and today is only accessible by boat, as the road from Makokou via the nearby Bélinga is no longer passable due to the collapsed bridge

Our boatman Beaudelaire knows all about the Ivindo and its tricks!

Relationships

The special colouration characteristics allow us to place this phenotype into two "groups" simultaneously.

The numerous red spots arranged in lines on the flanks enable us to place this phenotype with *Aphyosemion obscurum* and Phenotypes 1 from Mvilé and 9 from Ngoyang into the "striped" group.

The geographical separation is given below as the distances between Bélinga and those forms:

-From *Aphyosemion obscurum* 350 kilometres to Bikok.
-From Phenotype 1 about 320 kilometres to Mvilé.
-From Phenotype 9 some 360 kilometres to Ngoyang.

On the other hand, however, the Yellow Blotch makes it possible to place it in the "yellow" group. The geographical distances separating the other species and phenotypes with this feature have already been given under *Aphyosemion amoenum*, *Aphyosemion halleri* and Phenotype 3.

As Phenotype 4 combines the characteristics of the "yellow" and the "striped" groups, the only differentiation needed for colouration characteristic is with Phenotype 9. The other forms with the Yellow Blotch have, as is well known, strongly divergent red pigmentation on the flanks:

-The red spots merge on the flanks in Phenotype 9, whereas in Phenotype 4 a red spot appears to lie on each individual scale.
-The caudal of Phenotype 9 is heavily streaked in the central area and not covered with round blotches.
-Phenotype 9 has a much smaller Yellow Blotch on the caudal peduncle, on the fish from Bélinga the whole caudal peduncle is orange in colour.

Diagnosis

The representatives of the "*cameronense*"-group which were brought back from a stream five kilometres to the west of Bélinga on the road to Mayibout and distributed in the hobby are a very divergent phenotype.

The Bélinga area was fished for killies only in the sixties and in 1987. The only road to it has not been used or repaired since the end of the eighties, so any collecting in the area around the town, which has since been abandoned, is only possible if ones starts out from Mayibout. This could entail a long journey on foot to get to NUMRICH's finding place.

The presence of a phenotype with a clearly developed Yellow Blotch and also a regular pattern of spots on the flanks in north Gabon seems to be the continuation of the first mentioned characteristic of Phenotype 3 to the south. The relationship between the two "yellow" phenotypes cannot be investigated due to the lack of roads in the area covered.

Nevertheless differences in the pigmentation of the flanks and also in the markings of the unpaired fins can be recognised. Moreover these two phenotypes inhabit completely different hydrographic systems (the Dja and the Upper Ivindo).

Discussion

In this case it can be argued that a single locality may not be sufficient to draw lasting conclusions on the geographical distribution and the classification of this phenotype with regard to the other representatives of the "*cameronense*"-group.

This is made especially difficult by the fact that Bélinga lies in the frontier area between Cameroon, Gabon and the Republic of Congo, which means there are no passable roads there. We will not be able to expect further information on the appearance of the representatives of the "*cameronense*"-group until either new roads are built in the Bélinga neighbourhood or the existing one is reinstated. And that may take time!

In the meantime we shall have to be satisfied with the knowledge that is available to us at present. The characteristics mentioned by us that distinguish this form from the other species and phenotypes of the "*cameronense*"-group surely provide enough arguments for regarding it at least as not belonging to *Aphyosemion cameronense* or any other representative.

This is suggested by two factors in particular: the Yellow Blotch and the regular markings on the flanks.

Those who consider *Aphyosemion amoenum* and *Aphyosemion halleri* to be distinct species or subspecies should not think of the population from Bélinga as belonging to *Aphyosemion cameronense*, even if this is the common practice among many killifish keepers. An objective discussion of the Bélinga "problem" becomes all the more urgent when one bears in mind the presence of other phenotypes with the Yellow Blotch in the frontier regions of the "*cameronense*"-group.

Admittedly fish have not been collected from the east of Bélinga into the Republic of Congo, but it seems as if *Aphyosemion punctatum* would increasingly occupy the biotopes suited to both species groups and finally replace the "*cameronense*"-group to the east of Makokou in the direction of Mékambo. If this were also true to the north of the Makokou-Mékambo road, the Bélinga form would represent a genuine frontier form in the same way as *Aphyosemion amoenum* and Phenotypes 3, 5 and 9 do (see also **Summing-up**).

Crossing experiments together with morphological, meristic and genetic investigations we have urged for on several occasions would be of great significance.

What is the relationship between Phenotype 4 and the populations of *Aphyosemion cameronense* from Latta ("GWW 86/2") and the area around Makokou? Are *Aphyosemion amoenum*, *Aphyosemion halleri* and Phenotypes 3, 5 and 9 interfertile?

If these forms were incapable of hybridizing, this would provide an argument for the raising of these phenotypes to separate species!

Phenotype 5 from Koumaméyong

Aphyosemion spec. aff. cameronense Phenotype 5 "LEC 93/12"

History

One of the first aquarists to collect methodically and thus gain valuable knowledge on the habitats and the appearance of *Aphyosemion* in West Africa was Wolfgang Herzog. In 1972, together with Franz Bochtler, he visited north Gabon. They found a population of the "*cameronense*"-group to the south of Koumaméyong on the road to Booué. At the time they called it "*Aphyosemion cameronense* yellow". Unfortunately this strain has disappeared from the hobby.

In December 1975 Radda and Pürzl went on collecting trip "G 75" to north Gabon, which provided systematic data on the distribution of representatives of the "*cameronense*"-group in its southern distribution area. In their article "Der *Aphyosemion cameronense*-Komplex" of 1976, there is at the bottom of page 133 a picture of a pair of a population which came "from a stream in the rainforest 24 km east of Koumaméyong, north Gabon".

In their 1977 publication "*Cyprinodontiden*-Studien in Gabun, II. Nordgabun" Radda and Pürzl published a table of localities which contains under code "G 39/75" a locality with the identical geographical position.

We assume that it is the same finding place.

Although only black and white photographs of the "G 39/75" strain are available to us, we place this population with the phenotype which HERZOG and BOCHTLER had described as "yellow".

As already mentioned, further collecting work was subsequently carried out in north Gabon, and certainly the area around Koumaméyong was fished. But we do not have any information as to whether this "yellow" phenotype was one of the fish brought back to Europe. It was not until 1980 that Jan PAP managed to bring back the "GJP 80/14" population ("Bélémé", "Beleme") from the Koumaméyong-Ovan road. For some time this strain was wrongly called "*Aphyosemion cameronense*". It was bred by aquarists but has now unfortunately disappeared from the hobby.

In 1986 BARDIN, HOUDU and LOMBARD found this phenotype west of Ovan, but they called it "*Aphyosemion halleri*". In 1990 Barbara and Allan BROWN also fished in the Koumaméyong vicinity. 2.2 kilometres west of the Lalara-Booué-Ovan crossroads they found their "GAB 18/90" strain. However, it did not survive long in the hobby after its import to Great Britain. In July 1992 GRELL travelled in the north of Gabon. On the western outskirts of Koumaméyong he too found this phenotype with the striking Yellow Blotch ("GBG 92/21").

January 1993 finally saw something of a breakthrough when LEGROS, CERFONTAINE and EBERL managed to bring back the strains "LEC 93/2" from Koumaméyong and "LEC 93/12" from Souganlam. Their distribution among aquarists has ensured that this superb phenotype will have a firm place in the hobby.

The findings acquired over recent years encouraged PASSARO and EBERL in August 1994 to investigate the distribution frontiers and the relationships of this phenotype with other *Aphyosemion*. With strain "PEG 94/15" a third population of this divergent representative of the "*cameronense*"-group was brought back to Europe.

Geographical Distribution

This phenotype was thoroughly investigated, as far as circumstances permitted and along the passable roads. All that is still missing is information from the Koumaméyong-Booué road, which would establish with more certainty where the southern distribution frontier lies (north of Koumaméyong there are no roads at present).

This road has been driven along on many occasions (GRELL 1992; LEGROS, CERFONTAINE and EBERL, 1993; PASSARO and EBERL, 1993). However collecting efforts failed due to lack of streams, climatic problems or simply pressure of time.

The most westerly known locality of this phenotype known today lies 2.2 kilometres west of the Koumaméyong crossroads. Only as far away as between Djidji I and Djidji II, PASSARO and EBERL discovered *Aphyosemion cameronense* (see also "PEG 94/6", page 289).

To the east the distribution area extends as far as a stream 26 kilometres west of the bridge in Ovan; just six kilometres to the east is where the distribution area of the "blue" form of *Aphyosemion maculatum* begins (see also "PEG 84/14", page 350).

The general map shows that this phenotype has been found on the southern edge of the "*cameronense*"-group. Thus it occurs at a great distance from the other species and phenotypes with the Yellow Blotch.

On our second map one can see the localities known to date along the Lalara-Ovan road, together with the occurrence of *Aphyosemion cameronense* as well as of *Aphyosemion maculatum* in its "yellow" and "blue" forms in this area of such ichthyological interest.

The exact position of these localities is shown - as far as is known - in the following section.

We cannot exclude the possibility that between the distribution frontiers near Djidji II and at locality "PEG 94/15", collectors might discover further localities where this phenotype occurs. Then it would be important to investigate the road to Booué.

Known Localities

"South of Koumaméyong" is the locality description of the stream that Herzog and Bochtler discovered on the road to Booué. Unfortunately we do not know a relevant distance, proximity to a village or the name of the stream, so we cannot determine the exact location.

What is certain is that the stream lies in the drainage area of the Ké, which flows from north to south parallel to the road in the direction of Booué, where it runs into the Ogooué.

This strain was not distributed in the hobby, nor are there any colour pictures. Nevertheless our experience suggests it should be included in this phenotype, due to the hydrographic factors and the fact that the collectors called it "yellow".

"G 39/75" is the code used by Radda and Pürzl for the 39th locality of their Gabon trip in 1975. They started in Koumaméyong, measuring the distance in the direction of Ovan. 24 kilometres east of Koumaméyong they found a stream by the road, in which they found the pair depicted on page 133 in their 1976 publication.

The Koumaméyong-Ovan stretch is 52 to 53 kilometres long, so this finding place should be about 28 kilometres west of Ovan. Our measurements in the field suggest that it is quite likely to be the 'Bélémé' ("Bèlém") stream, which was then later fished by Jan Pap.

The geographical co-ordinates for the bridge over the Bélémé are 11°59' E and 00°18' N at 461 metres above sea level. The Bélémé flows south and runs into the Ivindo near Booué. This strain did not last long in the hobby.

"LEC 93/2": a locality of *Aphyosemion spec. aff. cameronense* Phenotype 5 near Koumaméyong. Both in January and July 1993 the water level was very low and the bottom covered with mud and leaves

"GJP 80/14" is the locality code which the Dutchman Jan Pap used for the 14th locality of his Gabon trip in 1980. The name used in the hobby was "Beleme" or "Bélémé", which we think suggests that the locality is the same as the "Bèlém" or "Bélémé" stream, or at least that it is in the immediate neighbourhood. We therefore cannot exclude the possibility that this is the stream which we have already described under the presentation of locality "G 39/75" on the previous page.

Investigations in the field by Legros, Cerfontaine and Eberl (1993) as well as by Passaro and Eberl (1994) showed that the Bélémé is in fact too wide for *Aphyosemion* in January as well as in August (both in dry seasons). On each occasion the water was too wide and deep to try catching fish. Experience has shown that in streams of this size killies are only to be found in small quantities.

Jan Pap had found *Diapteron georgiae* alongside Phenotype 5. Both strains were brought back to Europe and bred (there are some colour pictures of both killies), but they disappeared from aquarists' tanks towards the end of the eighties.

Coming from Booué one reaches the crossroads near Koumaméyong, where one passes this road sign. A narrow footpath leads from the right of the sign for about 400 metres into the forest to locality "LEC 93/2"

This wild male comes from Koumaméyong ("LEC 93/2")

"GBHL 86/19" is a stream, whose position is given by BARDIN, HOUDU and LOMBARD as 26 kilometres west of Ovan.

If one takes into account the inevitable slight variations in measuring distances by various authors, this locality could be the same as the stream "G 39/75" in which RADDA and PÜRZL fished. It could also be locality "GJP 80/4" or locality "PEG 94/15".

What would be helpful in this context would be the width of the stream being investigated, its position in relation to the road and the direction of the current. What is certain, however, is that these three localities must all be very close to each other.

In February 1986 the three collectors found Phenotype 5, *Diapteron georgiae* and *Epiplatys neumanni*. Unfortunately this strain has died out in the hobby.

"GWW 86/12" refers to the locality that WAGNER and WENDEL fished "10 kilometres before Koumaméyong" on 08.01.1986. As they had come from Makokou, the stream lies 10 kilometres to the east of this village. We guess the geographical co-ordinates to be 11°57' E and 00°14' N. The height above sea level cannot be determined.

The two collectors reported finding "*Aphyosemion cameronense*" and *Diapteron georgiae*, but the geographical location suggests to us that the fish was Phenotype 5. Unfortunately no live specimens were brought back from this locality.

PASSARO and EBERL's attempts to find this locality in July 1993 proved fruitless.

"GBG 92/21" is GRELL's 21st locality of his 1992 trip. It lies directly at the crossing of the Lalara-Ovan-Booué roads. The stream crosses the road from south to north.

Koumaméyong lies just half a kilometre to the east of the crossroads, and its geographical co-ordinates are 11°52' E and 00°13' N at 455 metres above sea level. The stream of unknown name flows into the Nté, which further south is called the Ké. Just a few kilometres to the north of the Ivindo it runs into the Bélémé.

A second killifish species was found in *Diapteron georgiae.* We do not know anything about the distribution of this strain in the hobby at the present time.

"LEC 93/2" is the code for the second locality of this trip. It is a small stream which was shown to LEGROS, CERFONTAINE and EBERL on 08.01.1993 at about 10 a.m. by a friendly forest dweller on the right side of the road coming from the south (i.e. to the east of it).

The distance to the point where the road from Booué joins the N4 from Lalara to Makokou is some 400 metres, so the geographical co-ordinates are pretty well the same as for the previous locality.

Again *Diapteron georgiae* was the only killie found together with *Aphyosemion spec. aff. cameronense* Phenotype 5. In addition a *Ctenopoma* species, some characins and two barb species were present. This and the following strain have been spread around the hobby.

