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CONTENTS

NEWS AND NOTES

A NEW BOOK ON GENERAL ICHTHYOLOGY

Martin R. Brittan

*The Life of Fishes**, by N. B. Marshall, was published last spring, and is a worthy addition to the slowly-increasing list of general books about fishes.

Dr. Marshall, Senior Principal Scientific Officer of the British Museum (Natural History), has written a book that is at the same time authoritative, well-organized, and lively. It falls nicely in between such strongly structured and highly factual accounts as Nikolskii's *Special Ichthyology* and Lagler, Bardach, and Millers' *Ichthyology* and the more popular, but nonetheless useful, treatments such as Curtis' *Life Story of the Fish* and Schultz and Sterns' *The Ways of Fishes*.

The book is divided into major sections entitled "Life from Day to Day", "Life Histories", "Living Spaces", and "Diversity". The first treats the anatomy and physiology of fishes, as well as intra- and interspecific relationships and ethology; the second, reproduction and early life of marine and freshwater fishes; the third, shallow and deepwater marine and freshwater habitats and their fishes; and the last surveys the major groups of fishes. The illustrations are excellent, and equally pertinent, explicitly labelled.

Not the least important is the fact that the book is not only extremely informative but quite engrossing. This reviewer recommends that all ichthyologists and advanced laymen give it a thorough perusal.

*Marshall, N. B. 1966. The Life of Fishes. World Publishing Company, Cleveland and New York. 402 pp., 47 half-tone plate illustrations, 64 figs. $12.50.

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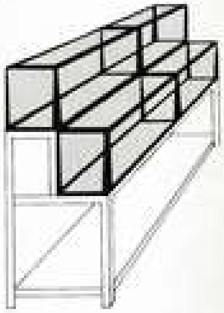

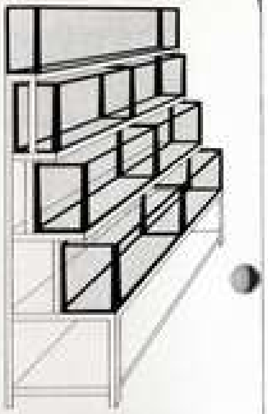

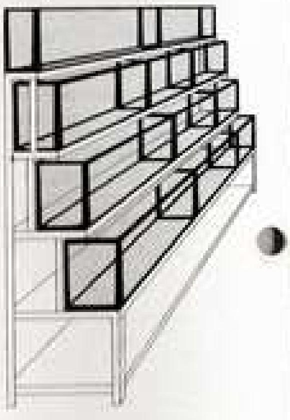

NOTES ON PHENOTYPY, DISTRIBUTION, AND SYSTEMATICS OF *APHYOSEMION BIVITTATUM* (LOENNBERG), WITH REMARKS ON THE CHROMOSOME NUMBER IN THE RIVULINAE

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Within the Rivulinae (Cyprinodontidae) of the Old World there are several phenotypes in which a dark lateral band is seen in females during the pre-mating display and in individuals which are frightened. This color-pattern appears to appease the male in the initial phases of reproduction and during fighting.

Most of these banded phenotypes belong to the genus *Epiplatys*. Some species of *Aplocheilus* are also able to produce this marking. Similar markings are absent in *Pachypanchax* and *Nothobranchius* and are very rare in *Aphyosemion*.

Within *Aphyosemion*, two rather different phenotypes develop this particular marking. In *Aphyosemion sjoestedti* (Arnold, 1911) this pattern is rarely seen in the spawning female, and as a pattern of fear only juveniles use it. In the second phenotype, for which *Aphyosemion bivittatum* (Loennberg, 1895) is the oldest zoological name, the dark lateral band is an almost permanent color-pattern at least in females and juveniles of western populations. This marking is less permanent in eastern and southern populations, and there are indications that it is not present in certain populations. In the male, the spawning or fighting individual does not show this marking. Also females may lose the marking when fighting. This means that in the behavior of *Aphyosemion bivittatum*, this particular marking is used as in *Epiplatys*.

The phenotype here identified as *Aphyosemion bivittatum* (Loennberg) extends over a rather large area of Atlantic Africa. Stenholt Clausen (unpublished) found this phenotype in Togo, and several populations have been reported from Dahomey. According to Clausen (1964) this phenotype is found all over southern Nigeria in the forest and in the savanna. In this country, *A. bivittatum* is restricted to the sediments, being replaced by *Aphyosemion nigerianum* Clausen on the basement complex. These two kinds of biotopes differ in their water types. During a recent trip to Cameroon, Stenholt Clausen and the author had the opportunity to study the distribution of the *A. bivittatum* phenotype in this country. In the lowlands of Eastern Cameroon (formerly French Cameroon), this phenotype occupies a biotope similar to that in Nigeria, whereas in the southern parts of Western Cameroon (formerly British Cameroons), it is also found on the slopes of the Cameroon Volcano in watertypes which correspond to those of the basement complex of Nigeria in salinity and hardness. This occupation of a new biotope is probably a result of the absence of *A. nigerianum* and similar phenotypes in this particular area. The total salinity of the waters of the Cameroon Volcano area is ten times that of the lowlands of Eastern Cameroon, and the hardness reaches four German degrees at least (nil or one degree in the lowlands). Under aquarium conditions, most strains of the *A. bivittatum* phenotype belong to the rather few species of *Aphyosemion* which are able to reproduce normally in hard and alkaline water.

There are no zoological reports on this phenotype south of the Kribi River area of Eastern Cameroon, probably because there are no roads in the area. Arnold (1933), however, reported this phenotype in a shipment of aquarium fishes from Equata in Spanish Guinea, and it is likely that this is the southern limit of distribution for this phenotype.

The external morphology, including colors and color-patterns, of the *Aphyosemion bivittatum* phenotype does not vary much within the known range of distribution in nature. The meristic variation is moderate compared with other species of *Aphyosemion*. The dorsal fin count ranges between nine and thirteen rays, the anal fin between eleven and fifteen rays, and there are twenty-four to twenty-seven scales in a lateral series. These figures are based on 213 individuals covering the range from Dahomey to the Nyong River of Cameroon. The average values of these meristic characters do not undergo clinal variation, and the whole range of variation may be covered by a single local population. In spite of this, rather large numbers of zoological names have been created for individuals or groups of individuals which appear to belong to the *A. bivittatum* phenotype. Although some of the descriptions are not very informative it is likely that the following names can be referred to this phenotype:

Fundulus loennbergi Boulenger, 1903.	Kribi, Cameroon.
Fundulus bitaeniatus Ahl, 1924.	Aquarium trade.
Fundulus pappenheimi Ahl, 1924.	Bipindihof, Cameroon.
Fundulus riggenbachi Ahl, 1924.	Jabassi, Cameroon.
Fundulus rubrostictus Ahl, 1924.	Aquarium trade.
Aphyosemion bivittatum hollyi Myers, 1930.	Aquarium trade.
Fundulopanchax multicolor Meinken, 1930.	Lagos, Nigeria.
Fundulopanchax splendopleuris Meinken, 1930.	Tiko, Cameroon.
Aphyosemion unistrigatus Ahl, 1935.	Bipindi, Cameroon.

The descriptions of these nominal species have been based entirely on the external morphology of one or a few individuals. The slight differences in meristic characters between these types do not exceed the natural variation in the morphologically defined *A. bivittatum* (Loennberg). For this reason, all these names appear to be synonyms for *A. bivittatum* (Loennberg).

As it will be shown later in this article, there are reasons to believe that *phyosemion bivittatum* is a cryptic or monotypic superspecies which is mposed of several allopatric, biologically-defined species or sibling species hich in their biology have reached the level of good species without a rresponding differentiation of the phenotype. This situation is not at all ique for this species, as it seems that most of the Rivulinae of the forest hich have a large range of distribution are superspecies of the same nature, polytypic superspecies. At present, however, it will not be possible to entify the biologically-defined species in *Aphyosemion bivittatum* by their ternal morphology or by their geographical distribution in nature. Also me of the sibling species may be sympatric in certain areas. Sympatric bling species are known in the polytypic *Aphyosemion roloffi* superspecies cheel, 1966). For this reason, it would not be correct to place the above-entioned names as synonyms for Loennberg's species. The sole secondary me which probably can be placed correctly at present is *Aphyosemion lticolor* (Meinken), which can be linked to the SW Nigerian forest pulations and to almost all aquarium strains called *A. bivittatum* by uarists. A very rare aquarium strain called *A. multicolor* by aquarists is deed the nominal *A. splendopleure* (Meinken), but the validity of this name nnot be decided at present. As only one of the secondary names for the bling species in *A. bivittatum* can be used correctly at present, the author efers to use the name of the superspecies, *Aphyosemion bivittatum*, for all own populations which correspond to this phenotype.