"LEC 93/12" refers to the twelfth locality of this trip. It was visited on 10.01.1993 at about 2 p.m. It is a stream which is used as a washing place directly at its source to the east of Souganlam. After a few kilometres to the south-east of the road it flows into the Bélémé. The geographical co-ordinates are 11°58' E and 00°17' N.

Phenotype 5, *Silurus spec*. and a small barb species were the other fish in the very shallow stream which is only about 30 centimetres wide.

"PEG 94/15" is the most easterly locality of this phenotype known to date. Its precise location was determined by Passaro and Eberl on 14.08.1994 as being 26 kilometres west of the bridge in Ovan. The geographical co-ordinates cannot be given accurately enough. According to our maps it could be the Bénzé, which runs into the Yélélé and is thus a western tributary of the Mva.

However in some streams of this hydrographic system *Aphyosemion maculatum* has been found (see "PEG" 94/14", page 351).

Aphyosemion spec. aff. cameronense Phenotype 5 was very uncommon, which meant that only six specimens were found. All the males had the Yellow Blotch and corresponded in appearance to the Koumaméyong and Souganlam populations.

Syntopic Killifish

Diapteron georgiae
Epiplatys neumanni

The distribution area of this phenotype seems to be only very small, and it has been relatively well investigated alongside the roads which at present have reasonable surfaces. So, apart from possibly *Aphyosemion kunzi*, one would not expect there to be any further syntopic killifish.

Description

This phenotype can be placed in the "yellow" group thanks to the clearly recognisable Yellow Blotch. The basic ground colour of the front part of the body is a pale blue, which does not quite achieve the luminosity of other species and phenotypes of the "*cameronense*"-group. Behind the head there are only a few red spots, which form two parallel rows. The medio-ventral band is normal in its development. In the area near the beginning of the caudal fin it has a small oblique bend upwards. The zig-zag band is only hinted at and seems to have broken up into individual small blotches.

The pale blue to slightly golden dorsal fin has numerous red spots, which even in the distal area do not form long flames or streaks.

The caudal is spotted in a similar way to the dorsal fin. There is a faintly developed upper marginal band. The lower marginal band is whitish to pale blue. It is not divided from the central area by a sub-marginal red band.

To date, this dense and uniform spotting of the caudal has only been observed on this phenotype, and not on any other representative of the "*cameronense*"-group (see also the schematised drawing on the following page).

This photograph shows a part of Norbert DADANIAK's fish-room. Tanks of various sizes and shapes are used for keeping and breeding mostly killies of the genus *Aphyosemion*

Phenotype 5 from Koumaméyong

An adult female *Aphyosemion cameronense* "GWW 86/2"

This is a female *Aphyosemion amoenum* "C89/22". This strain was caught in Nkonga, about 6 kilometres north of Pouma in Cameroon

The anal has a whitish to faint pale blue marginal band, which is bordered by a red sub-marginal band. The distal area of the anal fin has similar colouration to the dorsal and caudal fins, but it has just a very small number of red spots. The basal area consists of a narrow dark red band, which on many specimens is joined to the uppermost of the red spots.

Relationships

In view of the Yellow Blotch we also place this phenotype in the "yellow" group. In the discussion of the relationships of *Aphyosemion amoenum*, *Aphyosemion halleri* and the other phenotypes dealt with which have this characteristic, we have already given in detail the differences between these forms, with regard to both the geographical distances and the colour features of the adult males.

Nevertheless, at this point we would like to stress the special position of the populations around Koumaméyong as we show how it differs from the other representatives of the "*cameronense*"-group with a yellow caudal peduncle:

- The red spots on the flanks are present in very small numbers, so that one gets the impression of exclusively blue-yellow coloured specimens. But in contrast Phenotypes 4 and 9 have a dense covering of red colouration. On the other forms with the Yellow Blotch the red pigments on the flanks are "normal" in their extent.
- On the anterior part of the body a small number of red spots form two rows, whereas the other forms of the "yellow" group have three or four such rows, which in addition extend much further back to the rear part of the body.
- The caudal has on it small round spots, the upper marginal band is almost "swallowed up" by the fin; the lower band is not bordered by a sub-marginal red band, but the two red bands on the caudal fin are almost absent. On the other hand, all the other representatives of the "*cameronense*"-group have this striking characteristic.
- The zig-zag band is scarcely recognisable; it consists merely of individual red spots and blotches, which may come together to form a broken line. This characteristic is present on all the other species and phenotypes of the "yellow" group.

Diagnosis

Phenotype 5 was among the first forms of the "*cameronense*"-group to be discovered in north Gabon, but until now it was called just "*Aphyosemion cameronense*" or "*Aphyosemion cameronense* yellow".

The distribution area in the southern frontier of the species group is known only along the N4 and seems to be very small, at least in its extent from west to east. For the time being it cannot be said how far this form goes to the south in the direction of Booué to the Ogooué and whether it occurs to the north of the Koumaméyong-Ovan road.

It is remarkable that a geographically isolated phenotype with the Yellow Blotch should occur in a region which is so to speak the southern edge of the distribution area with *Aphyosemion amoenum* and Phenotype 3 on the opposite northern edge.

Moreover it should not be forgotten that the distribution area to the west (*Aphyosemion cameronense*) and to the east (*Aphyosemion maculatum*) can be determined very accurately, and so far no transitional forms have been found.

Placing this form into another representative of the "*cameronense*"-group is not possible for geographical reasons and because of the colouration features (minimal number of red spots on the flanks, unique colouration of the caudal fin).

Discussion

Although strains of this phenotype were imported in the seventies, no attention was paid until now to the peculiarities in the colouration of this member of the "*cameronense*"-group.

This would be of less importance if the distribution area of this phenotype lay in Cameroon or on Gabon's northern frontier. Then the distances separating it from the other forms of the "yellow" group would not be so great.

However, as the populations around Koumaméyong are the most southerly representatives of the entire group and thus exist on the group's distribution frontier, important parallels with *Aphyosemion amoenum* and Phenotype 3 can be seen here:

- A representative of the "*cameronense*"-group with the Yellow Blotch is a so-called satellite form on the outer edge.
- Contact with an *Aphyosemion* species of another species group with identical or very similar requirements as to its biotope (*Aphyosemion lamberti* from the "*elegans*"-group) is - at least theoretically - possible, which is why Phenotype 5, in the same way as *Aphyosemion amoenum* and Phenotype 3, might well be exposed to a special form of competition.
- When the geographical spread of the species and phenotypes with the Yellow Blotch is considered, one gets the impression that around the "*cameronense*"-group there exists a broken ring consisting of populations with the Yellow Blotch.

We do not think that this phenotype is distributed where it is purely by chance, or that it is a whim of nature. Nor are we of the view that it is a population of *Aphyosemion cameronense*, a species which "every so often" has a yellow blotch on the caudal peduncle.

With the increase in our knowledge of the distribution of the "*cameronense*"-group and of the colouration of the adult males, it turns out that there is a certain regularity in the distribution of the "yellow" forms, even if they do differ quite considerably from each other.

In the chapter "**Summing-up**" we will attempt, using our present knowledge, to find an explanation for this phenomenon.

Phenotype 6 from Song

Aphyosemion spec. aff. cameronense Phenotype 6 "LEC 93/22"

History

During the discussion of *Aphyosemion mimbon* we pointed out that it was not until the mid seventies that the "Monts de Cristal" in north Gabon were investigated for killies.

The first to collect there were Austrian aquarists, who report the presence of "*Aphyosemion microphtalmum*" in Song and Atogafina-Mala. Whether it actually was this species (it was shown to exist near the village of Méla (="Mala"?) by Passaro and Eberl in 1993) or whether the fish found was a representative of the "*cameronense*"-group, we cannot say with any certainty. More recent findings suggest rather that this *Aphyosemion* of the coastal plain does not exist in Song itself.

During his collecting trip in August 1976, Jean Henri Huber travelled from Médouneu to the small village of Song, where he found a representative of the "*herzogi*"-group and a form of the "*cameronense*"-group. In the first description of *Aphyosemion mimbon* he calls this second fish "*Aphyosemion spec. aff. obscurum*". As it was only possible to catch two specimens , this population was not spread around the hobby. All that could be done was to photograph an adult male and illustrate it in the publication mentioned.

Until January 1993 this representative of the "*cameronense*"-group remained overlooked and absent from the tanks of aquarists. Then LEGROS, CERFONTAINE and EBERL collected in Song ("LEC 93/22") and also a little to the north-east in the direction of Akoga. It became clear that it was in fact a form that differed from *Aphyosemion cameronense* and *Aphyosemion mimbon*.

As HUBER had experienced 17 years earlier, the collectors in 1993 were only able to find one male in Song. This specimen was subsequently brought back to Germany alive (fortunately!), where we were able to photograph it.

Six months later PASSARO and EBERL were able to drive to Song. Just a few kilometres before their destination the road became impassable for an ordinary car, so they had to turn back just three kilometres south of Song.

In February 1994 BLUM and EBERL collected in Song but caught only *Aphyosemion spec. aff. herzogi*. However, they did manage, at locality "GEB 94/24", to find numerous specimens of this phenotype, which corresponded in the body colouration of the males very closely to HUBER's colour description and also in its basic characteristics to the male from "LEC 93/22".

Finally, another locality was discovered during this collecting trip, and this gave a clearer picture of the distribution frontier with *Aphyosemion mimbon* (near Ntom).

Geographical Distribution

After the existence of this phenotype at a single locality ("Nr. 55" = Song in HUBER, 1977) had become known, no further information became available on this representative of the "*cameronense*"-group for some years.

Then the collecting trips in 1993 and 1994 showed that the western distribution frontier must be along the road between Méla (*Aphyosemion microphtalmum*) and Song (*Aphyosemion spec. aff. cameronense* Phenotype 6). Song lies on a stream of the same name which flows west into the Noya. The Noya leaves the 'Monts de Cristal' and runs to the east of Cocobeach into the delta of the Muni (Mouni), which is the border with Equatorial Guinea. The most north-easterly known locality is near Etsam I in the drainage area of the Binguilé, which flows south-east into the Mbé, which itself is a tributary of the Komo. The Komo flows into the sea near Libreville, so this phenotype has been found in two different hydrographic systems.

The distance between Song and Etsam I comes to 21 kilometres as the crow flies, so we can say that the distribution area of this phenotype is very small, at least along the N5. All the same a future shifting of the distribution frontier from Etsam I in the direction of Ntom (eight kilometres as the crow flies from Etsam I, *Aphyosemion mimbon*!) by about six kilometres is theoretically possible, if one day this stretch is intensively investigated for *Aphyosemion*. The previously mentioned existence of *Aphyosemion microphtalmum* just six kilometres south-west of Song in Méla shows without doubt that Phenotype 6 lives on the distribution frontier of the "*cameronense*"-group and can thus also be called a "small satellite form".

The following map shows that the distribution area as we know it of Phenotype 6 is a tiny part of the "*cameronense*"-group at its western edge in north Gabon. On the opposite page can be seen the localities known to date on the N5.

Known Localities

"JH 55" is the locality investigated by Jean H. HUBER near the village of Song on 30.8.1976. This village lies on the N5, which has been mentioned several times already, and which goes from Kougouleu (on the Libreville-Kango road) to Médouneu, via Engong Kouamé, Akoga and Edoum.

The geographical co-ordinates are 10°16' E and 00°39' N. The height above sea level can be determined only roughly from our maps, but we estimate it to be about 500 metres.

In the first description of *Aphyosemion mimbon*, HUBER describes on page 5 the location of the finding place and its surroundings as follows:

> "Village de Song, à 6 km au nord de Mela. Ruisseau de 3 à 6 km de large qui se jette peu après dans la Soung. La profondeur atteint 60 cm à certains endroits le 30 août 1976; le fond est constitué de galets ou de petits cailloux; de gros rochers, épars au milieu du lit, sont recouverts d'*Anubias*... De beaux *Procatopodinés* sont présents par bancs; malheureusement, il n'a pas été possible de les conserver vivants, car ils sont choqués par le filet. Immédiatement, un marigot tributaire est recherché, mais sans succès. Seul un fossé à eaux plus calmes est trouvé, dont l'environnement est le même. Caractéristiques à 16 heures: température de l'eau 20.5°C, de l'air 22°C, pH 6.5, DH 1.5. Les formes "bleue" et "jaune" sont à nouveau sympatriques, mais très différentes des précedentes. Les poissons sont rares et présents uniquement dans trois endroits calmes très circonscrits. Après deux heures de pêche, deux exemplaires de la forme "bleue" et dix de la "jaune" ont seulement été capturés, ce qui laisse à penser que le biotope ne leur est pas favorable; les deux espèces sont vraisemblablement présentes en quantité non loin de là."

This detailed description of the habitat can be translated roughly as follows:

> "The village of Song, six kilometres north of Mela (Méla). The stream is three to six metres wide and after a short distance runs into the Soung (Song). The depth came to 60 centimetres in some places on 30th August, 1976; the bottom consists of pebbles and small stones; large rocks, scattered in the middle of the stream bottom, are covered with *Anubias*... Beautiful *Procatopodinae* are present in shoals; unfortunately it was not possible to keep them alive, as they suffered from shock when caught in a net. Then, a small tributary was looked for, but without success. All that was found was a ditch with still water and the same surroundings. Readings

> at 4.pm.: water temperature 20.5°C, air temperature 22°C, pH 6.5, total hardness 1.5 dGH. The "blue" and "yellow" forms are again sympatric, but very different from the previous forms. The fish are very rare and present solely in three very limited calm places. After two hours' fishing, just two specimens of the "blue" form and ten of the "yellow" were caught, which suggests that the biotope is not favourable to them. The two species are probably present in quantity not far from there."

The "blue" form mentioned by HUBER is *Aphyosemion spec. aff. cameronense* Phenotype 6, the "yellow" form is a representative of the "*herzogi*"-group.

As only two specimens of the form first mentioned were found, it was not possible for it to become established in the hobby.

"LEC 93/20" is the code for the 20th locality that LEGROS, CERFONTAINE and EBERL visited near Assok on 13.1.1993 at about 10 a.m. Coming from Médouneu they arrived at the northern outskirts of the village, where they found a bridge over a stream which crosses the road from left to right and then after a few metres flows into the Binguilé.

The geographical co-ordinates are 10°22' E and 00°44' N. The height above sea level cannot be determined. The distance from the edge of Médouneu was measured by the collectors as 76 kilometres.

The uncommon *Aphyosemion* resembled in their colour pattern the male later found near Song, but not enough specimens were found to make this strain available in the hobby.

"LEC 93/21" refers to the following locality, which was visited about half an hour later. The Binguilé crosses the N5 on the southern outskirts of Assok; the distance from Médouneu comes to 79 kilometres, in other words only three kilometres from the previous locality.

The geographical co-ordinates are 10°21' E and 00°42' N; the height above sea level cannot be determined.

A total of 14 young fish were found, which ensured that this strain was spread around the hobby and is thus available to aquarists.

"LEC 93/22" refers to locality "JH 55" which LEGROS, CERFONTAINE and EBERL were also able to investigate on 13.01.1993. at about 1.00 p.m.

HUBER's findings were confirmed. *Aphyosemion spec. aff. herzogi* was in fact rather more common, but despite intensive efforts only one male of Phenotype 6 was found.

In February 1994 BLUM and EBERL, and six months later PASSARO and EBERL were not able to find any examples of Phenotype 6, even though an 800 metre long stretch of the stream was systematically searched. Nor was it possible to discover any small tributaries which are better suited for *Aphyosemion* as a habitat.

So this strain has not been kept and bred in the aquarium, but there are colour pictures of male fish caught by HUBER and also by LEGROS, CERFONTAINE and EBERL.

This wild fish from locality "LEC 93/21" was brought back as a young fish and later showed body markings that differ from *Aphyosemion cameronense* and *Aphyosemion mimbon*; hence we include this strain in Phenotype 6

"GEB 94/24" is the 24th locality of Blum and Eberl's Gabon trip, which was investigated on 19.02.1994. at about 4 p.m. The 'Mbongmvong' stream crosses the N5 in Etsam I from left to right as one comes from Médouneu.

We determine the geographical co-ordinates as 10°24' E and 00°47' N; the height above sea level cannot be given.

Near the village the Mbongmvong flows into the Binguilé, which runs west of the road parallel to it.

The stream was some three metres wide and 20 to 30 centimetres deep. Alongside Phenotype 6 a barb species and a very large number of shrimps were found. In the middle the clear and slightly brownish water had a relatively strong current, so that the *Aphyosemion* kept near the bank and at the bottom among bamboo leaves.

As catching a sufficient number of adult fish presented no problems, this strain was brought back and has now been bred by several killifish keepers. The collectors could not find any young fish.

In August 1994 Passaro and Eberl were able to fish again near Etsam I. The number of *Aphyosemion* found was about the same as in February of the same year.

Syntopic Killifish

Aphyosemion spec. aff. herzogi
Plataplochilus spec.

This form of the "*herzogi*"-group was reported by HUBER from Song ("JH 55") in 1976. In the first description of *Aphyosemion mimbon*, on page 9, it was said to differ from *Aphyosemion herzogi* itself. We agree with HUBER in that we separate populations "LEC 93/22" and "LEC 93/23" (near Song) from *Aphyosemion herzogi* until detailed investigations show whether it is this species or perhaps a separate species.

The lamp-eye mentioned by HUBER was brought back alive by LEGROS, CERFONTAINE and EBERL and subsequently bred by CICÉRON and BUCHBERGER. The orange coloured "V" on the caudal fin is situated opposite the line of the fin rays, so that it may be possible to separate this form from the previously known populations of *Procatopodinae* from the 'Monts de Cristal' ("PEG 93/20", Méla).

Further syntopic killifish along the N5 are not to be expected, but they may be possible, if new roads are built in this area and especially to the east and west.

Description

If one looks at the colour picture in HUBER (1977, page 7), the one male of the "LEC 93/22" strain and the other strains, then the populations of this phenotype can be thought of as being very variable. The lack of the Yellow Blotch means that this form can be placed with the "blue" representatives of the "*cameronense*"-group.

The body ground colour is a pale metallic blue; on the flanks one can see numerous irregularly arranged red spots, whose form and size vary considerably from population to population and from individual to individual.

The scarcely recognisable zig-zag band hardly stands out from the rest of the dense red pigmentation, which is also true of the medio-ventral band.

The fish illustrated in HUBER (1977) is rather similar in this respect to the colour pattern that we know from *Aphyosemion obscurum*. On the caudal peduncle the parallel rows of red spots break up and form a trellis pattern, which can also be observed on the male of the "LEC 93/22" strain (same finding place). In addition neither the medio-ventral band nor zig-zag band is visible in this fish.

This trellis pattern is more clearly developed on the "LEC 93/21" strain and stretches from the root of the caudal to the beginning of the anal fin, where parallel rows of red spots extend to the head.

On the other hand the red spots seen on strain "GEB 94/24" seem to merge in places, so that on some individuals there are body markings reminiscent of the large blotches on *Aphyosemion maculatum* and *Aphyosemion mimbon*.

In any event these blotches are considerably smaller, so that here it is possible to separate the phenotype from these two species.

All populations have in common a tendency for the trellis pattern of the red pigments to break up on the rear part of the body.

The dorsal is always yellow in colour and on some specimens there are a few red spots in the basal area. The bluish to greenish colouration at the root of the fin is only visible when the fin is outstretched.

The caudal fin has the marginal bands which we know from most representatives of the "*cameronense*"-group. On many specimens both are yellow in colour, but fish have been found with a white lower band. Both bands are edged to the central area of the fin with a red sub-marginal band. The central area of the caudal fin is decorated with dark red longish blotches and flames over a very pale blue background.

On all specimens the anal fin has a broad marginal band, which is almost totally yellow in colour and edged by a red sub-marginal band. This red band may be very broad, and this is especially true of the specimens in HUBER, 1977 page 7 and of the male caught by LEGROS, CERFONTAINE and EBERL. Along the body there are isolated red spots, which are completely absent on many specimens.

HUBER (1977) emphasises that the red band on the anal fin in the *Aphyosemion cameronense* populations from Gabon lies in the marginal area, whereas on this phenotype it is much closer to the body, in fact in the middle of the fin.

The drawing on page 424 shows the significant colouration features of this phenotype.

Relationships

Within the "blue" group we can compare Phenotype 6 with its dense red pigmentation only with *Aphyosemion obscurum* and Phenotype 1. It is obviously a simple matter to separate it from *Aphyosemion cameronense*, *Aphyosemion haasi* and Phenotypes 2, 7 and 8.

The regular body markings typical of *Aphyosemion obscurum* extend from the head to the root of the caudal fin. They do not form a visible "trellis pattern" in the area of the caudal peduncle. Instead the red pigments merge only horizontally. The distance from Etsam I to Makak is about 340 kilometres as the crow flies. Both members of the "*cameronense*"-group lie on the south-west and north-east extremes of the group's range - allowing for the exception of the Diang *Aphyosemion cameronense*.

Phenotype 1 also has numerous red spots on the flanks. These spots, however, form parallel lines and do not merge with each other. With this representative of the "*cameronense*"-group there is absolutely no tendency for the "trellis pattern" to appear on the fish. The distance from Etsam I to Mvilé amounts to about 290 kilometres as the crow flies.

Neither *Aphyosemion obscurum* nor Phenotype 1 have such strong yellow colouration on the unpaired fins, which provides yet another feature that distinguishes Phenotype 6 from the other "blue" forms of the "*cameronense*"-group.

Diagnosis

This phenotype is a representative of the "*cameronense*"-group, which can be separated from the other specimens and phenotypes by the irregular body markings, the reticulation on the caudal peduncle as well as by the large proportion of yellow in the unpaired fins.

At present the distribution area can be driven only along the N5, so its relationship with the other representatives of the "*cameronense*"-group cannot be investigated. Its proximity with *Aphyosemion mimbon* (eight kilometres as the crow flies from Etsam to Ntom) indicates that there cannot be a transitional form.

Discussion

The Song population, which was first investigated in some depth by Huber, was never found in adequate numbers, but the divergent body colouration justified this phenotype being called "*Aphyosemion* sp. aff. *obscurum*".

The discovery of a similarly coloured male at the same locality 17 years later means that neither of the two specimens was a mutation. The possibility of such a coincidence is too slight.

It was not Huber's intention to place the population of his 55th locality in *Aphyosemion obscurum* from the north. Instead he was pointing out similarities between the two forms, which we in turn see as an argument for splitting Phenotype 6 from *Aphyosemion cameronense* and considering it as a separate form.

The relationship between this phenotype and *Aphyosemion mimbon* and the nearest populations of *Aphyosemion cameronense* to the east of Médouneu ("PEG" 94/42") should be investigated by means of crossing experiments, which might provide arguments for raising this phenotype to the status of species.

Phenotype 7 from Makokou

Aphyosemion spec. aff. cameronense Phänotyp "LEC 93/7"

History

From the mid sixties to the present day the Ovan-Makokou road has been investigated for killies, as it is a simple matter to find many interesting killifish in this area. All the populations of the "*cameronense*"-group were called "*Aphyosemion cameronense*".

In 1993 Legros, Cerfontaine and Eberl discovered a population which in its body colouration and the pattern of markings on the unpaired fins differs from the other strains brought back so far.

These wild fish were then successfully bred in the aquarium, so that the "LEC 93/7" strain has now been distributed in the hobby. By most killifish keepers it has been regarded as belonging to *Aphyosemion cameronense*.

In August 1994 Passaro and Eberl returned to this locality and were able to establish that all the males which were caught had the characteristic features of this population.

If this strain is compared with the populations of *Aphyosemion cameronense* from the vicinity of this finding place, one will appreciate the reasons for illustrating this form and separating it from *Aphyosemion cameronense*.

Geographical Distribution and Known Localities

The only locality at present is the Béniaré stream on the N1 in north Gabon. It crosses the road from Makokou to Ovan 48.5 kilometres west of the end of the asphalt in Makokou between the villages of Ebegna and Ebandak. The stream crosses the road from north to south and belongs to the Louli system. This small river is a northern tributary of the Ivindo.

We calculate the geographical co-ordinates to be 12°30' E and 00°32' N at 535 metres above sea level.

The code used by LEGROS, CERFONTAINE and EBERL for this strain is **"LEC 93/7"**.

The stream is 100 to 150 metres wide and a maximum of 40 centimetres deep. Other killies found in it were *Aphyosemion punctatum*, *Aphyosemion kunzi*, *Diapteron fulgens* and *Epiplatys neumanni*. This locality is illustrated at the top of page 428.

Diapteron fulgens and *Aphyosemion spec. aff. cameronense* were the two commonest species. In the case of the latter species females clearly outnumbered males; on the other hand only one male *Aphyosemion kunzi* was found.

Other accompanying fish were barbs, characins and a species of the genus *Mastacemballus*. Shrimps and the usual water insects were very numerous.

On 09.01.1993 at 4 p.m. the water temperature was 24°C and the air temperature just one degree warmer at 25°C. The pH was measured at 6.3, the total hardness below 1°dGH and the conductivity 30 µS.

"G74/4" refers to the fourth locality of GASPERS and others' Gabon trip; its position is given as "52 km before Makokou near the village of Essenkelle, stream 1 km on the left". On our maps the village is shown as 'Ntsenkélé' or 'Ntenkélé' (12°39' E and 00°31' N). Here too "*Aphyosemion cameronense*" was found. This stream belongs to the Loubi, which also runs into the Louli. In fact this place is the neighbouring village to the west of Ebandak and so lies just a few kilometres to the west of Béniaré.

"GWW 86/4" is the code for the fourth locality of WAGNER and WENDEL's trip. They give its location as "45 km west of Makokou". There they found "*Aphyosemion cameronense*", *Aphyosemion punctatum*, *Diapteron fulgens* and *Epiplatys neumanni*.

The combination of species and the presence of a single male *Aphyosemion kunzi* in 1993 point to it being the same stream. On the other hand the collectors' description of the body colouration of the males ("broad yellow borders or bands on the unpaired fins") suggest otherwise! At the moment therefore we cannot say whether the last two populations mentioned belong to *Aphyosemion cameronense* or to Phenotype 7. This question can only be answered by systematic collecting around Ebegna and Ebandak and also to the east and west of these villages.

The upper map on the next page gives the position of locality "LEC 93/7" in the distribution area of the "*cameronense*"-group. The second map shows it in more detail.

Phenotype 7 from Makokou

The Béniaré stream on the N1 between Ebegna and Ebandak, locality of Phenotype 7

Syntopic Killifish

Aphyosemion batesi
Aphyosemion punctatum
Diapteron fulgens
Epiplatys neumanni

As the killies of this region are relatively well known, the only other species one might expect to be sympatric is *Aphyosemion bochtleri*.

Description

This phenotype can be placed in the "blue" group, as the flanks have a light blue ground colouring; the Yellow Blotch is also absent on every wild fish caught and on all of the tank bred progeny.

Over the whole body individual red spots are distributed. They are not so dense as we know from *Aphyosemion obscurum* or Phenotypes 1 and 4. Nor do they tend to merge with each other. To the contrary, as with Phenotype 1, each spot seems to lie on its own scale.

These spots form three parallel lines on the front part of the body. The upper one is almost unbroken and is the longest. The two lower rows are significantly shorter and have a few "gaps", in which the spots seem to be missing.

There is no clearly defined zig-zag band, since the number and size of the red spots in the upper part of the caudal peduncle correspond to the arrangement on the front part of the body. The medio-ventral band begins below the gills. It is very regular in form and on the caudal fin becomes a very broad red marginal band.

The ground colouration of the dorsal fin corresponds roughly to the body colouration. On it there are numerous red dots, which are distributed very regularly on the fin. In the distal area they seem to be completely absent.

The caudal has an upper and lower marginal band; these are both pale blue in colour. The upper band is not clearly defined in the middle of the fin but has some red dots similar to those in the dorsal.

The central area of the fin consists of fairly long dark red blotches and streaks which lie very close to each other and also merge, which gives the impression of the central part of the caudal fin being dark red.

The anal has a narrow marginal band, whose colouration corresponds to that of the lower marginal band of the caudal. It is edged by a dark red submarginal border, which close to the body breaks up into streaks which lie very close to each other. These are arranged in the direction of the fin rays. Only at the actual base of the anal fin are there a few dark red spots.

No yellow has been observed on the unpaired fins of population "LEC 93/7".