The first investigations of the genetics of this phenotype were carried t by C. Kosswig during the thirties. Bozkurt (1945) prepared a cytological udy on the gonads of the hybrids which Kosswig produced by crossings tween the nominal *A. bivittatum*, *A. loennbergi*, *A. multicolor* and *A. lendopleure*. Although the origin in nature of the different strains is not own the crossing experiments disclosed important post-mating isolating echanisms to resist any exchange of genes between some of the strains.

During 1962, Stenholt Clausen collected live individuals of the *A. bi-ttatum* phenotype at several localities of the Dahomey-Nigeria area, and aced these individuals at the author's disposal. These strains originated m Porto Novo in Dahomey; Meko, Lagos and Ijebu-Ode in SW Nigeria; d Benin and Umudike in the western and eastern parts of the Niger Delta. fter some training, it was possible to distinguish between four variations the *A. bivittatum* phenotype in the males and between two slightly fferent phenotypes in the females.

Although it was possible to detect small and constant differences in the lor-patterns and development of fins in the nature-caught males from rto Novo, Lagos, and Ijebu-Ode, these differences disappeared in the er generations of aquarium-raised males. On the other hand it was possible to tell apart the four male phenotypes of the Meko, SW Nigerian, Benin, and Umudike strains even after several generations in the aquarium. These differences are mainly differences in colors and color patterns, and they are normally lost after preservation. The females of the Umudike strain differed from all other females by their broader dark lateral bands.

Individuals belonging to the four western strains were crossed and no important post-mating isolating mechanisms were discovered. The hybrids produced from crossings of the Meko and the Lagos strain suffered from hybrid-weakness and were difficult to raise. Although the savanna strain (Meko) appear to belong to the same biological species as do the three forest strains (Porto Novo, Lagos, and Ijebu-Ode), it may represent a subunit in this biological species.

Severe post-mating isolating mechanisms were discovered when individuals belonging to the two Niger Delta strains were crossed to individuals from the four western strains. Although most of the F_1 individuals were rather viable, they were not able to produce a viable F_2 generation, not even in backcrossings. Only one of these combinations contained females. These females spawned eggs which contained an abnormally small amount of yolk. These eggs could, nevertheless, be fertilized, and they developed embryos. However, these embryos died in the eggs. Most embryos died from a complete breakdown of the blood system. No cytological study was carried out by the author on these hybrids and the whole live material was taken over by Professor Curt Kosswig.

These findings did not prove that the Niger Delta populations were reproductively isolated from the populations of SW Nigeria. Probably there is an unbroken chain of populations of the *A. bivittatum* phenotype in between these geographical areas. An indirect exchange of genes through this chain is theoretically possible. On the other hand, other crossing experiments by the author on other phenotypes of Rivulinae from the two geographical areas in question showed that similar post-mating isolating mechanisms exist within other superspecies. Crossings between individuals belonging to the superspecies *Aphyosemion arnoldi* (Boulenger, 1908) gave F_1 sterility in both sexes when individuals belonging to the SW Nigerian representative [*A. filamentosum* (Meinken)] were crossed to individuals belonging to the Niger Delta representative [*A. arnoldi* (Blgr)]. See Scheel (1963). In the superspecies *Aphyosemion nigerianum* Clausen, individuals from Akure were not able to exchange genes with individuals from Port Harcourt of the eastern Niger Delta because of an almost complete F_2 breakdown similar to that of *A. bivittatum*, see Scheel (1964). See also Moreau (1963) for other indications of a fauna-border for birds and primates in the geographical area in question. For these reasons it is likely that the Niger Delta representatives of the *A. bivittatum* phenotype are not able to exchange genes with the SW Nigerian representative of this phenotype.

It is difficult to explain why the F_2 embryos failed to develop into viable individuals. A breakdown of the embryos from an $F_1 \times F_1$ crossing can be explained by Muller's theory (1940). If each of the two parent strains possesses a developmental system which is controlled by a series of interacting genes situated in a number of non-homologous chromosomes, the F_1 individuals will receive a single complete set of such genes from each parent strain, but during the random recombination of the paternal and maternal chromosomes during the meiosis of the hybrid, it is not likely that the gametes receive a complete series of one of the interacting sets of genes. For this reason the development of the F_2 individuals will break down.

This theory is not able to explain why the F_2 generation also breaks down in backcrossings. Such breakdowns appear to occur also in other apparently infra-species hybrids from rain-forest species in the Rivulinae. A study of the meiosis in males from such infra-species crossing in the superspecies *Epiplatys fasciolatus* (Günther) disclosed a highly abnormal meiosis in some of the F_1-F_1 males. The homologous chromosomes failed to pair completely in almost all cases of meiosis which could be studied at diakinesis and metaphase. A very variable number of univalents was observed. In this species, there are rather large differences in the size of the chromosomes, and it appeared that only the smallest chromosomes failed to show synapsis. Apparently the number of viable spermatozoa was rather high and many of these might be unbalanced, containing more or perhaps also less than the haploid number of chromosomes which seems to be constant in this species. Secondary meiotic divisions were present, but the number of chromosomes could not be counted in these divisions as in other rivulins.

If females are also able to produce unbalanced gametes, it is likely that the F_2 zygotes are also not viable in backcrossings. On the other hand, such abnormalities may cause an increase in the chromosome number by aneuploidy if some combinations of unbalanced gametes are able to produce viable and fertile individuals.

The cytological technique developed by Hsu & Pomerat (1953) and Karbe (1961) has made the study of the chromosomes of fishes easy and exact. Using this technique, Post (1965) published the haploid chromosome number for more than a hundred bony fishes, thus increasing the number of species of fish for which the chromosome number is known to more than two hundred. Post's paper gives the chromosome number for twenty-seven species in Cyprinodontidae and for eleven species in Poeciliidae. The present author (1966), concentrating on the Rivulinae, increased the number of rivulin species of the Old World for which the chromosome number is known to thirty-seven, and since the preparation of the paper, some fifteen more species belonging to this group of the Rivulinae have been studied.

Post's study on the chromosome numbers among the bony fishes gives valuable information which can be used in a study of the phylogeny of the Rivulinae. There are good indications that the basic haploid chromosome number for the Cyprinodontiformes and also for other orders of bony fishes is $n = 24$. Most groups of bony fishes still maintain this fundamental number of chromosomes, and only a few groups have been able to disengage from this number in spite of their long and divergent evolution. Within the Cyprinodontidae, all but one of the subfamilies appear to have maintained the basic chromosome number. Only in the Rivulinae have derivations from $n = 24$ been discovered.

The basic chromosome number also occurs in Rivulinae and appears to be rather common among the species of the New World, where $n = 24$ has been found in *Cynolebias*, *Cynopoecilus* and *Rivulus*. This number is less common among the Rivulinae of the Old World, but is retained by some species in *Aplocheilus*, *Epiplatys* and *Pachypanchax*. A small increase in the basic chromosome number occurs in *Aplocheilus* and *Epiplatys*, where some species develop $n = 25$. This increase might have resulted from aneuploidy in the way previously described in this article. A decrease in the basic chromosome number occurs in all genera where several species have been studied. These decreases reach $n = 18$ and $n = 17$ in *Aplocheilus* and *Epiplatys* respectively. A much more profound decrease has taken place in the genera of *Aphyosemion* and *Nothobranchius*, where $n = 9$ occurs in both genera, in *A. christyi* (Boulenger) and *N. rachovii* Ahl, respectively. It is likely that these decreases in the basic chromosome number are due to a step-by-step fusion of smaller acrocentric chromosomes into larger metacentric chromosomes.

At the present time the genus *Aphyosemion* might be divided into two major groups. One group is found west of the Togo Hills of Ghana. The second group, probably more closely related to *Nothobranchius*, is found east of the Togo Hills with one species [*A. sjoestedti* (Blgr.)] west of this border. These two groups are characterized by the development of the pattern of lateral line pores on the head, by details in the color patterns, and by their crossing possibilities. In the western group, $n = 25$ is found in both subspecies of *A. gardneri* (Arnold), and the chromosome number falls to $n = 19$ in *A. guineense* Daget. Intermediate values are $n = 20$ and 21 in the group of smaller species. In the eastern group, $n = 20$ is the maximum figure found so far. The haploid chromosome number falls to $n = 9$ in some strains of *A. christyi* (Blgr). Intermediate values are $n = 10$, 15, 16, 17, 18, and 19.