The following drawing represents a male of this phenotype and its important colouration characteristics:

Relationships

The completely pale blue body ground colour enables us to place this phenotype in the "blue" group. It is very easy to separate this form from the other representatives of the "*cameronense*"-group without the Yellow Blotch (*Aphyosemion cameronense*, *Aphyosemion obscurum*, *Aphyosemion haasi*, *Aphyosemion maculatum*, *Aphyosemion mimbon* and Phenotypes 1, 2, 6 and 8) if one concentrates on the features given as follows:

- The dorsal is covered with regular red dots, which do not merge to form long blotches or streaks. This first characteristic is not seen to this extent on the other forms of the "blue" group; rather there is a tendency for the formation of the latter.
- The anal has a narrow pale blue to whitish marginal band; the rest of the fin is almost completely dark red in colour. The almost solid red colouration of the anal fin of this kind is otherwise only found on some specimens of *Aphyosemion amoenum*, which however has a Yellow Blotch.
- The caudal is not symmetrically coloured; the upper marginal band corresponds with the dorsal to a certain extent with regard to the red spots, while the lower marginal band is not spotted at all. The spots on the upper marginal band are typical in this phenotype.
- The medio-ventral band extends to the gills. Admittedly this had also been observed on other populations of *Aphyosemion cameronense* as well as on several phenotypes, but these forms lack the peculiarities of Phenotype 7 mentioned above.
- The zig-zag band is absent, being replaced by the red spots which are distributed irregularly on the flanks. All the members of the "*cameronense*"-group that can be called "blue" have a recognisable zig-zag band, with the exception of Phenotype 8 with its divergent anal fin.
- The absence of blotches on the flanks and the clearly defined medio-ventral band enable this form to be easily separated from *Aphyosemion maculatum* and *Aphyosemion mimbon*, which form the "blotched" group and have no red band on the rear part of the body.
- The irregularly arranged spots provide a distinguishing characteristic that separates Phenotype 7 from *Aphyosemion obscurum*, *Aphyosemion haasi* as well as Phenotypes 1, 2 and 6.
- Finally the shape of two fins can be described as unusual. The caudal is rounded on its corners, whereas on the other representatives of the "*cameronense*"-group the corners are rather pointed. The anal does not have the parallelogram shape; in this respect too it differs from the normal form seen in the group.

This phenotype does not have a specific criterion to separate it from the species and phenotypes mentioned here, nor does it differ as markedly from *Aphyosemion cameronense* as do the other species and phenotypes of this species group. Nevertheless, in view of the combination of its peculiarities and the resulting general impression given by the fish, it can be regarded as an isolated form.

One is almost inclined to say that "something is not quite right with this *Aphyosemion cameronense*".

One can see features in common with *Aphyosemion cameronense* and Phenotype 1, so we would place Phenotype 7 close to these two forms.

It seems clear that Phenotype 7 lives in the wild in close proximity to *Aphyosemion cameronense*, as is also the case, for example, with Phenotypes 1, 2 and 9. The direct distance between locality "LEC 93/7" and Phenotype 1 (Mvilé west of Lolodorf) comes to some 370 kilometres.

Diagnosis

As far as we know this phenotype has until now been available from just one locality, which lies in the drainage area of the Loubi, a northern tributary of the Ivindo.

The distribution area needs to be defined more accurately, and systematic collecting work should be carried out in the area around this stream. Of particular interest is the presence of *Aphyosemion cameronense* to the west and east of this phenotype.

The lack of passable roads prevents investigations to the south, where one would like to know the situation regarding an *Aphyosemion* species which there replaces the representatives of the "*cameronense*"-group (*Aphyosemion punctatum*?).

The specimens caught at locality "LEC 93/7" as well as the F1 and F2 progeny have a colour pattern which only differs from *Aphyosemion cameronense* when one has a second glance. It is not a simple matter to point out or describe the features which suggest this phenotype should be split from the other representatives of the "*cameronense*"-group.

Only when the individual colouration characteristics are compared is it possible to recognise differences from similarly coloured populations of this group.

Discussion

It cannot be denied that here we are dealing with a form of the "*cameronense*"-group whose distribution - like that of Phenotypes 1, 2, 4 and 9 - has been very little investigated.

Nevertheless it does seem as if the distribution area will be limited to the tributaries of the Louli. Much collecting in the past had produced "*Aphyosemion cameronense*" along the Makokou-Ovan road.

It would be especially important to know if this phenotype is also a small form on the edge of this species group.

In addition we need to know whether other streams of the Louli actually contain populations of *Aphyosemion cameronense*. Then we would have a situation similar to the one we know from Nsessoum. Two forms of the same species group which differ from each other in colouration exist in one and the same hydrographic system. Crossing experiments could help us to find out more about the significance of such external characteristics in deciding the validity of a species.

Phenotype 8 from PK 14 West Mitzic

Aphyosemion spec. aff. cameronense Phenotype 8 "LEC 93/14"

History

In the course of numerous collecting trips in north Gabon the area around Mitzic has been investigated for killies on several occasions. Collectors have only ever reported finding "*Aphyosemion cameronense*".

Legros, Cerfontaine and Eberl also investigated this region during their January 1993 trip and were able to confirm the presence of *Aphyosemion cameronense* in almost every stream they fished. This species seems to be by far the commonest killie there. To the west of Mitzic on the way to Sam they found a population of the "*camero-nense*"-group, which immediately drew their attention because of its body colouration. The wild fish were reminiscent of *Aphyosemion gardneri* or *Aphyosemion scheeli*. Moreover "pure blue" specimens were found alongside males with yellow on the dorsal and anal fins. This phenomenon of the coexistence of blue and yellow phases of one species in one biotope has been known for a long time in the case of representatives of the "gardneri"-group in west Cameroon and in the east of Nigeria. This form was later compared in the aquarium with the populations of the nearest localities on the Mitzic-Sam road, and it was shown that the "LEC 93/14" strain actually differs significantly in body colouration, which is why we here wish to regard it as a separate phenotype.

Geographical Distribution and Known Localities

This phenotype, like the previous one, is at present known from only one finding place. So its distribution in the wild cannot be given accurately. We can only give here the single locality we know of.

"LEC 93/14" is the 'Bidon' stream between Engué and Essong (Essong-Ville), which was fished by LEGROS, CERFONTAINE and EBERL on 12.01.1993. This locality lies 14 kilometres west of the outskirts of Mitzic on the road to Sam. The geographical co-ordinates are 11°28' E and 00°49' N at about 500 metres above sea level.

The Bidon crosses the road from south to north and then runs into the Nkam which flows to the west. The Nkam is a north-eastern tributary of the Lara, which flows south into the Okano.

Apart from *Aphyosemion spec. aff. cameronense* only *Barbus spec. aff. jae* could be found. In addition there were large numbers of a small shrimp species.

At 9 a.m. the air temperature was 22.7°C, the water temperature 21.5°C. The pH was found to be 5.7 (!), the total hardness was not measurable (0° dGH) and the conductivity was extremely low at 14 µS.

We do not know if other collectors have been able to find similarly coloured populations of the "*cameronense*"-group in the immediate vicinity of these villages. 40 kilometres north-west of Mitzic WAGNER and WENDEL found a population of *Aphyosemion cameronense* ("GWW 86/15", page 272), which unfortunately was not brought back alive to Europe, so we cannot place it with any accuracy. Locality "LEC 93/15" with an *Aphyosemion cameronense* typical of this region is situated 34 kilometres in the direction of Sam (see also page 286).

This suggests that the distribution area of this phenotype cannot be very large and that it may be limited to the Nkam.

This male with a high proportion of yellow was caught at the same locality

Phenotype 8 from PK 14 West Mitzic

On the following general map the position of locality "LEC 93/14" can be seen; the lower map shows the Mitzic-Sam road with the only locality known at present.

Syntopic Killifish

As the only other fish found in the one known locality was a barb species, we can only guess at possible syntopic killifish. We consider it to be at least theoretically possible for a representative of the "*herzogi*"-group and *Episemion* (*callipteron*?) to be found with Phenotype 8.

Description

The ground colour of the flanks is a metallic light blue to blue-green; the yellow "colour phase" seems to have s stronger tendency to be greenish. No Yellow Blotch is to be seen on the caudal peduncle. The red pigments are irregularly distributed on the flanks and have no pronounced tendency to merge nor do they form a medio-ventral or zig-zag band. The ground colour of the unpaired fins corresponds to the body colouration. In the basal and central areas the dorsal is covered with red dots which towards the outer area of the fins are replaced by longish flames and streaks. The yellow phase males have a yellowish outer area to the dorsal fin.

The caudal fin on the blue phase has a weakly defined upper marginal band, which is somewhat lighter in colour than the rest of the fin. The lower marginal band is broader and separated from the central area by a narrow red submarginal band. The middle of the fin is like that of Phenotype 5 in being regularly covered with red dots. The caudal of the yellow phase, on the other hand, has a light blue upper and yellow lower marginal band; the central area of the fin is covered with red blotches, which in places merge with each other and with the two submarginal bands. This makes the fin appear to have a much "coarser" pattern.

The anal fin of both phases have almost identical markings: a narrow pale blue band is followed by a rather broader submarginal band. The inner area of the fin has six or seven individual red spots leading out from the base of the fin.

Relationships

This phenotype quite obviously lacks the Yellow Blotch, so we place it in the "blue" group. The poorly developed red colouration enables one to separate it from the "striped" representatives (*Aphyosemion obscurum* and Phenotype 1) as well as from the "blotched" *Aphyosemion maculatum* and *Aphyosemion mimbon*.

In addition the two bands on the caudal peduncle are not present, which makes it easy to separate the phenotype from *Aphyosemion cameronense* and *Aphyosemion haasi*.

Phenotype 6 also has an irregular arrangement of the red colour elements on the flanks, but they are considerably denser and more numerous.

The population from locality "LEC 93/14" can also be distinguished from Phenotype 7: this latter representative of the "*cameronense*"-group seems to have just a suggestion of the zig-zag band, but on the other hand the medio-ventral band is very broad and extends over the whole of the lower part of the body. As there is no closely related form within the species group, geographical separation is not called for.

Phenotype 8 from PK 14 West Mitzic

The following drawing shows all the most important colouration characteristics of this phenotype:

Diagnosis

The only locality known to date lies on the Mitzic-Sam road, which passes through the drainage of the upper Lara. This road has been travelled by many collectors, but unfortunately there are gaps along it where no fishing has been done. We do not know anything about the appearance of the populations of the "*cameronense*"-group from east of Engué I to Mitzic. In addition information is lacking on collecting work between Essong and locality "GWW 86/15", nor do we know the colouration of the males of these populations.

The pigmentation of the flanks and the spotted caudal (at least on the blue phase of this phenotype) resemble the populations of Phenotype 5 from Koumaméyong, but this phenotype has the Yellow Blotch.

Since the "LEC 93/14" population is obviously replaced by *Aphyosemion cameronense* in both directions along the Mitzic-Sam road and to the south near Oveng, our present-day knowledge suggests it is not a geographical frontier form of the "*cameronense*"-group.

Of particular interest is the unique occurrence for this species group of "blue" and "yellow" males in one stream, which justifies our splitting them into two colour phases.

Discussion

The discovery of a population west of Mitzic with clearly divergent colouring poses questions which should be answered as fully as possible as a result of intensive collecting work and crossing experiments with neighbouring populations of *Aphyosemion cameronense* (and with other representatives of the species group?).

In addition investigations on the behavioural biology of the phenotype would be interesting, as then we might learn whether the females prefer to mate with the "blue" or the "yellow" males.

Phenotype 9 from Ngoyang

Aphyosemion spec. aff. cameronense Phenotype "EMS 90/2"

History

The Eséka-Lolodorf stretch in south Cameroon has also been investigated for killies since the sixties (Scheel; Radda and Pürzl; Amiet; Chauche, Poliak and Tanaka; Vlijm and many others). Repeatedly "*Aphyosemion cameronense*" has been reported as one of the killie species occurring there.

In the mid eighties wild fish with the code "Ngoyang Chantier" arrived in France, where they were subsequently photographed by Maurice Chauche and called "*Aphyosemion* cf. *cameronense*", as this population differed from the other strains of this species.

In August 1990 Eberl and others were able to bring back from Ngoyang a popula-tion which strongly resembles the strain distributed in France and Germany. However, as it has not been established whether the two strains come from the same stream, they have been kept and bred pure with different names ("Ngoyang Chantier", "EMS 90/2").

At almost the same time Vlijm and others found two further populations in the 'Mentanyé' stream near the village of the same name and near Minlongo (also between Eséka and Lolodorf). They were then bred in Belgium and the Netherlands for a short time but subsequently disappeared from the hobby.

With the increasing number of populations of members of the "*cameronense*"-group brought back from Cameroon and Gabon and known to us, it has become clearer that these strains from around Ngoyang, Mentanyé and Minlongo are a divergent form. We therefore consider it as Phenotype 9 and intend to deal with it here in detail for the first time.

Arguments for this treatment are the facts which will be presented below, such as the geographical distribution, the Yellow Blotch, the regular pigmentation on the flanks and the phenotype's immediate proximity to *A. cameronense* near Madang I.

Geographical Distribution

The distribution area of this phenotype has not been investigated adequately yet, so for the time being we can only work on the four known localities. These lie in a very small area on the road from Eséka to the south in the direction of Lolodorf. This area is drained by the upper reaches of the Mougué (a tributary of the Lokoundjé) and also by the Nkoumbala, which flows west into the Nyong.

The most northerly locality at present would seem to be Mentanyé, which is situated only about ten kilometres south of the bridge over the Nyong. The southern distribution frontier seems to be near Ngoyang, since *Aphyosemion cameronense* "Madang I" has been found in the very next village. The distance between these two localities of Phenotype 9 is 18 kilometres as the crow flies.

How far the phenotype extends to the west and east of the Eséka-Lolodorf road cannot be investigated for the time being. 24 kilometres west of Ngoyang near Song Mahi *Aphyosemion heinemanni* has been found (see also pp 120 and 121). This fish seems to be a species of the coastal plain or the transitional zone to the inland plateau. This would indicate that Phenotype 9 is also a small satellite form on the edge of the "*cameronense*"-group.

The general map on the opposite page shows the distribution area of this phenotype in relation to that of the whole "*cameronense*"-group. The lower map shows the Eséka-Lolodorf road with the localities known at the present time.

Known Localities

"Ngoyang Chantier" is French for "Ngoyang work-site" or "Ngoyang timber felling camp". When Eberl made inquiries in Ngoyang itself in August 1990, the villagers knew nothing about any "chantier", so we cannot give any data on the precise location of this finding place. Our 1 : 200,000 scale maps do not show any "chantier" or similar establishment either.

Ngoyang itself has the geographical co-ordinates 10°45' E and 03°21' N at about 450 metres above sea level. The streams around Ngoyang run into the Mougué, which flows past Mvilé (Phenotype 1!) and into the Lkoundjé near Bipindi.

This strain has been bred by keepers of the small *Aphyosemion* and is still kept in the hobby.

Phenotype 9 from Ngoyang

"EMS 90/2" is the code for the locality which EBERL and others visited in Ngoyang on 16.8.1990 at about 11.30 a.m. The 'Mbyada' stream crosses the road from west to east and flows into an unnamed tributary of the Mougué, which rises eight kilometres south-east of Ngoyang. The air temperature was 25°C, the clear and slightly brownish water flowed slowly and its temperature was 22°C. The stream was 40 to 60 centimetres deep and one to two metres wide. As well as a barb species some specimens of *Aphyosemion exiguum* were also found. This strain was spread around the hobby with the population name "Ngoyang Mbyada".

"Mentanyé" is the name of a small village about ten kilometres south of the Nyong on the road from Eséka to Lolodorf - a road we have mentioned on several occasions. The geographical co-ordinates are 10°44' E and 03°30' N at 422 metres above sea level. We know nothing about the precise location of this finding place, the date of the import or if any accompanying fish were present. The small streams around Mentanyé run into the stream of the same name, which joins the Nkoumbala and then flows west into the neighbouring Nyong. This strain disappeared from the tanks of killifish keepers just a few years after its import (summer 1990).

"Minlongo" is the locality name of a strain, which was imported from south Cameroon by Bas VLIJM and others in 1990. This village lies on the Eséka-Lolodorf road: 10°45' E and 02°29' N. The height above sea level cannot be determined. The 'Minlongo' stream crosses the road from east to west and flows into the Koumla, a tributary of the Nyong. This strain is no longer kept in the hobby.

Syntopic Killifish

Aphyosemion exiguum

The inadequate information on both the "Ngoyang Chantier" and the "Mentanyé" localities mean we are not able to say whether there are any other syntopic killies. We assume that future collecting work within the distribution area known at present might result in one or two other killifish species being found alongside Phenotype 9 (*Aphyosemion batesi* or *Epiplatys sangmelinensis*).

Description

The body ground colour is a weak pale blue, so this phenotype appears somewhat lighter in colour than most of the other members of the "*cameronense*"-group. Four horizontal rows of dark red spots run from the gill covers to almost the caudal peduncle. As in *Aphyosemion obscurum* these spots merge with each other, giving the impression of a "striped" *Aphyosemion*.

The lower rows of spots are shorter than the two upper ones. The lowest one consists of six to ten red spots which are separated from each other.

The top row of spots consists of the zig-zag band, which extends to the head in a thin line, which is virtually continuous.

The medio-ventral band is not well defined and in many specimens ends at a point above the middle of the anal fin. From above the base of the anal fin to the pectorals there are individual red spots, which can be thought of as "left-overs" of the lower red band.

On the caudal peduncle there is a Yellow Blotch, which in comparison with the other species and phenotypes having this characteristic is significantly smaller. It usually ends at the back of the dorsal or the anal fin. With only a few fish does it reach the middle of the anal fin.

The dorsal fin has the same ground colouring as the flanks. In the basal area it is covered with red dots which in the central area form long blotches and streaks. The distal area of the fin lacks the red pigments and thus appears paler than the interior of the fin.

The caudal fin has the pattern typical of *Aphyosemion cameronense*; the upper marginal band is yellowish in colour. In the lower band small yellow areas can be seen, while the rest is light blue. In the central area of the caudal fin numerous red blotches and streaks lie on a pale blue background. These blotches and streaks merge into each other.

The anal fin has a white marginal band, whose inner edge is scalloped. The dark red submarginal border continues into the markings of the same colour of the central and basal area of the fin. Irregularly arranged blotches join and form a dense pattern, which gives the impression of an anal fin with a pronounced red colouration.

The following drawing shows the significant colour characteristics of this phenotype:

Relationships

All the wild fish from the Mbyada stream as well as all the tank bred males of the other strains have the Yellow Blotch, so this phenotype has to be placed in the "yellow" group. It is worth noting that the Yellow Blotch on Phenotype 9 is relatively small and less striking than on the other forms.

Separation from the other species and phenotypes with this characteristic by reason of geographical distance has been dealt with under the discussion of *Aphyosemion amoenum* (page 318), *Aphyosemion halleri* (page 330) and Phenotype 3 (page 394).

In addition the section on Phenotype 4 deals with the geographical separation from the other two "striped" representatives of the "*cameronense*"-group (see also page 402).

Phenotype 9 can be separated from the other species and phenotypes of the "yellow" group (*Aphyosemion amoenum*, *Aphyosemion halleri* and Phenotypes 3, 4 and 5) by the following characteristics:

- The spots on the flanks are very dense, the pigments merge and form parallel lines. Only Phenotype 4 has a similar proportion of red colouring, but with this fish every spot is isolated and every individual scale seems to be red in colour.
- The anal fin has a similar pattern to that on some populations of *Aphyosemion amoenum*, but the marginal band on Phenotype 9 is broader. *Aphyosemion halleri*'s anal has no pale marginal band, while Phenotypes 3, 4 and 5 have different colouring in the central and basal area of the anal fin.
- The caudal on *Aphyosemion halleri* has "coarser" markings, Phenotype 3 has two clearly recognisable white marginal bands, Phenotype 4 has no yellow colouration on the marginal bands and the caudal on Phenotype 5 is covered with numerous red dots.

When all the species and phenotypes of the "*cameronense*"-group are compared, one gets the impression that Phenotype 9 is as it were a mixture of *Aphyosemion obscurum* and *Aphyosemion amoenum*. Nevertheless the specimens of the three populations concerned cannot be placed in either species, in view of crucial differences: *Aphyosemion amoenum* has strong yellow colouring on the dorsal fin and body markings that correspond to *Aphyosemion cameronense*, i.e. much less dense and not arranged in lines; *Aphyosemion obscurum* in all populations found to date lacks the Yellow Blotch.

Diagnosis

This is the last of the nine phenotypes dealt with in this book. It does occur very near to *Aphyosemion amoenum*, but has never been connected with that species. CHAUCHE called it "related" to *Aphyosemion cameronense*, while EBERL and others considered it to be "*Aphyosemion cameronense*" itself, until the significance of the Yellow Blotch became recognised. Actually the Yellow Blotch is smaller than on the other forms of the "yellow" group.

The occurrence along the Eséka-Lolodorf road and of course on either side of it (east and west) as well as the distribution frontier of Phenotype 9 to the north as far as Nyong are not adequately known; there is a lack of information on the *Aphyosemion* from around Eséka.

In 1990 VLIJM and others discovered the "Minlongo" locality (*Aphyosemion cameronense* according to the collectors?), which lies only a few kilometres south of Mentanyé. This population is unfortunately no longer available in the hobby, but according to the collectors the specimens caught there corresponded to the Mentanyé fish.

The occurrence of *Aphyosemion heinemanni* to the west of the road (Song Mahi = terra typica!) and the geographical factors suggest that this is a frontier form of the "*cameronense*"-group with the Yellow Blotch (see also the chapter **Summing-up**).

Discussion

The populations in the area between *Aphyosemion amoenum* and *Aphyosemion cameronense* along the road from the Axe lourd to Eséka and beyond in the direction of Lolodorf still have not, in our opinion, been adequately researched yet. We are convinced that the form we call Phenotype 9 cannot be placed in either of these species.

Unfortunately we were not able to examine the "Mentanyé" or "Minlongo" populations before they were lost nor were we able to compare them with the fish from Ngoyang. At present we do not have access to any photographic material of these strains. What is clear, however, is that A. CERFONTAINE's males bred from the "Mentanyé" strain all had a small Yellow Blotch and the regular body markings that have been mentioned (personally confirmed by EBERL). We would recommend that killies be collected near Eséka and to the south of the Nyong and also near Mentanyé, Minlongo and along the road to as far as Ngoyang; there may now be roads which did not exist in 1990. If this were so, our knowledge of the *Aphyosemion* to the west and east of the Eséka-Lolodorf road could be extended. The Yellow Blotch and the typical "*obscurum*" pigmentation occur in this combination only in the populations of this phenotype. When the "Ngoyang Chantier" and "EMS 90/2" strains are bred, these characteristics have proved to be constant and fixed. So the specimens photographed by CHAUCHE and LÜTJE can hardly be regarded as mutations or individual specimens with peculiar colouration.

This phenotype poses some questions regarding the body colouration of the males and also its geographical distribution:

- Why does a population of the "*cameronense*"-group with a small Yellow Blotch on the caudal peduncle and regular body markings exist in Ngoyang, only a few kilometres north of Madang I, where a very typical population of *Aphyosemion cameronense* has been found?
- According to our maps both streams lie in the area of the source of the Mougué, which means that at least theoretically they are in contact with each other. Is a genetic exchange between the two biotopes possible, so that direct competition can come about? A similar situation is known from Nsessoum (*Aphyosemion cameronense* and AMIET's Phenotype 2).
- Why has a representative of the "*cameronense*"-group in the form of AMIET's Phenotype 1 been found in the lower part of the Mougué, a form which differs both from *Aphyosemion cameronense* and from Phenotype 9? What is the relationship between these three forms?
- Why do two phenotypes with a high proportion of red on the flanks exist on the western edge of the "*cameronense*"-group in Cameroon?
- What is the relationship between Phenotype 9 and *Aphyosemion obscurum*? The body colouration is very similar, but the Ngoyang males have the Yellow Blotch.
- This phenotype closes the circle which seems to link the forms with the Yellow Blotch around the "*cameronense*"-group. We analyse this phenomenon in the chapter **Summing-up**, where we offer a possible explanation.

Identification Key for Males of the "*cameronense*"-group

In the two previous chapters we dealt with the species described to date and the phenotypes of the "*cameronense*"-group that differ from them. Now we would like to show how it is possible to put an individual male or strain of unknown or uncertain origin into our scheme and place it with a certain species or phenotype.

This need may arise when one receives from a breeder or aquarists *Aphyosemion* which definitely belong to the "*cameronense*"-group, but precise identification of these fish is not possible. Frequently the exact locality code has been lost or passed incorrectly so often that now the name or code sounds quite different.

It will scarcely ever be possible to reconstruct a lost locality name for a strain with any certainty (they could have been specimens of the same species but crossed with another strain). So we cannot give a complete or comprehensive identification key for these killies. We would therefore again like to stress that every serious aquarist should remember the importance of keeping a permanent record of locality codes with as exact details as is possible.

Amiet (1987) in his book on the *Aphyosemion* of Cameroon gives an identification key for the different species groups of this genus, enabling the individual species and phenotypes to be separated from each other using colour characteristics. LEGROS (1990) adopted this method of presentation for the subgenus *Chromaphyosemion*, which was the subject of his investigation.

Both these examples show that it is possible in this way to use a key for several species and/or phenotypes, and we would like to adopt this method too. For the case in question of the "*cameronense*"-group we follow in particular Amiet (1987, pp 108 and 233), who splits the four species and three phenotypes from Cameroon step by step.

Admittedly this results in what at first seems an involved jumble of figures and colouration features. However this changes when one gets a little more familiar with it. We begin by dividing the "*cameronense*"-group into three groups, based on the colour characteristics of the adult males. These groups we call "blue", "yellow" and "blotched". So these artificial units we have created will contain eight, six and two representatives in each of these groups respectively. Then, with closer examination, colour differences will enable these groups to be split into smaller units, until one finally ends up with the individual species or phenotype.

In the case of the "blotched" group just one step is needed to separate *Aphyosemion maculatum* and *Aphyosemion mimbon*, whereas the splitting up of the "blue" and "yellow" groups requires considerably more steps.

In this step by step procedure you will be led by figures which indicate the next step. So if you want to classify males of a certain phenotype, you just have to check the appropriate colour feature and if it is present, you then move on to the next number indicated.

If everything goes according to plan, you will finally arrive at the lowest level, which should tell you what strain the fish belongs to.