Post (1965) published $n = 20$ in *Aphyosemion bivittatum*, but it is not known from which population in nature his material originated. The present author found $n = 20$ in males from Porto Novo of Dahomey and from Meko and Ijebu-Ode of *SW* Nigeria. Among the Cameroon strains

Fig. 1—*Aphyosemion bivittatum*. The SW Nigerian phenotype of the [illegible]. Two fighting males from Ijebu-Ode, SW Nigeria. Photo by the author.

$n = 19$ was found in males from a locality near Buea of Western Cameroon (on the slopes of the volcano) and a locality near Douala of Eastern Cameroon (lowlands), whereas $n = 17$ was found in a male from a locality near Eseka near the Nyong River of Eastern Cameroon. No heterozygocity for variable chromosome numbers was found in the meiosis and mitosis of these males.

Crossings between individuals of *A. bivittatum* having $n = 20$, 19, and 17 have been prepared and the results from these crossings will be reported in a later article in this series. At present it is not possible to identify the three genotypes ($n = 20$, 19, and 17) by their external morphology, except for small differences in the color patterns.

The chromosome situation in *Aphyosemion bivittatum* may give information about the evolution of the karyotype among the Rivulinae of Africa. A rather profound reduction of the chromosome number has taken place in this species almost without any visible change of the phenotype. It is indeed likely that the different genotypes are not able to exchange genes at present, but this might not be a result of the differences in the haploid chromosome number but due to gene mutations. In the superspecies *A.*

Top—Fig. 4—**Aphyosemion bivittatum.** The SW Nigerian phenotype of the savanna. A male from Maku, Nigeria. Bottom—Fig. 5—**Aphyosemion bivittatum.** The phenotype of the western part of the Niger Delta area. A male from Benin City, Nigeria. Photos by the author.

Top—Fig. 6—**Aphyosemion bivittatum.** The phenotype of the eastern part of the Niger Delta area. A male from Umudike, Nigeria. Bottom—Fig. 7—**Aphyosemion bivittatum.** The phenotype of the coastal lowlands of Western Cameroon and the northern coastal part of the lowlands of Eastern Cameroon. A male from the Mbaumbaula River, north of Douala, Eastern Cameroon. Photos by the author.

Top—Fig. 10—**Aphyosemion bivittatum.** The Cameroon Yellow phenotype. A male from a locality near Buea, Western Cameroon. Bottom—Fig. 11—**Aphyosemion bivittatum.** The phenotype from a locality, 12 miles north of Eseka, near the lower Nyong River, Eastern Cameroon. Photos by the author.

Top—Fig. 12 and bottom—Fig. 13—**Aphyosemion bivittatum.** Sterile males from cross between a male from Benin City and a female from Porto Novo. Photos by the author.

Fig. 14—*Aphyosemion bivittatum*. Phenotype of the western part of the Niger Delta area.

fish itself as a breeding aquarium fish until about 1930 when live individuals from Lagos and Tiko were imported.

The individuals which Ahl used for his description of *Fundulus bivittatus* and *F. rubrostictus* are listed in these descriptions with the type locality: Niger. Ahl, however, received his material from the German aquarist Mätte, who is known not to be a collector of aquarium fishes in Africa. The types for these two species thus probably came from the German aquarium trade and were said to originate from the Niger area. Meinken (1930a) also considered at least the types for the former species as aquarium specimens of unknown origin. For this reason the type-localities for *A. bivittatum* and *A. rubrostictum* should not be taken into consideration in a review on the geographical distribution of the biological species in "*Aphyosemion bivittatum*". During 1930 Meinken (1930b) named a certain color variety of this species as *F. bivittatus* var. *coerulea*. Since the name "*coerulea*" was found to be preoccupied [*Aphyosemion coeruleum* (Blgr)], Myers (1933) renamed the variety as *A. bivittatum hollyi*. The origin in nature of this variety is not known.

The individuals on which Meinken (1930c) based his descriptions of *F. multicolor* and *F. splendopleuris* were also aquarium fishes. Meinken, however, got his material directly from the collector (Grimm of Hamburg) and, for this reason, the type localities given in the descriptions can be considered as reliable. Also the phenotypes of Lagos and Tiko males of *A. bivittatum* correspond well to Meinken's descriptions of these two forms. The name *A. loennbergi* has been attached to different aquarium-kept strains of *A. bivittatum*, starting with Boulenger's identification of individuals from Warri, as belonging to *F. loennbergi*. Since the type locality for *F. loennbergi* is the Kribi area of southern Cameroon, this name should be

reserved for individuals from that area and for this reason it is not likely that individuals of this species were ever imported as aquarium fishes. In his Catalogue of 1915, Boulenger, however, also listed individuals from the Kribi area under *F. bivittatus*. The description of *F. loennbergi* does not contain any information on dark lateral bands in the two type individuals, and, also, the figure of one of the types (a male) in the Catalogue shows no trace of such bands, although the description and the figure clearly indicate that the type for *F. loennbergi* belongs to the *A. bivittatum* phenotype. Fowler (1930) pictured three males from the Kribi area and only on one of these are the two dark lateral bands clearly visible. On the second male there are traces of these bands, and on the third male there are no such bands in the picture. During the expedition of Stenholt Clausen and the author to Cameroon in 1966, the Kribi area was also visited and individuals of the *A. bivittatum* phenotype were collected at many localities. There were no indications of two different phenotypes in this area. For this reason it is likely that the individuals from the Kribi area which Boulenger placed under *F. bivittatus* should really be placed under *F. loennbergi*, and it is likely that the dark lateral bands also occur in this species.

The name *A. rubrostictum* has been used for a strain of aquarium fishes which apparently does not belong to the *A. bivittatum* phenotype but instead to the *A. cameronense* phenotype. The descriptions of *A. rubrostictum* in aquarium literature are a mixture of data from the original description and from the strain mentioned above. Ahl placed this species close to *A. bivittatum* only.

In order to avoid further confusion of names for the biological species in *Aphyosemion bivittatum* it is recommended that this name only be used for individuals of the *Aphyosemion bivittatum* phenotype. When possible, the locality from which the strain originated should be published. As live individuals from the type locality (Ndian River of eastern Nigeria) have not yet been brought into any crossing experiment, we do not know if individuals from this population are able to exchange genes with the different populations of the Niger delta or the populations from the Tiko area (nominal *A. splendopleure*). A correct naming of the sibling species in *Aphyosemion bivittatum* probably will not be possible in the near future.

Individuals belonging to the *A. bivittatum* phenotype are frequently to be had in the aquarium trade, and these strains are easily kept and bred. The Niger delta strains and the different Cameroon strains are, however, not so easily kept and bred as the SW Nigerian strains, and soft and slightly acid water is recommended for breeding. Although *A. bivittatum* can not be considered as an "annual species", the fully developed embryo shows annual characters, the circulation of blood being completely stopped and the embryo hibernating before hatching takes place. The eggs from the SW Nigerian strains measure 1.25–1.30 mm. Those from the Niger delta

Fig. 13—*Aphyosemion bivittatum*. Sterile male from cross between a male from Umudike and a female from Lagos. Photo by the author.

populations are somewhat smaller, 1.15–1.20 mm. The two northern Cameroon strains (Buea and Douala) differ constantly and markedly in egg size. The eggs from the "mountain-strain" (Buea) measure 1.50 mm, whereas those from the "lowland-strain" (Douala) measure 1.25 mm. Among rivulins, differences in egg sizes generally can be considered as indications for sibling species. The size of the egg generally is very constant within a certain species and within groups of closely related species.

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SOUND PRODUCTION BY THE AFRICAN CICHLID *TILAPIA MOSSAMBICA*

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Sounds of fish have been recorded and analyzed for numerous marine species (Tavolga, 1960, 1964), but for only a few freshwater species (Winn, 1960). The African cichlid *Tilapia mossambica* (fig. 1), a freshwater fish, has never been reported to produce intentional sound.

Freshwater fish were studied at the Bureau of Commercial Fisheries Biological Laboratory, Seattle, Washington, for underwater sounds of biological origin during experiments with recording instruments. Six male African cichlids were maintained in a 22-gallon aquarium, with a 3-inch layer of coarse gravel on the bottom. The fish produced adventitious sounds while they ate food or mouthed gravel (fig. 2). After they became accustomed to their environment, each fish constructed a shallow depression and attempted to exclude intruders. Territorial-threat behavior involved short, repetitive advances and retreats by the opponents. Intentional sounds were produced at this time (fig. 3).