Identification Key for Males of the "*cameronense*"-group

1a. The body ground colour is a uniform metallic blue to greenish with red pigments; this colouration extends from the head to the root of the caudal fin; there is a complete absence of yellow on the flanks...2
1b. On the caudal peduncle there is a yellow blotch, beginning below the dorsal, ending at the root of the caudal; the front half of the body appears blue, the rear half yellow..3
1c. Above the blue-green ground colour of the flanks there are on the caudal peduncle numerous large red blotches, which partially merge with each other; neither a medio-ventral band nor a zig-zag band are visible..4
2a. The medio-ventral band and the zig-zag band are with regard to their length formed as described for *Aphyosemion cameronense*...5
2b. The very dense pigmentation consists of red spots and forms 3 to 4 parallel lines..6
2c. Either the upper or both bands are absent..7
5a. Both red bands on the rear part of the body correspond to the pattern typical of the species group...8
5b. The red bands are very broad and the space between them is therefore narrower than they are; in places both bands merge; the anal has a white to pale blue marginal band, there then follows a very broad submarginal red band, the central area is light blue, the base of the fin is also red in colour, the red parts clearly predominate over the blue colouration..*Aphyosemion haasi*
8a. The anal fin has a narrow whitish to pale blue marginal band, above which there is usually an equally narrow red submarginal band; the two together cover at most half of the breadth of the fin; the central area of the fin is pale with red blotches or streaks..*Aphyosemion cameronense*
8b. The anal fin has a very broad yellow marginal band, which is bordered by an equally broad red submarginal band; the basal area of the anal fin has a scattering of a few red spots...Phenotype 2
6a. The red lines consist of spots that merge with each other, giving the impression of "linemarkings" ....*Aphyosemion obscurum*
6b. Along the lines on the flanks each individual scale seems to be red in colour, so that regularly arranged rows of spots results; the red spots do not merge with each other...Phenotype 1
7a. On the flanks there are numerous red blotches, which form a "trellis" pattern, especially on the caudal peduncle; neither the upper nor lower red band is clearly visible..Phenotype 6
7b. The medio-ventral band is very broad and begins below the gills; the (upper) zig-zag band is replaced by red pigmentation, which is also present on the front part of the body; the anal fin is almost completely dark red in colour.........................Phenotype 7
7c. Over a light blue ground there are just a few red spots, which are isolated from each other and arranged irregularly; this colour pattern corresponds to some sparsely spotted populations of *Aphyosemion gardneri/Aphyosemion scheeli*; the caudal also has isolated red spots..Phenotype 8

3a. The red pigmentation on the flanks is very dense and forms parallel lines............9
3b. The medio-ventral and zig-zag bands are of the form typical of *Aphyosemion cameronense*...10
3c. On the flanks there is just a very small number of red spots, the zig-zag band is only hinted at, the medio-ventral band is poorly defined and very short; red colouring seems to be present only to a minimum extent; the caudal is covered with numerous red dots; both red submarginal bands are absent...Phenotype 5
9a. The red spots on the flanks are separated from each other, so that each individual scale seems to be red in colour (see Phenotype 1); the colouration of the caudal peduncle has rather a tendency to be orange-yellow..Phenotype 4
9b. The red spots merge with each other, as described under *Aphyosemion obscurum*; the Yellow Blotch on the caudal peduncle is considerably smaller than on the other forms with this feature..Phenotype 9
10a. The caudal corresponds in its general colour pattern to that of *Aphyosemion cameronense*; two marginal bands are bordered by a red submarginal band towards the centre of the fin; the outer bands give the appearance of a lyre shape.....................11
10b. The dorsal is only yellow in the distal area; the upper edge of the caudal does not have a marginal band, the lower marginal band is pale blue in colour, like the rest of the fin; the anal fin has no white marginal band.......................*Aphyosemion halleri*
11a. In most populations the dorsal fin is not a clear yellow; the caudal has two well developed marginal bands, which are yellow, pale blue or whitish in colour; the marginal band on the anal fin is whitish and narrow............*Aphyosemion amoenum*
11b. The caudal fin is covered with red spots and streaks, so that as a whole it has a relatively large proportion of red colouring; the colour pattern of the dorsal fin corresponds to that of *Aphyosemion cameronense*; only the central area has a denser concentration of red blotches and flames which merge with each other; the anal fin has a broad white marginal band and a dark red submarginal band; towards the centre of the fin a few red spots can be seen..Phenotype 3
4a. The pattern on the anal fin is equally blue and red in colouring; on only a few populations does it have a narrow yellow marginal band, but the inner area of the fin always has red mottling; the dorsal is also blue-green with irregular red blotches and flames; the cau-dal fin is in its central area covered with red spots and blotches..*Aphyosemion maculatum*
4b. The dorsal and anal fins are always yellow coloured in the outer area; the anal fin has no blotches or spots but just a broad red submarginal band in several populations; the colour pattern of the caudal fin differs from those of the other forms of this species group: the two marginal bands are broad and always bright yellow, their shape and extent on the caudal fin does not correspond to the pattern known from *Aphyosemion cameronense* and similar forms; the central area of this fin has no red blotches or streaks but is a uniform dark red in colour..*Aphyosemion mimbon*

Identification Key for Males of the "*cameronense*"-group

To demonstrate how such a key can analyse the subgenera and species groups within the genus *Aphyosemion*, we have produced below a second identification key for the representatives of the "*cameronense*"-group, in which the previously very important criterion of the Yellow Blotch is not used to separate the individual forms until the later stages.

We can in fact also set up an identification key based on other characteristics, resulting in a quite different division of the species and phenotypes into "striped" and "non-striped" groups (= depending on whether the red pigmentation on the flanks is typical or atypical of *Aphyosemion cameronense*) and finally a "blotched" group.

The user of this key should again go through it step by step as indicated by the numbers; to avoid any confusion with the previous key, we have used Roman numerals I, II, III,...

Ia. On the flanks there are three or four parallel horizontal rows of numerous red spots and blotches, the top one of which is usually the longest and the lowest the shortest...II

Ib. The red pigments are not arranged in lines but form the medio-ventral and zig-zag bands; only on the front part of the body are three short rows of spots to be seen...III

Ic. The pigmentation on the flanks does not correspond to that of *Aphyosemion cameronense*; instead either the upper or both the red bands on the rear half of the body are absent or only very faintly suggested..IV

Id. The whole caudal peduncle is covered with numerous large red blotches, which in part merge with each other; neither a medio-ventral nor a zig-zag band are clearly visible...V

IIa. The rows of spots consist of pigments that merge with each other, giving the impression of completely continuous lines..VI

IIb. The individual red spots are isolated from each other: one is inclined to say that a red spot lies on each individual scale..VII

VIa. The whole body has a metallic blue-green ground colour, on the flanks there is no hint of any yellow... *Aphyosemion obscurum*

VIb. Immediately before the root of the caudal fin there is on the caudal peduncle a roundish to slightly longish Yellow Blotch, but which never extends as far as the ray of the dorsal or anal fin...Phenotype 9

VIIa The ground colour of the flanks is again a uniform metallic blue to greenish colour, but it can also assume a copper-coloured shade......................................Phenotype 1

VIIb. On the caudal peduncle there is a Yellow Blotch, which can definitely extend as far as the first ray of the dorsal or anal fin; in many specimens its colouration can become an attractive orange colour...Phenotype 4

IIIa. The whole body has a metallic blue-green ground colour; there is no yellow visible on the flanks..VIII

IIIb. On the caudal peduncle there is a Yellow Blotch, which can easily extend as far as the first ray of the dorsal or anal fin..IX

VIIIa. The medio-ventral and the zig-zag bands are in their patterns as described for *Aphyosemion cameronense*; depending on population and place of origin they begin below the root of the dorsal or anal fins...X
VIIIb. The red bands are very broad and the space between them is narrower than they are; in places both bands merge; the anal fin has white to pale blue marginal bands, inside which there is a very broad submarginal red band; the central area is a pale blue, and the root of the fin is red again; the general impression is of the red colour clearly predominating over the blue colouration.....................................*Aphyosemion haasi*
Xa. The anal has a white marginal and a red submarginal band; it is never yellow in colour..*Aphyosemion cameronense*
Xb. The anal fin has a very broad marginal yellow band, which is bordered by an equally broad submarginal red band; the basal area of the anal fin has a sprinkling of red spots...Phenotype 2
IXa. The markings on the anal fin are as described under *Aphyosemion cameronense*..XI
IXb. The dorsal fin is yellow only in the distal area; the upper edge of the caudal has no marginal band, the lower marginal band is light blue in colour, like the rest of the fin...*Aphyosemion halleri*
XIa. The marginal band on the anal fin is always narrow and whitish to bluish; the marginal bands on the caudal are mostly yellow...................*Aphyosemion amoenum*
XIb. The marginal band in the anal fin is broad and pure white; it is bordered by an equally broad red submarginal band; the two marginal bands on the caudal fin are always a pure white...Phenotype 3
IVa. The whole body has a metallic blue-green ground colour; no yellow is visible on the flanks..XII
IVb. The caudal peduncle has the Yellow Blotch; the zig-zag band is absent, while the medio-ventral band is very short and narrow or else poorly developed; there are very few individual red spots on the flanks; caudal thickly covered with red dots..Phenotype 5
XIIa. On the whole surface of the flanks there are numerous red spots and blotches, which develop into a reticulated pattern in the area of the caudal peduncle; the medio-ventral and zig-zag bands are absent or just suggested; the colouration of the caudal fin corresponds to the pattern of *Aphyosemion cameronense*........................Phenotype 6
XIIb. The medio-ventral band is very broad and begins below the gills; the (upper) zig-zag band is replaced by red pigmentation, which is also present on the front part of the body; the anal fin is almost entirely dark red..Phenotype 7
XIIc. Over the light blue background of the flanks there are only a few individual red spots isolated from each other, and arranged irregularly; this colour pattern corresponds to some slightly spotted populations of *Aphyosemion gardneri*/*Aphyosemion scheeli*; the caudal fin also has a few separate red spots......................................Phenotype 8
Va. The anal fin has a pattern of equal amounts of red and blue colouring; in only a few populations it has a narrow yellow marginal band; the inner area of the fin, however, is always mottled red; the dorsal is also blue-green with irregular red blotches and

streaks; caudal has numerous red spots and blotches in the central area. *Aphyosemion maculatum*

Vb. The dorsal and anal fins are always yellow in the outer area; the anal has small blotches and spots, but only in some populations a broad red submarginal band; the colour pattern of the caudal differs from those of the other forms of the species group: the two marginal bands are broad and always a strong yellow in colour, their form and extent on the caudal fin not corresponding to the pattern known from *Aphyosemion cameronense* and the forms similarly coloured in this respect; the central area of this fin has no small red blotches or streaks but is a uniform dark red....*Aphyosemion mimbon*

It may be possible to create a third identification key with yet another sequence of criteria, but then one would end up going round in circles. The practical use of it would therefore be questionable.

We hope that these two keys will be of some help in identifying representatives of the "*cameronense*"-group and thus avoiding wrong namings in the future as far as possible.

Of course these two identification keys are neither comprehensive nor infallible. Indeed with time they should be extended and refined. Newly discovered populations and phenotypes (from Equatorial Guinea, the Congo Republic and Cameroon?) might mean the keys will need extending and being brought up to date.

As this could only have a positive effect on our knowledge of these killifish, we hope that in this area there will be as much fruitful co-operation as possible among all those interested in these fish!

Aphyosemion spec. aff. cameronense Phenotype 3 "CGE 91/6"

Previous Publications on the "*cameronense*"-group

In the **Introduction** we pointed out that in the course of time our knowledge about killies has become more and more comprehensive, resulting in an increasing specialisation of the literature. This is true not only of killies in general, but also for individual genera, subgenera and even individual species. These publications can be divided into three groups, depending on their contents; reports on collecting trips, reports on breeding and scientific publications. The different authors have varying methods and purposes in writing, so there are considerable divergences when it comes to form, compass and use of aids such as maps, pictures of fish, drawings and tables.

In this chapter we intend to mention briefly some of the outstanding publications that deal with the representatives of the "*cameronense*"-group and make a few comments on them. If we were to discuss all the books and articles on these fish, this book would need to grow in size considerably. Many killie enthusiasts have published in the DKG-Journal or fish-keeping magazines reports on breeding, in which they describe from a practical viewpoint their special experiences with representatives of the "*cameronense*"-group. We therefore ask for people's understanding in our having to make a certain selection and leave some material out.

We can wholeheartedly recommend that the interested reader acquire or read the literature given below and also the publications listed in the Bibliography. Should anyone have any problems, we will be pleased to help at any time (see also the chapter **Summing-up**).

Cyprinodontidenstudien im südlichen Kamerun, 4. Das Inlandplateau im südwestlichen Ostkamerun is the fourth part of a series of articles in the magazine "Aquaria", published by RADDA in 1971. On pp 157 to 167 various aspects are discussed, such as geography, climate, vegetation, chemical qualities of the water in the biotopes and some localities with their fish fauna.

A map, five photographs of localities and five pictures of *Aphyosemion*, *Epiplatys* and *Aplocheilichthys* give a detailed impression of the killifish of south Cameroon.

A supplement to it contains the first description of *Aplocheilichthys camerunensis*, a small lamp-eye.

Der *Aphyosemion cameronense*-Komplex by RADDA and PÜRZL in the DKG-Journal, year eight, 1976 (pp 131 to 144) contains a comprehensive presentation of the distribution of these killifish in south Cameroon and north Gabon based on the collecting work of the authors. Also included are the resulting descriptions of *Aphyosemion amoenum* (pp 134 to 138), "*Aphyosemion cameronense halleri*" (pp 138 to 140) and "*Aphyosemion cameronense haasi*" (pp 140 and 141). There are in this article a total of twenty colour and black and white photographs of both sexes of *Aphyosemion cameronense*, *Aphyosemion obscurum*, the forms described in the article and some phenotypes divergent from *Aphyosemion cameronense* (Phenotypes 2 and 5 according to our definition?), as well as a distribution map and a table with meristic data.

***Cyprinodontiden*-Studien in Gabun, II. Nordgabun** is the second part of a series of articles, in which RADDA and PÜRZL published in exemplary fashion the results of their collecting work in Gabon. On pp 21 to 31 in the "Aquaria" magazine of 1977 the killifish of the Bitam-Lalara and Lalara-Makokou stretches are discussed with two maps and eight photographs of *Aphyosemion* and *Diapteron*. A table contains the chemical and physical data of some water readings taken from killifish biotopes in north Gabon.

This work also deals with *Aphyosemion herzogi*, *Diapteron georgiae* (at the time still regarded as *Aphyosemion*), *Aphyosemion kunzi* and *Aphyosemion batesii*, which had been described only a short time previously and about which very little was therefore known. In the appendix that starts on page 27 there follows the first description of *Aphyosemion maculatum*, which on three pages contains four photographs of two males and two females from the terra typica, which is the authors' locality "G 40/75".

The article ends on pp 29 to 31 with the first description of *Aphyosemion punctatum* with the terra typica "G 37/75", four kilometres west of the Mvoung near Ovan.

Une chaîne de deux *Aphyosemion* sympatriques dans les monts de Cristal, Gabon, avec description d'une espèce nouvelle: *A. mimbon* n.sp. is the title of the eight page long article by J.H. HUBER in the Revue française d'Aquariologie 1, which was published in Nancy on 15th June 1977. After the introduction the author puts forward some theories on sympatry (= distribution in the same area) of yellow and blue species of the genus *Aphyosemion*, which are explained with some examples from the Monts de Cristal in north Gabon. Then the localities "JH 48" to "JH 56" fished in August 1976 are discussed, illustrated by six photographs of biotopes. HUBER finally discusses the findings made in the wild and on pp 8 and 9 describes a new species of the "*cameronense*"-group: *Aphyosemion mimbon*.

The article contains a total of thirteen photographs of killifish, two black and white drawings, two close-up photographs of the frontal scalation and a table of the meristic figures and proportions.

The second part deals with an investigation of the sympatric killifish, namely *Aphyosemion herzogi* s.l. and the north Gabon forms belonging to *Aphyosemion cameronense* which HUBER calls "blue".