Fig. 1—*Tilapia mossambica*. Photo by Wolfgang Bechtle.

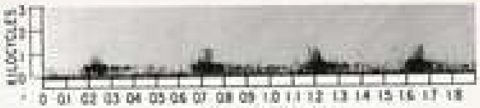

Fig. 2—Adventitious sounds produced by *Tilapia mossambica* while working gravel.

Fig. 3—Intentional sounds produced by *Tilapia mossambica* during territorial-threat behavior.

The sounds were detected with a University Model 402S microphone, waterproofed with a rubber diaphragm. They were recorded on tape with an Ampex PR-10-2 recorder-reproducer and subsequently analyzed with a Sound Spectrograph [Sonograph-Kay Electric Company]. The intentional sounds were in a series of paired bursts that lasted up to 0.6 second and included individual bursts of 0.02 second. The distribution of energy was uniform in all frequency bands from 50-600 cycles per second.

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HOPLOCHARAX GOETHEI, A NEW GENUS AND SPECIES OF SOUTH AMERICAN CHARACOID FISHES, WITH A REVIEW OF THE SUB-TRIBE HETEROCHARACINI

Jacques Géry[1]

The present study deals with a little group of interesting South American characoid fishes of the subfamily Characinae, composed of only three monotypic genera. The genus *Heterocharax* was described by Eigenmann (1912) from five specimens collected by him in British Guiana. Fifteen years later, Myers (1927) found a close relative of it, *Lonchogenys*, in the collections of Carl Ternetz from the Rio Negro. Recently, while collecting around Manaus during a research trip sponsored by the T.F.H. Fund, I identified another, much more specialized, form of the same group. This form was afterwards recognized in the Ternetz collection, presently in Stanford University, as well as in a collection made by Dr. M. Brittan in the Rio Ira and Rio Jufari. It will be described after a redescription of the types of the other taxa, supplemented by still undescribed material, in order to compare them and detail their affinities.

I am indebted to Drs. George S. Myers and Warren Freihofer, as well as to Dr. Loren P. Woods and Miss Pearl Sonoda, for allowing me access to the types of *Lonchogenys* and of the new genus, as well as of *Heterocharax*, respectively, in the Stanford University collections and the Field Museum of Natural History in Chicago, and to Drs. Herbert R. Axelrod and Martin R. Brittan, who kindly provided me with the additional material.

Heterocharacini sub. trib. nov.

Small-sized Characinae, apparently still rather close to the generalized tetragonopterine type, without dorsal hump, characterized by the cycloid scales, the dorsal fin in the middle of the body and with the anal fin, of moderate length, slightly behind its level, the pseudotympanum, and, chiefly, by the head structures: very large eye and short snout; long, double-curved, almost fully-toothed maxillary, slipping under the antorbital; teeth conical or small caniniform, in one or two series (none on pterygoid), large fontanels, uppermost gill-rakers rudimentary, opercle notched, and preopercular angle *more or less pointed*, instead of being rounded as in most Characinae.

Related genera with pointed preopercular angle, which apparently pertain to different sub-tribes, are *Acanthocharax* Eigenmann, which has the body shape of *Charax*, and *Xiphocharax* Fowler, which comes near *Gilbertolus*, *Gnathocharax* (?) and *Roestes* (?). They have been discussed by Myers (1927: 121-122).

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[1] Contribution number 48 to the study of characoid fishes.

Heterocharax Eigenmann, 1912

Heterocharax Eigenmann, 1912, Mem. Carnegie Mus., 5, 405–406; *Myers*, 1927, Bull. Mus. Comp. Zool., 68 (3): 121-122.

Type species *H. macrolepis* Eigenmann, 1912.

Small size, generalized body form; lateral line complete, downward-recurved at the beginning; a very narrow pseudotympanum; predorsal and post-dorsal not keeled, irregularly scaled (predorsal line covered mostly with the lateral scales, with some very small median scales interpolated); preventral rounded, scaled; post-ventral rather acute, formed by the lateral scales placed side by side; apparently no sexual anal hooks or tubercles; some scales on base of anal; caudal not scaled; no prominent interhaemals; clavicle not notched; opercle notched; preopercle with a rather acute inferior angle, sometimes quite pointed, never with a sharp spine; great suborbital entire or nearly entire, three post-orbitals nearly entire; anterior fontanel up to level of anterior border of eye; teeth (fig. 1) rather like those of *Gnathocharax* and other Characinae, conical, some enlarged in front, almost caniniform (with respect to the small size of the fish), those in the premaxillary uniserial, numbering 8-10 or 11, the 3 or 4 most anterior ones the largest, and with some replacement teeth; maxillary long and slender, reaching to middle of eye, partially covered by the antorbital, with a slight S curve, almost entirely armed with 20-30 teeth (of which the smallest ones may be replacement teeth), the uppermost ones slightly larger; dentary with 6-8 front teeth, the median one, and generally the two lateral ones, by far the largest, followed by a series of about 20-25 smaller teeth beginning somewhat behind the front series, at the level of the lateral caniniform teeth; gill-rakers about 2-3/12, those in the upper arch rudimentary; structure of the scale (fig. 2a) that of a rather generalized tetragonopterine-characine-type, the nucleus slightly basal, reticulated, the circuli divergent toward the apex, the basal border without notch, few radii (generally 2), purely apical, rather divergent, the apical border without denticles.

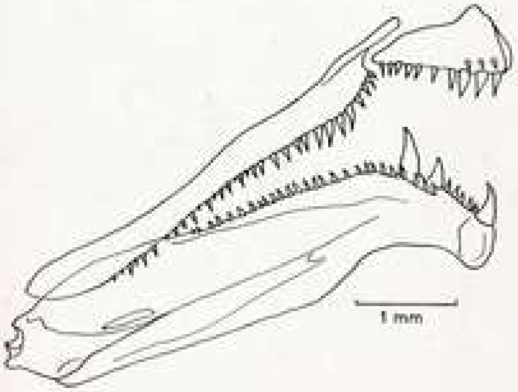

Fig. 1—Jaws of **Heterocharax macrolepis** specimen from Manacapuru; schematic assemblage, internal view.

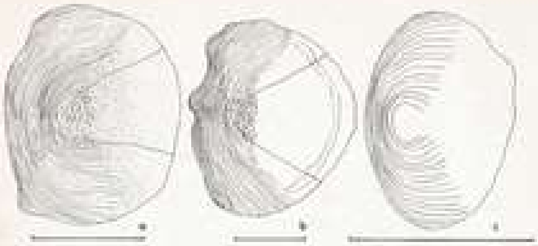

Fig. 2—Scale of the left flank, taken below lateral line, of: a, **Heterocharax**; b, **Lonchogenys**; and c, **Hoplocharax** gen. nov.; the lines represent 1 mm.

Heterocharax macrolepis Eigenmann, 1912 (fig. 3, above)

Heterocharax macrolepis Eigenmann, 1912, Mem. Carnegie Mus., 5: 406, pl. 61, fig. 2.

Besides the type, in the Field Museum of Natural History [No. 53,669, from Rockstone, Essequibo River, British Guiana], I studied 22 unrecorded specimens (largest 43.1 mm in standard length), from Lago Grande do Manacapuru, Amazon, collected by Dr. Herbert R. Axelrod, Harald Schultz and Dr. Fritz Terofal, Oct., 1963. Miss Pearl M. Sonoda kindly checked two paratypes from Rockstone (FMNH 53,670) and from Wismar (FMNH 53,671), in order to ascertain the range of the number of anal rays in the Guianean specimens.

The species, which was until now only recorded once by its discoverer in British Guiana, does not seem to be rare in certain places: I have collected more than 200 specimens in a tributary of the Rio Negro above Manaus, along with the new genus described below. *H. macrolepis* is new for the Amazon and the Rio Negro.

The principal counts and proportions of the type and of the 6 largest specimens from Manacapuru, are recorded in table 1. The counts not recorded are the following: dorsal ii 8(i); pectoral i 10-12; predorsal scales about 13 (counting the lateral series bordering the median line), peduncular scales about 14; anal rays 37 in the type, 37 and 42 in the paratypes (total count, checked by Miss P. Sonoda), iv 31-36(i), mode 33, in the Amazonian specimens, distributed as follows (branched rays, 20 specimens): 31: 2; 32: 3; 33: 9; 34: 3; 35: 2; 36: 1. Other characters as in the generic description.

The type of the species, as compared with the Amazonian specimens of approximately the same length, has a smaller eye, a narrower interorbital, shorter maxillary and snout, and a more elongate peduncle; these differences are probably beyond the subspecific level, and may be due, in part, to the measurements being taken at different times and with different instruments.

The color-pattern of the species (fig. 4) is characteristic: in life, eye somewhat reddish, body rather translucent, olive-yellow with two green, plumbeous bands, one, longitudinal, somewhat shiny, and the other one, oblique, above anal-base; fins all greyish; the bands become dark in formalin and help to recognize the species at first sight.

Lonchogenys Myers, 1927

Lonchogenys Myers, 1927, Bull. Mus. comp. Zool., 68 (3): 121-122.

Type-species *L. ilisha* Myers, 1927.

This genus is much like *Heterocharax*, except for the following differences

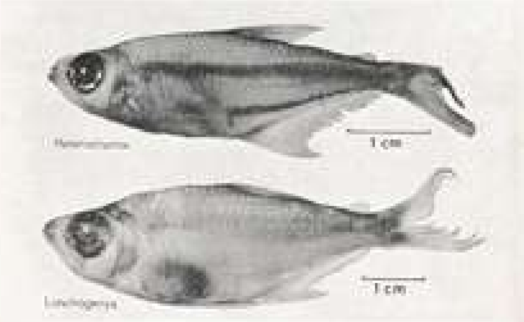

Fig. 3—Top, **Heterocharax macrolepis** specimen from Manacapuru, about 43 mm; bottom, **Lonchogenys ilisha** specimen from the Rio Itu, about 58 mm.

(mostly in the arrangement of the teeth): somewhat larger size; lateral line less recurved; predorsal irregularly scaled, the median scales, when present, of the same size as the lateral ones; preopercle generally more pointed, although without actual spine; great suborbital leaving a narrow naked area below or behind; first postorbital nearly entire, second one weak, dermosphenotic apparently absent; anterior fontanel not quite reaching to level of front of eye; teeth (fig. 5) clearly in two rows on both jaws: on the small and very low premaxillary, about 10-12 outer teeth and about 8-10 inner ones, of which one or two, near the middle of the bone, are caniniform; maxillary very similar to that of *Heterocharax*, with more teeth (34-52), of which some are probably replacement teeth; dentary with two rows of teeth, the outer one numbering about 18, of which 3 or 4, on the somewhat raised side of the dentary, are caniniform (fig. 5, below); the inner row forms a shorter, more frontal series, beginning with a caniniform tooth, followed by 8-9 smaller ones (inversely to the outer series, fig. 5, middle); gill-rakers (6-8/12-14) probably more numerous on the upper arch than in *Heterocharax*; the structure of the scale (fig. 2, b) is essentially the same as that of *Heterocharax* except that, as pointed out by Myers, the basal border is bilobed.

Lonchogenys ilisha Myers, 1927 (fig. 3, below; head fig. 6)

Lonchogenys ilisha Myers, 1927, Bull. Mus. comp. Zool., 68(3): 122-123.

Besides the type, provisorily in the Division of Systematic Zoology at Stanford University No. SU 17,696, from Cucuhy (Rio Negro near the Colombian border), and some paratypes, I have studied 2 unrecorded specimens (largest 58.3 mm in standard length) from the beach "Bufufu"[1] in the Rio Itu (tributary of the Rio Negro), collected by Dr. Martin Brittan, April, 1964, and kindly loaned by him. The species is new for the Middle Rio Negro basin.

The principal counts and proportions of two types and of the above cited specimens are recorded in table 1. The other following counts were made: dorsal ii 8(i) or 9(i); pectoral about i 13-14; predorsal scales 11 or 12 (lateral) peduncular scales 12-13; anal rays more numerous in the specimens from the Rio Itu (branched rays 35 and 36) than in the types (branched rays 32-34), suggesting a subspecific or racial differentiation, but the other differences are not impressive; other charactery as in the generic description.

The coloration of the species is not known; judging from its aspect after preservation, it may be rather similar to that of *Heterocharax macrolepis*, but the typical longitudinal and supra-anal bands must be very attenuated: they are actually scarcely visible in formalin.

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[1] Typical locality of *Brittanichthys axelrodi* Géry, 1965 (Trop. Fish Hobb., 13 (6): 22-24, and 62).

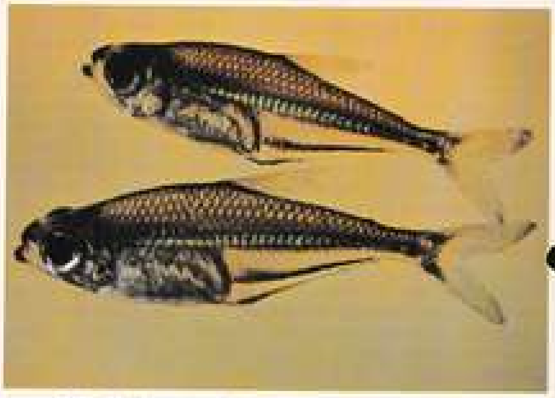

Fig. 4—*Heterocharax macrolepis* (Monocopora); by Dr. Herbert R. Axelrod.

Hoplocharax gen. nov.[3]

Type-species *Hoplocharax goethei* sp. nov.

Very small-sized, tetragonopterine-shaped Characinae; a narrow pseudotympanum or humeral hiatus; scales rather numerous on sides; lateral line incomplete; predorsal and postdorsal not keeled, or very slightly, the predorsal region *entirely naked*, the naked zone on each side corresponding to about 4 or 6 transverse scale-rows, from behind the head to well behind the dorsal fin; preventral rounded, without scales on the median line, except in front of the ventrals; postventral not keeled, probably without a median series of scales; dorsal with an unusual low number of branched rays (7), behind the middle of the body; adipose fin quite large; anal fin beginning under the first rays of the dorsal, relatively short, the first 3 unbranched rays spinuous, separated, fan-like (fig. 7, A); a number of sexual (?) tubercles or hooks on the branched rays; no scale on base of anal nor on caudal; no prominent interhaemals, but the accessory caudal rays spinuous, fan-like as are the first anal rays (fig. 7, C); first, unbranched pectoral ray modified into a rather strong, very pointed spine; clavicle notched; posterior border of the opercle (fig. 8) with two strong spines on each side of the notch, the lower one, horizontal, reaching well beyond the clavicle, the upper one much smaller and pointing up; preopercular angle armed with a similar, strong spine; great suborbital rather narrow, but without a naked zone and reaching the preopercular canal all around; three postorbitals apparently entire; anterior fontanel reaching to level of middle of eye; teeth (fig. 9) rather like those of *Heterocharax*, but less numerous on maxillary: premaxillary with a single row of 10 or so conical teeth, almost caniniform in front (relative to the size of the fish), much smaller on side; maxillary slipping under the antorbital, long, slender, slightly doublecurved, reaching to level of front of pupil, incompletely armed with 10-12 similar teeth, the upper half of which are much stronger; dentary with a frontal row of about 6 teeth, the median one, and the two lateral ones, the strongest, followed by about 20 much smaller teeth beginning behind the front row, and joining backwards the border of the bone (thus forming an incipient "second" series, in a somewhat more accentuated manner than in *Heterocharax*, and on the contrary of *Lonchogenys*, where it is the front series which

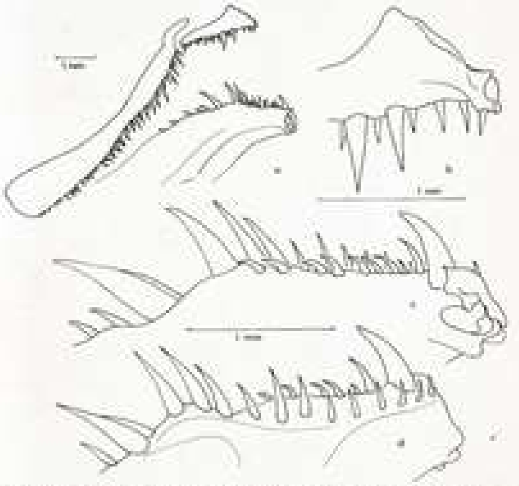

Fig. 5—Jaws of *Lonchogenys ilisha* (paratype): a, ½ schematic assemblage, interna view; b, enlarged view of the mesial part of the premaxillary; c and d, enlarged view of the mesial part of the dentary, internal (above) and external (below) views.