With regard to the Song population, herein called Phenotype 6, HUBER describes the colour pattern and then writes at the top of page 10: "L'ensemble de ces observations tendrait à montrer que ces caractères sont bien fixés et que l'on pourrait créer un nom nouveau pour désigner ce phénotype, surtout celui de la population no° 55".

This could be translated as follows: "These observations as a whole would tend to show that these characteristics are definitely fixed (= constant) and that one could create a new name to define this phenotype, especially the one from population no 55".

HUBER here suggests that the Song male in particular is a strongly divergent form of the "*cameronense*"-group, which it would be justifiable to raise to the status of a separate species.

A female of the "Bélinga" strain from north Gabon, which we call Phenotype 4 because of the special body colouration of the male

This female *Aphyosemion mimbon* belongs to the "LEC 93/18" strain

This male with its intensive red anal fin belongs to the *Aphyosemion amoenum* population which was imported as the "Dibang" strain

This is a male *Aphyosemion mimbon* "GWW 86/30"

Rapport de synthèse sur l'expédition au Congo (1978) Cyprinodontidés récoltés et *Micropanchax silvestris* synonyme de *stictopleuron* sounds complicated, but it is just the title of an article by Dr HUBER in the Revue française d'Aquariologie of 26th May 1982. In it he reports on the killifish collected in the Congo Republic in 1978. He uses the opportunity to explain that the taxon *silvestris* is a synonym of *stictopleuron* (a lamp-eye fish).

The twelve pages contain nine colour pictures of killifish and five maps. In addition HUBER lists his localities "RPC 101" to "RPC 180" and eleven further localities of J. BUYTAERT ("RPC 251" to "RPC 253" of August 1980).

Of crucial importance to us are the localities where representatives of the "*cameronense*"-group ("*Aphyosemion cameronense*" according to the author's data) were found in the extreme north-west of the country.

Killifische aus aller Welt is the title of a series of field guides for the coastal countries of Central Africa, which were published by RADDA and PÜRZL in the mid eighties. Volumes 3 (east Cameroon) and 4 (Gabon) also contain some data and colour and black and white pictures of *Aphyosemion cameronense*, *Aphyosemion haasi*, *Aphyosemion maculatum* and *Aphysemion mimbon*.

Each species is given a double page which has a picture, distribution map and data in the form of an information pamphlet. These books are ideally suited for the speedy identification of killies found while collecting in these countries. They should be in the library of every serious killifish enthusiast.

Faune du Cameroun - Fauna of Cameroon, 2. - Le genre *Aphyosemion* MYERS The genus *Aphyosemion* MYERS is the bilingual title of the book by J.L. AMIET, which deals with the killifish of the genus *Aphyosemion* in Cameroon. Ten tables with numerous black and white drawings illustrate the colouration features and fin shapes, which AMIET draws on to separate the species and phenotypes. 34 distribution maps (one for each species!) have a standardised squared format which enables one to compare the spread of the species.

36 colour plates with a total if 132 colour pictures of males and females give one the unique opportunity to compare the *Aphyosemion* species of Cameroon directly with each other.

In connection with the "*cameronense*"-group, as we have mentioned several times already, the splitting off of the three phenotypes is especially significant and has given us a clear model of how the divergent forms from Cameroon and Gabon known at present might be separated from each other.

Although this work was written on a very high scientific and linguistic plane, we would warmly recommend it to the lovers of the colourful *Aphyosemion* species of Cameroon who want to go into these fish more seriously.

Bemerkungen über die Sammlung der *Cyprinodontiformes* (*Pisces*: *Teleostei*) des Zoologischen Museums Berlin, I. Die Gattungen *Aphyosemion* Myers, 1924 und *Fundulosoma* Ahl, 1924. Teil 2 is the lengthy title of a scientific publication by Lothar Seegers, which was published on 29.4.1988 in the "Mitteilungen des Zoologischen Museums Berlin" 64 (1988) 1, pp 3 to 70.

The author presents the results of his own investigations which he carried out on the preserved specimens in the museum mentioned. His work enabled him to make clear statements on some taxa, which it had earlier been impossible to investigate sufficiently.

On pp 8 to 12 the taxon *Aphyosemion cameronense* (Boulenger, 1903) is discussed. Seegers deals with the many names which can be regarded as synonyms of this species and gives a large number of publications which should be referred to in this context. Some of his findings were a great help to us.

Typuslokalität: Belinga (Gabun) is the title of a four page article by Roland Numrich in the DKG-Journal year 21, Vol. 1, of January 1989 (pp 9 to 12), in which the author describes his collecting work and experiences in the area around Bélinga in February 1987. Two colour pictures show *Diapteron georgiae* and *Diapteron cyanostictum*; there are also black and white pictures of a male *Aphyosemion spec. aff. cameronense* from Bélinga (our Phenotype 4) and of a female *Diapteron cyanostictum*.

A very good drawing shows how the species occupy different parts of the stream. One can see how the *Aphyosemion*, *Diapteron* and *Epiplatys* stay in the places suited to them and thus practically divide the biotope between each of them.

Atlas of Killifishes of the Old World is the title of the wonderful book that Scheel wrote on the *Rivulinae* of the old world (= Africa and Asia). It was published in 1990 shortly after his death. Besides a very large number of colour pictures of a wide range of killifish, the book contains some results of research obtained by Scheel from his investigations on chromosomes. To this day this book remains unrivalled in its wealth of information and in its unique presentation of numerous killifish.

The individual species are not divided into genera but are dealt with in alphabetical order, where there are also colour pictures of *Aphyosemion cameronense*, *Aphyosemion obscurum*, *Aphyosemion haasi* and *Aphyosemion halleri*. The author uses abbreviations made up of three letters to indicate the individual killies (CAM, OBS, HAL, HAA, MAL, MIM, RAD and many others).

Scheel considers the taxon *obscurum* a "valid subspecies", thus recognising it as a separate subspecies of *Aphyosemion cameronense*. This opinion has been accepted by most subsequent authors. The taxon *haasi* is given the label "status uncertain", whilst the taxon *halleri* is regarded as a "synonym of *cameronense*".

While his view on "*haasi*" can be justified, his classification of the Ambam fish is in direct contradiction to AMIET and our own experiences in Cameroon. On page 241 he writes: "They did not point out by which characters HAL can be separated from CAM s.s.".

In other words he is saying that the authors of the first description, RADDA and PÜRZL, do not in his opinion explain by what characteristics HAL (=*halleri* according to RADDA and PÜRZL) can be separated from CAM s.s. (*cameronense* sensu stricto)".

This attempt to synonimise the taxon "*halleri*" with *Aphyosemion cameronense* can be refuted very easily. On page 134, just a few pages before the first description of "*Aphyosemion cameronense halleri*" (i.e. in the same publication), RADDA and PÜRZL write: "The Ambam populations show in their meristic data scarcely any differences from the previously known populations of *Aphyosemion cameronense*, but their markings and colour pattern are clearly separable, particularly in the strong orange shading to the caudal peduncle and the large red flamed pattern on the deep blue unpaired fins of the males".

These are just the characteristics that SCHEEL required. Whilst in his book he accepts *Aphyosemion amoenum* as a valid species, the equally divergent *Aphyosemion halleri* is regarded as "*Aphyosemion cameronense*", and the similarly divergent *Aphyosemion obscurum* is considered to be just a subspecies of *Aphyosemion cameronense*. We see in this classification certain inconsistencies, which could be resolved by further investigations; either *Aphyosemion amoenum* and *Aphyosemion halleri* are separate species, or both of them should be regarded as synonyms of *Aphyosemion cameronense*.

Aphyosemion maculatum and *Aphyosemion mimbon* are placed in the "*cameronense*"-group, since SCHEEL found in his chromosome investigations arguments for placing them there (page 134 of the publication quoted).

This wild male of Phenotype 3 comes from locality "CGE 91/4"

Summing-up

As we come to the end of our discussion of the killies dealt with in this book, we would like to express some more ideas about what we know at present about these killies, what still needs "researching" and what the consequences are for the killie enthusiast who wishes to work responsibly with these superb fish.

In the previous chapters we have presented our findings and personal views regarding the "*cameronense*"-group. We place special emphasis on the fact that we do not have available to us all the information that may have been obtained on these killifish.

In addition we see some of the facts in a different light to many of the authors and killie enthusiasts who have been involved with the small *Aphyosemion* species and this species group in particular.

But who is in the position to interpret and judge with absolute objectivity facts observed in the wild?

What do we know about the "*cameronense*"-group?

The number of biotopes with representatives of this species group, which it has been possible till now to visit in the countries of Cameroon, Gabon, Equatorial Guinea and the Congo Republic is undoubtedly huge, even if it cannot be quantified exactly. In practice we have to limit ourselves to the streams that are situated alongside passable roads or a few hundred metres from inhabited places.

Between them, however, there are immense areas of forest, whose streams and pools are undoubtedly lived in by species and phenotypes of the "*cameronense*"-group. If we compare these with the number of streams investigated to date, then the latter represent a very small proportion. It can be said that we know a correspondingly small number of the populations that exist in the wild.

Systematic collecting of these killies has shown that the males of neighbouring populations can be distinguished by small differences in the body colouration. With a little experience they can be placed in certain localities, even when the distances between the streams are in our view very small.

On the other hand the high degree of variability in these species means that it does not seem possible to "predict" or guess what the colouration of males will be in a certain stream, even if the colour patterns of the neighbouring populations are known. To a certain extent the same may possibly be said for the species and phenotypes.

To date meristic data have been taken from less than 5% of the known populations of the representatives of the "*cameronense*"-group. Frequently such investigations were carried out only on the type specimens, whose finding places were either the terra typica itself or neighbouring streams.

Scheel's work on the number and shape of the chromosomes can be seen as a promising method of explaining the variability in colouration of the species (and subspecies in his sense) or at least recognising connections between both observations. In any case they covered only a very small percentage of the populations available at that point in time. Unfortunately since his death these investigations have not been continued.

What steps need to be taken in the future for these killifish to be better understood?

Not until new roads are built will regions be opened up; then it will be possible to investigate them for their killifish fauna (and of course for new plants and animal life). Then further forms of this species group may be discovered, which differ from the previously described species and phenotypes discussed in this book. This may provide us with more riddles (or help us to clear up existing questions?). The information available at the present time on the distribution in certain areas and on the colour patterns of the males is limited, so we consider further collecting work to be essential. In this book we have indicated quite specifically on several occasions the regions which need to be investigated intensively and systematically for representatives of the "*cameronense*"-group. This would teach us considerably more about the "sharp" distribution frontiers known to date and the relationships with other species or species groups.

In addition collecting in areas which have received but scant attention hitherto should produce further examples of species or phenotypes that are direct neighbours. We would not wish to exclude the possibility of many other cases being found sooner or later in which two representatives of the "*cameronense*"-group are found at a distance of less than one kilometre from each other and moreover possibly in the same hydrographic system. This means finding this invisible "frontier", which demands a lot of collecting in a very limited area. One would have to collect virtually all around each village along the road and also in every stream crossing the road. The colour patterns of the males would have to be recorded photographically or by sketches, so that they can be compared later. A comparison of the females, based on the poorly developed colour features on the flanks and unpaired fins could extend the identification keys produced by us and provide new findings on the relationships and criteria for separating the species and phenotypes.

Following on from this, pure tank bred strains or even wild fish could be used for crossing experiments. In this field it is worth looking for reproductive frontiers between the species and phenotypes. If two populations of two species or phenotypes (or also subspecies in the opinion of some authors) are fertile only when crossed to the second or third generation, this will support the splitters, who regard these forms with divergent colouration and their own distribution area as separate species.

If the hybrids of two divergent forms are viable for an unlimited number of generations, then the two forms could be regarded as "colour or local forms" of the same species. This would support the views of lumpers.

At the same time one should also deliberately cross strains of the same species or the same phenotype. Then cases might arise of intersterility also between populations which are almost identical in colouration. In this case not too much attention should be paid to the crossing experiments. There is not much sense in considering as a separate species a population which is genetically isolated but not very divergent in its colouring. This would also lead to the unnecessary description of many new species.

Of particular interest would be the hybridisation of populations of a form occurring a great distance from each other; it could be that fish from the opposite frontiers of an externally identical form are no longer able to cross with each other for an indefinite number of generations.

Speciation would be encouraged by the isolation in small forest streams together with the limited tendency to wander within a river system. Possibly local or regional factors first cause differences in the colour pattern of the populations, which are then followed by genetic changes. Or do geographically separated species do things the other way round by developing in different directions genetically, which then results in divergences in colouration?

These differences should be researched by chromosome investigations following on from SCHEEL's work. But it is questionable whether there are connections between the ability to hybridise or intersterility and the number of chromosomes.

To find further differences between the representatives of the "*cameronense*"-group, behavioural biological experiments should be carried out (see page 218) and the meristic data of as many populations as possible be investigated and compared with each other. Perhaps the reader will be presented with arguments for the splitting up of the "*cameronense*"-group or for bringing together forms into a few "large" species.

Radiophotography offers the possibility of investigating the structure of the skeleton. It could also provide a considerably easier and more accurate way of counting the number of fin-rays. What part does the number of vertebrae play within the "*cameronense*"-group? Might it be possible to see clear differences between the species or phenotypes, which would then also support the views either of the splitters or of the lumpers?

Finally electrophoresis could produce information on whether all the populations of a species or phenotype have the same protein structure. Are there differences within a group of strains very similar in colouration or do all representatives of the "*cameronense*"-group have the same protein structure?

Is it possible that "groups" of species or phenotypes could be placed together, because their protein structure makes them more closely related to each other than to the other forms? Would our artificially produced "blue", "yellow", "striped" and "blotched" groups be allowed to stand, or would these forms have to be reclassified according to other criteria? Might this method produce conclusions in general on the relationships within the "*cameronense*"-group? Are there "older" or "younger" forms?

With all these investigations it is not so much a matter of trying to find the one valid characteristic that makes species valid - in so far as such a characteristic actually exists! Instead the assertions made in the first descriptions should be checked, so that they can be confirmed or refuted with as many arguments as possible.

One could then establish which of the distinguishing characteristics are of critical importance (body colouration, geographical distribution, meristics, genetic isolation, ability to hybridise, protein structure, skeletal structure and perhaps more); also whether these can be arranged in order of their importance.