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[3] Meaning an armed *Charax*, owing to the numerous spines which are diagnostic for the genus; gender masculine.

Fig. 6—Head of **Lonchogenys ilisha** specimen from the Rio Itu.

continues backwards); apparently no pterygoid teeth; gill-rakers about 4 or 5/12, the uppermost rudimentary; the very small scale (fig. 2 c) is evidently derived from the above-described type found in *Heterocharax-Lonchogenys*, but much more simplified.

DISCUSSION: judging from its general shape and color-pattern (see species description), and chiefly from the structures of the dermal-skull and of the jaws, *Hoplocharax* gen. nov. appears to be derived from some ancestor of *Heterocharax*.

It has nevertheless acquired a number of features which are highly unusual in the characoid fishes. Some could be called regressive or degenerative, like the low number of the dorsal rays, the simplified structure of the scales, and chiefly the partially naked body, which is to be found only, to a lesser degree, in *Charax rupununi*, as well as in an undescribed form, close to *Petersius* auct., from Sierra Leone in Africa[4].

The other features are clearly adaptive (defensive ?). Among the characoids, the opercle spine is to be found in *Diapoma*, where it is not nearly so

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[4] An entirely naked body exists in the southern South American tetragonopterine *Gymnocharacinus*, and in an African genus which will be described by Mr. Tyson Roberts, Stanford University.

strong. As we have seen, the preopercular spines begun to develop themselves in *Acanthocharax* and in *Xiphocharax*, as well as in the *Heterocharax-Lonchogenys* line; in *Hoplocharax* it reaches the largest development thus known. The other spinuous formations could also be ways of defense; this kind of protection (or supposed protection) has been achieved in a number of lines, but not with the same means, which here seem to constitute an innovation. We know of the dorsal spine of *Stethaprion* and others, of the abdominal serrae of many Serrasalminae, or of the protruding ventral spines ("innominate bones") of some Tetragonopterinae, as in certain *Astyanax* or *Deuterodon*, and even of the anal spines of *Brachychalcinus*, but never, as far as known, has any characoid fish achieved a pectoral spine which, in other, probably less primitive, Ostariophysi (many siluroids, barbine cyprinids, etc.) attains a great development.

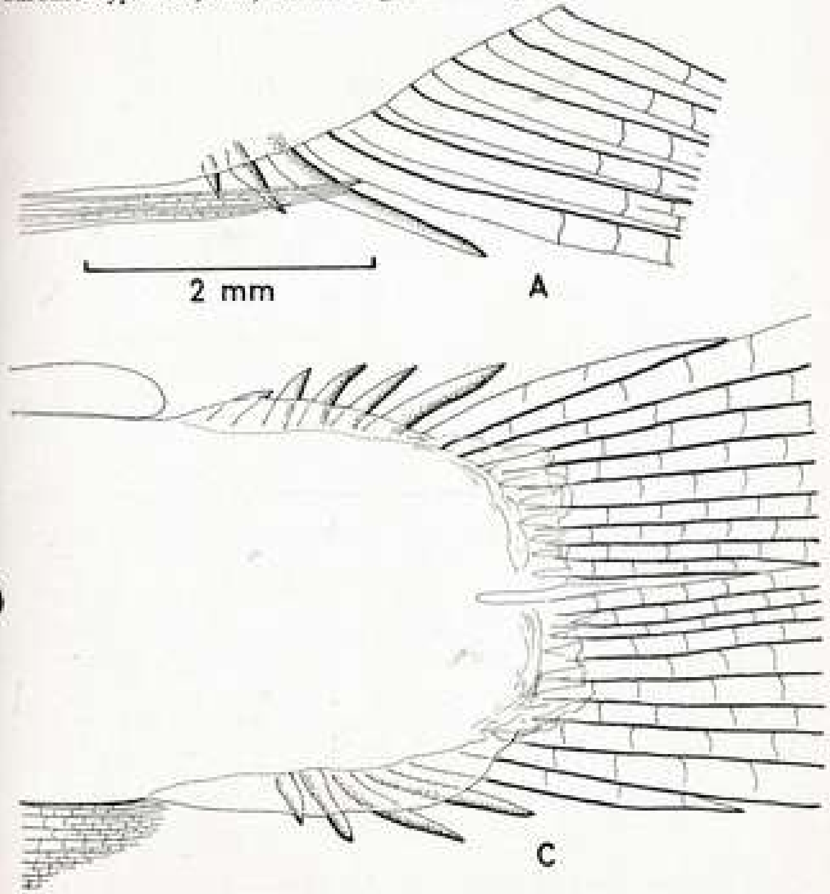

Fig. 7—**Hoplocharax goethei** gen. et sp. nov.: A, spinous rays of the beginning of anal; C, accessory spinous caudal rays.

TABLE 1. Principal counts and proportions of 7 ex. of *Heterocharax macrolepis* and 4 ex. of *Lonchogenys ilisha*, including type of both species.

	HETEROCHARAX MACROLEPIS								LONCHOGENYS ILISHA				
	British Guiana	Manacapuru						RANGES	Upper Negro		Rio Iiu		RANGES
No.	1 Type	2	3	4	5	6	7	(6 ex. from Manacapuru)	1 Type	2 18074 Parat.	3	4	(4 ex.)
Standard length (mm)	43.8	43.1	39.7	34.1	32.7	30.8	30.3	30.3–43.1	51.4	55.9	58.3	52.2	51.4–58.3
Sd. length/depth	3.15	3.26	2.99	3.07	3.20	3.18	3.0	2.99–3.26	2.87	2.77	2.83	3.16	2.77–3.16
Sd. length/head	3.56	3.68	3.71	3.59	3.76	3.54	3.48	3.48–3.76	3.27	3.35	3.41	3.33	3.27–3.41
Head/eye	2.73	2.49	2.66	2.32	2.29	2.15	2.18	2.15–2.66	ab. 2.3	2.35	2.38	2.49	2.3 –2.49
Head/interorb.	4.92	4.50	4.12	4.31	3.95	4.1	3.95	3.95–4.50	—	4.91	4.89	5.07	4.91–5.07
Head/maxill.	2.72	2.25	2.49	2.32	2.29	2.39	2.35	2.25–2.49	ab. 2.15	2.32	2.22	2.18	2.15–2.32
Head/upper jaw	—	2.05	1.78	1.98	1.85	1.92	1.85	1.78–2.05	1.75	—	1.75	1.95	1.75–1.95
Head/snout	4.56	5.85	5.63	5.59	5.44	5.06	5.12	5.06–5.85	—	4.28	3.98	5.07	3.98–5.07
Dorsal to caudal Snout to dorsal	.98	1	1	1	1.06	1	.95	.95–1.06	ab. .95	.97	.97	1	.95–1
Length of peduncle Depth of peduncle	1.37	1.33	1.14	1.47	1.32	1.30	1.18	1.14–1.47	ab. 1.4	—	1.26	1.46	1.26–1.46
Anal	iv 33(i)	iv 33(i)	?	iv (35i)	iv 33(i)	iv 33(i)	?	Ca. 31–36 (20 ex.)	iv 32(i)	iii 33(i)	iv 35(i)	iv 36(i)	(iii) iv 32–36(i)
Longit. scales	39	39	39?	39?	38	38	38	38–39	35	35	35	35–36	35–36
Transv. scales	7/5	6½/4½	6½/5	6½/5	7/?	7/5	7/4½	6½–7/4½–5	5/4	6/4½	6/3½	5/4	5–6/3½–4½

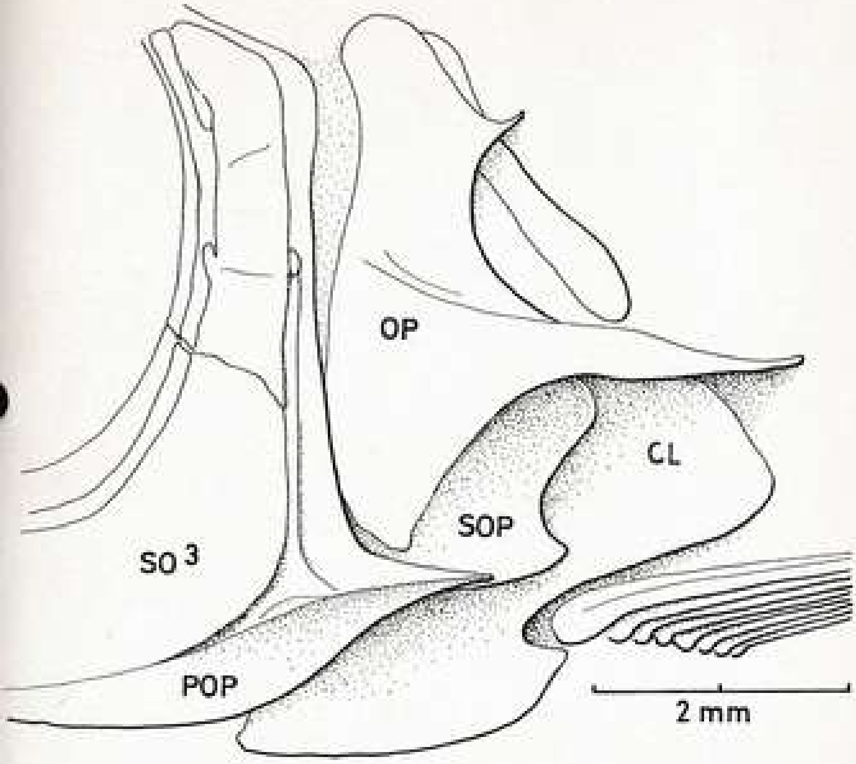

Fig. 8—**Hoplocharax goethei** gen. et sp. nov.: opercular and preopercular region of the head of the holotype.

Combining in its own body such a collection of spines of various origin, *Hoplocharax* may be considered as a museum in miniature of defensive specialization: it, and its group, would be a material of choice for the study of evolutive adaptation.

Finally the other features may be considered as relatively generalized. Sexual books or tubercles are common on the lower fins of the males of the Tetragonopterinae *sensu lato*, as well as in the Characinae and even in the primitive serrasalmine *Colossoma*. The structural type of the teeth is rather wide-spread among the Characinae, and even in some Tetragonopterinae: the maxillary of *Prionobrama*, for instance, is rather like that of *Hoplocharax*.

Hoplocharax goethei sp. nov.[5]

HOLOTYPE: (?), 29.7 mm in standard length, "Igarapé da Mae Joana"[6]

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[5] To honor Dr. Charles M. Goethe, Sacramento, California, for his support of scientists and students in the fields of biology, conservation, and education. Dr. Goethe died on June 10, 1966, at the age of 91.

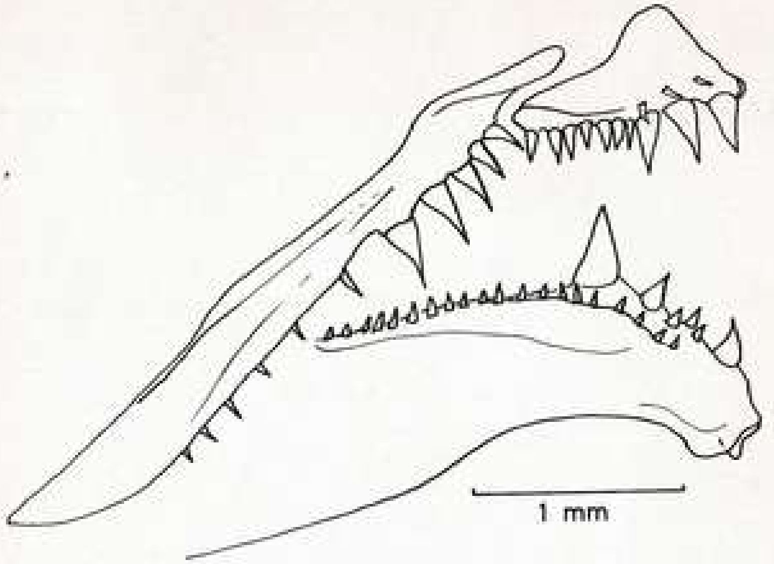

Fig. 9—Jaws of **Hoplocharax goethei** gen. et sp. nov. (paratype); ½ schematic assemblage, internal view.

near Manaus, lower Rio Negro, Brazil, coll. Dr. Carl Ternetz Dec. 25, 1924; provisorily in the Division of systematic Zoology, Standford University No. 56,478.

PARATYPES: 1, ♀ (?), 27.7 mm in standard length, Praio Bulufu in the Rio Itu, about 80 km from its confluence with the Rio Negro, coll. Dr. M. Brittan, Apr. 26, 1964; Sacramento State College St. No. 061.

1, ♂, 25.5 mm in standard length, "Santa Fé" on the Rio Jufari, at about 240 km. from its confluence with the Rio Negro, coll. Dr. M. Brittan, Apr. 4, 1964; Sacramento State College, Sta. No. 056.

8, at least 2 ♂♂, 21.3-26.8 mm in standard length, Igarapé Castanha, into Rio Negro (right bank), about 2 hours by motor-boat above Manaus, coll. Dr. E. Fittkau and J. Géry Oct. 23, 1965; pers. No. 0478.

SPECIFIC DIAGNOSIS: greatest depth 3.38-3.87 and length of head (measured up to the base of the spinuous opercular process) 3.57-4.0 in the standard length; snout-to-dorsal .88-.98 in dorsal-to-caudal; depth of

[*] The late Harald Schultz (Trop. Fish Hobb., 12(10): 25-32, 59-63, 1964) believed this Igarapé to be near Manacapuru: I have studied the rather extensive collection from the spot; it includes *Heterocharax* (22 ex. cited above), but not a single *Hoplocharax*, whereas the latter is mixed with *Heterocharax*, in the approximate ratio 1 to 20, not far from Manaus. Thus the typical locality is Rio Negro basin, not Amazon basin. Note that *Hoplocharax* is also sympatric, with *Lonchogenys* this time, in the Rio Itu.

peduncle 1.4-1.8 in its length; eye 2.07-2.31, bony interorbital 3.77-4.32, maxillary 2.5-2.95, upper jaw 1.86 (?)-2.30 and snout (in oblique) 4(?)-4.92 in the length of head; dorsal ii 7(i); anal IIi or IIIi 24-28(i); longitudinal scales (6-7) 43-48, about 11-13 in a transverse series at dorsal level, from the beginning of the squamation to the root of ventral.

DESCRIPTION: the principal counts and proportions, resumed above, are recorded in table 2. The characters not recorded in the table nor in the generic description are the following: pectorals I 8, not quite reaching ventrals; ventrals probably i 7, reaching to first (spinuous) rays of anal; caudal about IVi 9/8 iV (small Roman figures indicating soft unbranched rays, Roman capitals indicating hard rays), the lower lobe being apparently somewhat longer than the upper one; about 16 or 17 peduncular scales; the male from the Rio Jufari has a number of tiny hooks (7-14) on the last unbranched and first two branched rays; it may be mature; the largest males (?) from the Igarapé Castanha have 4-6 very tiny tubercles on the first two-thirds of anal, beginning with the last unbranched ray; they may be almost mature; some of the other ones have also some tubercles, scarcely visible, and their sex cannot be ascertained, whereas the type and the Rio Itu paratype are probably females.

The color-pattern of the species (fig. 11) has been noted *in vivo*: eye bright red, body olive with a brilliant, golden longitudinal band and a dark conspicuous line above anal; fins all greyish. This color-pattern is not far from the basic type of the other members of the group.

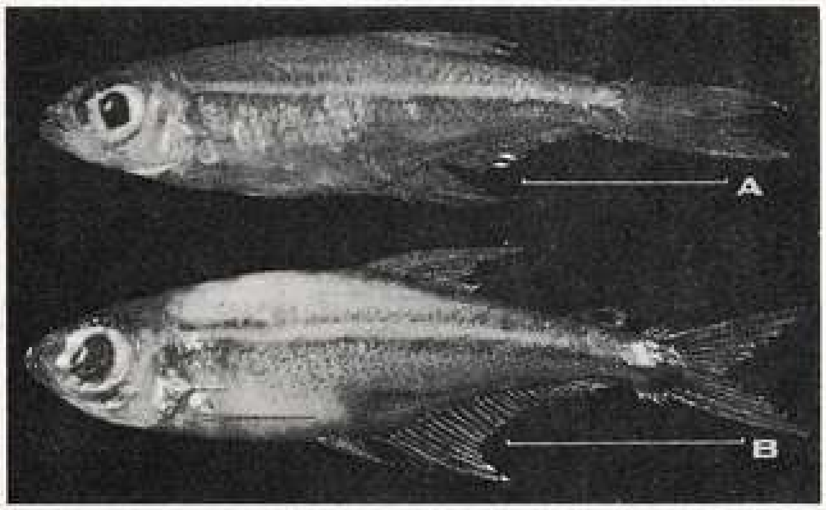

Fig. 10—**Haplocharax goethei** gen. et sp. nov.: type, above (A, 29.7 mm sd. lgth.) and paratype, below (B, 26.8 mm sd. lgth.); the lines represent 1 cm.