Finally there is the clarification of a phenomenon which we in this book have called the Yellow Blotch. This striking characteristic was recognised by RADDA and PÜRZL and used as an argument for the description of *Aphyosemion amoenum* and *Aphyosemion halleri* (or *Aphyosemion cameronense halleri*).

AMIET (1987) recognised that there is in Cameroon a third form with a Yellow Blotch on the caudal peduncle and he called it "Phenotype 3". On page 240 he puts forward an explanation for the appearance of this characteristic:

> "It is not possible to say for the present if the "yellow caudal peduncle" characteristic appeared separately in several races of the *A*. *cameronense* group, or if, on the contrary, it is evidence of phylogenetic affinities between *A*. *amoenum*, *A*. *halleri* and the phenotype described above. In the latter case, it would be possible to imagine the existence of a species with a yellow caudal peduncle, firstly widely distributed, then supplanted little by little by *A*. *cameronense*, and whose remaining, widely separated populations, have evolved independently to give *amoenum*, *halleri* and this phenotype no. 3."

This analysis of the situation in Cameroon is a model for the future treatment of the whole "*cameronense*"-group.

AMIET does not try to place the three Cameroonian forms with the Yellow Blotch together in one species but considers the taxa "*amoenum*" and "*halleri*" to be separate species. However he does not commit himself on Phenotype 3. On the other hand he does suggest a logical explanation for this phenomenon.

Aphyosemion amoenum and Phenotype 3 exist at the very edge of the distribution frontiers of the "*cameronense*"-group and are thus "frontier or satellite forms". At present it cannot be said for certain that this is true of *Aphysemion halleri*, as it seems highly likely that it is to be found in Equatorial Guinea, at least to the west of Ebébiyin (see also the map on page 324).

Nevertheless one gets the impression that these three forms of what we call the "yellow" group in Cameroon forms an arc or semi-circle at the edge of the distribution area of the "*cameronense*"-group which is broken in many places. This adds logic to AMIET's assertion that an "old" species with a yellow caudal peduncle inhabited the present distribution area of the "*cameronense*"-group (or an even larger area?) and was then replaced by the stronger species *Aphyosemion cameronense*.

This new species could have originated in the centre of this area and spread outwards roughly in a circle, with the result that isolated "forms" with this yellow caudal peduncle only still exist in places on the edge of the area. These forms became geographically and genetically separated due to *Aphyosemion cameronense* and then developed into separate species.

This theory sounds logical and is supported by the fact that the form we define as Phenotype 9 occurs south of *Aphyosemion amoenum* and to a certain extent to the north of *Aphyosemion halleri*. Phenotype 9 completes the arc or semi-circle mentioned above, even if there are still gaps, i.e. areas on the edge of the group's distribution area which are inhabited by "blue" forms (*Aphyosemion cameronense*, *Aphyosemion obscurum*, Phenotype 1).

The facts we have presented for the representatives of the "*cameronense*" in Gabon seem to build on to the mosaic begun by AMIET. Phenotypes 4 (Bélinga) and 5 (Koumaméyong) also occur on the edge of the distribution area. The last named phenotype is actually the most southerly form of the entire "*cameronense*"-group.

To illustrate this situation, we have tried to show with the coloured general map on pp 460 and 461 the position of all the species and phenotypes known to us at present. The ring-shaped arrangement of forms with the Yellow Blotch can in fact be seen.

In addition we recognise that other members of this species group, which are not *Aphyosemion cameronense* itself, can be found on the edge of the distribution area (*Aphyosemion obscurum*, *Aphyosemion maculatum* and Phenotypes 1 and 6). This situation poses new questions, which also need specific investigations, as far as circumstances allow. What connections are there between the three "striped" or the two "blotched" forms? Will they produce viable crosses? Are there meristic differences? To find the answer to these questions, the methods mentioned on pp 458 and 459 could be used. There are also numerous indications under the relevant species and phenotypes.

What are the resulting guidelines for the responsible aquarist to follow?

Anyone who looks at the colour pictures of representatives of the "*cameronense*"-group and also the whole *Aphyosemion* genus or has the opportunity to visit an aquarist friend and see them in a beautifully set up aquarium, will sooner or later wish to keep these fish so that they can enjoy them at home every day.

The first rule should be to give the killies the best possible conditions and to keep these strains pure, so that their uniqueness among aquarium fish can be preserved.

Crossing experiments should only be carried out as part of intensive scientific work; hybrid strains should be known as such and should only be distributed with an absolutely accurate identification. In no circumstances should pure strains be crossed without proper records being kept. In a very short time impure strains can destroy the work of years of people trying to keep the strains pure. This makes the unimpeded exchange of information and experiences essential.

Anyone who has the opportunity to visit the distribution area of these killifish and plans to collect fish there, should do this conscientiously and with thorough preparations (see also HUBER, 1994, pp 204 and 205). We are always happy to help you with information on localities and our experiences and personal connections in Cameroon and Gabon.

In certain areas in particular, when one looks for representatives of the "*cameronense*" group, valuable information can be obtained on the distribution frontiers, syntopic killifish, the *Aphyosemion* that replace this species group and the occurrence of hitherto unknown phenotypes.

Of course this includes most particularly Equatorial Guinea and the north-west of the Republic of Congo; but also regions easier to travel in, such as the area between Yaoundé and Diang or the areas around Eséka, Lolodorf and Ambam are all worth collecting in.
If you are also looking for specific strains for the aquarium or need information of any kind you can write to these addresses:

Norbert Dadaniak	Reinhard Lütje	Wolfgang Eberl
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D-40597 Düsseldorf	D-40597 Düsseldorf	D-73614 Schorndorf
Germany	Germany	Germany

We too will be grateful for any kind of information that we can get on localities which are new or unknown to us.

We would also be happy to receive criticism in any form. All encouragement and suggestions will be welcome. For the widening of everyone's knowledge will always help us to learn a little more. Even if new questions and "problems" are produced, this is much better than the present situation, which allows Amiet's phenotypes and the forms we consider divergent to be considered "normal *cameronense*".

Aphyosemion spec. aff. cameronense Phenotype 6 (locality "GEB 94/24" near the village Etsam I)

Acknowledgements

In the final part of this book we would like in this chapter to thank as many people as possible who have helped us during the three years it has taken to produce all the material for this work. It is certainly not simple to convey these thanks, and there is always the danger that someone will be forgotten or not given an appropriate mention.

We have therefore decided, after giving our friends' names, to mention the help and support they have undoubtedly contributed to the success of the present book, even if a direct connection is not obvious at first glance. We are consciously avoiding saying how much they all actually contributed, as we think this would be simply impossible. This is also reflected in our decision to list people in alphabetical order. Any person can then be found by looking up his or her surname.

At least as important as the mention of the work produced is the acknowledgement that such a book can never be written and produced alone.

So the following list contains the names of many people who in many cases do not know each other, but they all have one thing in common: they have helped us a great deal!

We may have been able to provide killifish enthusiasts and aquarists a small example of how working together usually achieves more than working in isolation. This has proved true for us above all within the Deutsche Killifish Gemeinschaft (German Killifish Association) and through our friendship with numerous members of other killifish associations (there are unfortunately perhaps cases where a different attitude has been apparent, but we have declined to mention them here).

Should these acknowledgements not be complete, we apologise to those concerned.

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Manfred STEINS / Bergheim-Hüchelhoven, assisted us with his invaluable help in breeding populations of the "*cameronense*"-group which were very important to us. In addition he contributed to the maintenance of many strains by successfully breeding them and passing them on to interested aquarists.

Klaus Szafranek / Bochum, placed at our disposal some of his strains of the "*cameronense*"-group as well as pictures of them, which we could use for purposes of comparison. We had stimulating discussions with him on the problems involved in keeping and breeding these killifish.

Detlef Tillmanns / Düsseldorf, helped one of the authors with a lot of advice on photography. Without his help, it would not have been possible to produce such high quality colour pictures.

Jean Pol Vandersmissen / Marcinelle, in his capacity as Chairman of the Association Killiphile Francophone de Belgique arranged for one of the authors to give a slide lecture in Belgium on the representatives of the "*cameronense*"-group, which brought these fish closer to a wide circle of killie enthusiasts.

Peter Wagner / Gomaringen, took part in the collecting trip "GWW 86", which resulted in numerous localities of representatives of the "*cameronense*"-group, and which contributed a great deal to our knowledge of their distribution. He placed at our disposal his information on these biotopes as well as the wealth of his experience in all aspects of killies.

Johnny Walker / Great Britain, supported the translation of this book into English by making his computer available for bringing the text on floppy disks and correcting Peter Watkins' translation.

Peter Watkins / Great Britain, was willing to translate the entire text of this book from German into perfect English. Without his help it never would have been possible for us to create the English edition in such a quality.

Klaus Wencher / Deilingen, taught one of the authors how to be a serious and competent aquarist; he was always happy to pass on his wide experience.

Roland Wendel / Mühlen am Neckar, helped us with his findings on the killifish of north Gabon, the biotopes of which he visited in January 1986. His skill as a fish breeder made possible the distribution of many strains from the "GWW 86" trip, which today still represent a considerable proportion of these fish still in the hobby.

Pauline and Keith Wilbraham / Manchester, kindly enabled one of the authors to give a lecture at Manchester; the long conversations with them provided further encouragement for this book.

Klaus-Peter Zerbst / Darmstadt, allowed us to see his comprehensive book collection which gave us a full picture of the literature on the representatives of the "*cameronense*"-group.

The inhabitants of the numerous villages in Cameroon, Gabon and the other countries where killies are found all helped the collectors listed in this book in every possible way. They showed them the killifish biotopes and gladly gave details of the changes in the environmental conditions throughout the seasons in the streams we were investigating.

Illustrations

At this point we would like to mention the killie enthusiasts who have allowed us to use their colour pictures in this book. For their help and support in this special field we must once again thank Jean-Paul Cicéron, Wolfgang Grell, René Hannecart and Guido Passaro. After the name of the photographer there follow the page numbers in numerical order. If there are two colour pictures on one page, a small "t" after the page number means that it is the picture at the top of the page; a "b" means it is the one at the bottom of the page. Pictures printed on a double page have both page numbers.

Jean-Paul Cicéron: 124 t + b, 125, 128, 129. **Wolfgang Grell:** 13, 449, 456. **René Hannecart:** 201 t + b. **Guido Passaro:** 4, 64 b, 133 t, 160/161, 236/237. **Reinhard Lütje:** 1, 5, 8, 9, 16, 17, 24 b, 25, 29 t + b, 32, 33, 49 t + b, 80 t + b, 81 t + b, 84 t + b, 85 t + b, 88 t + b, 89 t + b, 92 t + b, 93 t + b, 96 t + b, 97 t + b, 100 t + b, 101 t + b, 112 t + b, 113 t + b, 133 b, 140 t + b, 141 t + b, 145, 148 t + b, 149 t, 164, 172 t + b, 173, 176 t + b, 177 t + b, 180 t + b, 185 t + b, 188 t + b, 189 t + b, 193, 196, 200 t + b, 216 b, 217 t + b, 220 t + b, 221 t + b, 224 t + b, 225 t + b, 228 t + b, 233 t + b, 245, 248 t + b, 249 t + b, 252 t + b, 253 t + b, 265, 284 t + b, 285 t + b, 296, 308, 317 b, 320, 329 b, 336 b, 344, 349 b, 353, 356, 369, 376, 381 t + b, 384 t + b, 385, 393 b, 396, 404, 409 b, 412 t + b, 413 t + b, 416, 421, 425, 432, 433, 437, 452 t + b, 453 t + b, 464.

For the reader to be able to find the pictures of specific killies quickly, a list is given below of the photographs of species and localities with the corresponding page numbers:

Aphyosemion cameronense "Bibouleman" 216 b; "CGE 91/8" 25, 248 b; "CGE 91/9" 245, 285 b; "CGE 91/11" 284 b; "EMS 90/3" 285 t; "EMS 90/4" 1, 248 t, 381 b; "GAB 10/90" 252 t; "GBG 92" 253 b; "GWW 86/2" 164, 413 t; "HJRK 92/7" 249 t, 265; "HJRK 92/11" 24 b, 228 t; "LEC 93/3" 5, 217 t, 220 t, 224 t, 253 t; "Melen" 284 t; "PEG 93/16" 336 b; "PEG 94/36" 249 b, "PEG 94/41" 252 b.

Aphyosemion obscurum "EMS 90/13" 296.

Aphyosemion amoenum "C 89/22" 413 b; "CGE 91/13" 29 b, 317 b; "Dibang" 220 t, 224 t, 453 t; "EMS 90/8" 17, 308; "EMS 90/9" 228 b; "Sonbo" 217 b.

Aphyosemion halleri "EMS 90/6" 168; "EMS 90/7" 33, 320; "PEG 94/31" 329 b.

Aphyosemion maculatum "GAB 19/90" 9; "LEC 93/4" 233 t + b, 344, 353; "PEG 93/14" 349 b; "PEG 94/17" 384 t + b.

Aphyosemion mimbon "GEB 94/25" 220 b; "GWW 86/30" 453 b; "LEC 93/18" 356, 452 b; "LEC 93/19" 17, 221 t + b.

Phenotype 1 "CGE 91/12" 369.

Phenotype 2 "HJRK 92/10" 376, 381 t.

Phenotype 3 "CGE 91/4" 456; "CGE 91/6" 49 t, 385, 393 b, 449.

Phenotype 4 "Bélinga" 16, 396, 452 t.

Phenotype 5 "LEC 93/2" 409 b; "LEC 93/12" 404.

Phenotype 6 "GEB 94/24" 464; "LEC 93/21" 421; "LEC 93/22" 29 t, 416.

Phenotype 7 "LEC 93/7" 32, 425.

Phenotype 8 "LEC 93/14" 145, 432, 433.

Phenotype 9 "EMS 90/2" 49 b, 437.

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Norbert Dadaniak and Wolfgang Eberl, 1991: "*Aphyosemion amoenum* Radda & Pürzl, 1976". Encyclopedia of Killifish, Information Pamphlets of the Deutsche Killifisch Gemeinschaft, appeared September 1990. Four pages with a colour picture of an adult male by Eduard Pürzl and data on systematics, relationships, distribution, maintenance and breeding of *Aphyosemion amoenum*.

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