TABLE 2: Principal counts and proportions of the 10 type-specimens of *Hoplocharax goethei* gen. et sp. nov.

COLLECTOR	TERNETZ	BRITTAN		GÉRY								
No. and Sex	1 ♀? Type	2 ♀?	3 ♂	4 ♂	5 ♂	6 ♀?	7 ?	8 ?	9 ?	10 ?	11 ?	RANGES
Standard length (mm)	26.7	25.7	25.5	24.8	24.0	23.9	23.0	22.4	21.8	21.5	21.3	21.3–26.7
Sd. length/depth	3.60	3.36	3.75	3.63	3.81	3.62	3.59	3.67	3.71	3.64	3.87	3.36–3.87
Sd. length/head	3.65	4.0	3.59	3.56	3.66	3.57	3.59	3.67	3.66	3.64	3.60	3.57–4.0
Head/eye	2.25	2.09	2.22	2.15	2.19	2.31	2.21	2.10	2.07	2.11	2.15	2.07–2.31
Head/interorb.	4.05	4.32	3.95	4.17	4.06	3.95	3.77	3.82	4.0	3.94	4.0	3.77–4.32
Head/maxill.	2.70	2.55	2.54	2.66	2.50	?	2.78	2.90	2.55	2.65	2.80	2.50–2.90
Head/upper jaw	2.30	2.10	2.22	2.03	1.97	1.867	2.21	2.26	2.07	2.27	2.04	1.867–2.30
Head/snout	4.25	4.32	4.19	4.67	4.66	4.59	4.77	4.67	4.35	4.92	4.8	4.19–4.92
Dorsal to caudal / Snout to dorsal	.89	.88	.93	.90	.89	.93	.90	.89	.88	.90	.88	.88–.93
Length of peduncle / Depth of peduncle	1.6	1.7	1.65	1.5	1.4	1.6	1.5	1.4	1.5	1.8	1.5	1.4–1.8
Anal	iv 25(i)	iii 27(i)	iv 24(i)	iii 26(i)	iv 28	iv 25(i)	iv 27(i)	iv 24(i)	iv 26(i)	iii 25(i)	iv 26(i)	III-iv 24–28(i)
Longit. scales	(7) 45–48	(6) 45	(6) 45	(7) 45	(6–7) 47	(6) 44–46	(6) 45	(6) 44	(6) 43	(7) 47	(6) 46	(6–7) 43–48
Transv. scales	12	12	11	13	13	13	13	12	11	12	12–13	11–13

Fig. 11—Coloration of *Hoplocharax goethei* gen. et sp. nov. (from a sketch made immediately after preservation in formalin).

DISCUSSION: *Hoplocharax goethei*, as compared with the two other forms, has the smallest size, the most elongate body and peduncle, and the shortest maxillary; it has probably a larger eye and a broader interorbital than *Lonchogenys*, but not than *Heterocharax*; it has much more numerous scales, apart from the fact that some rows are lacking in the dorsal part of the body, and a much shorter anal fin. Table 3 (with rounded figures) permits an easy comparison of the three forms.

TABLE 3. Counts and proportions (rounded figures) of the three monotypic genera of the Heterocharacini

	LONCHOGENYS	HETEROCHARAX	HOPLOCHARAX
Greatest sd. length (mm)	60	45	30
Sd. lgth./depth ...	2.75-3.2	3-3.33	3.35-3.9
Sd. lgth./head ...	3.25-3.4	3.5-3.75	3.55-4
Head/eye	2.5-2.5	2.15-2.75	2.05-2.3
Head/interorb. ...	4.9-5	3.9-4.9	3.75-4.35
Head/maxill. ...	2.15-2.35	2.25-2.75	2.5-2.95
Head/upper jaw ...	1.75-1.95	1.75-2.05	1.857-2.3
d/snout ...	4-5.1	4.55-5.85	4.2-4.9
Lgth. ped./depth ped.	1.25-1.45	1.15-1.6	1.4-1.8
Dorsal	ii 8-9(i)	ii 8(i)	ii 7(i)
Anal	iv 32-36(i)	iv 31-36(i)	III; 24-28(i)
Pectoral	i 13-14	i 10-12	I 8
Longit. scales ...	34-36	38-39	(6-7)43-48
Transv. scales ...	5-6/3½-4½	6½-7/4½-5	11-13 tot.
Pedunc. scales ...	12-13	13-14	16-17
Gill-rakers	6-8/11-14	2-3/12	4-5/12

The generic differential diagnosis has been sketched above. It may conveniently be resumed in the following key:

a. Opercle notched, without spines; preopercular angle more or less pointed, without a spine; clavicle practically not notched; first pectoral ray soft; predorsal line scaled, lateral line complete; dorsal ii 8 or 9, anal iv 31-36, apparently without sexual hooks; medium size (40-60 mm).
  b. Teeth in a single, more or less regular, series on both jaws; maxillary with about 22 teeth; great suborbital almost complete
  Heterocharax Eigenmann
  bb. Teeth in two rows on both jaws; maxillary with 34-52 teeth; great suborbital leaving a narrow naked area below or behind
  Lonchogenys Myers

aa. Opercle with two important spines; preopercular angle prolonged into a spine; clavicle notched; first pectoral ray spinuous; predorsal region naked, lateral line incomplete; dorsal ii 7; anal IIi or IIIi 24-28, with some tubercles; small size (about 30 mm)
Hoplocharax gen. nov

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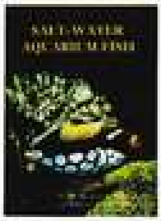

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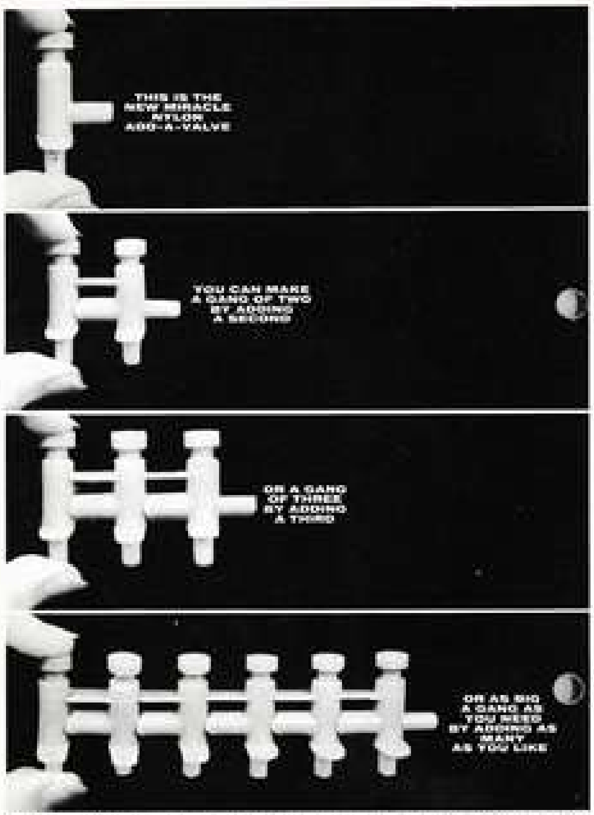
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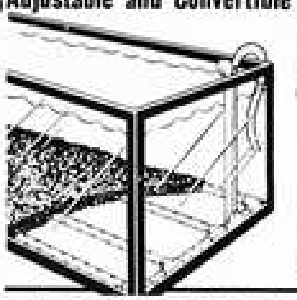


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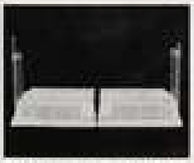
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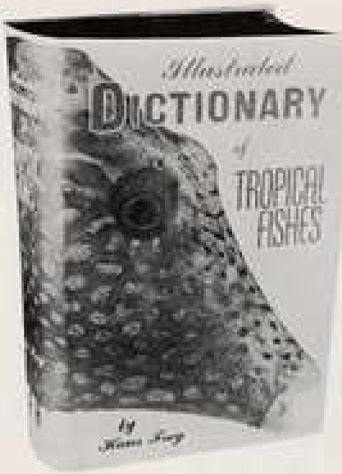

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