

The

Volume 5

CICHLIDS yearbook

Ad Konings (Ed.)



The Cichlids Yearbook

Volume 5

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Mary Bailey and
Martin Geerts (Co-Editors)*



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Cover photographs:

- 1 - *Tropheus brichardi*; Kipili, Lake Tanganyika, Tanzania.
- 2 - *Thorichthys meeki*; from Villahermosa, Mexico.
- 3 - *Haplochromis aeneocolor*; Katwe Bay, Lake Edward, Uganda. Photo by Mark Smith.
- 4 - *Aulonocara gertrudae* n. sp.; Lupingu, Lake Malawi, Tanzania.

Mary Bailey (Spalding, UK)
corrected the manuscripts and
translated the German articles.

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This book is dedicated to our friend
Peter Knabe, who regretfully lost
his life in Tanzania while exploring
the northern coast of Lake Malawi.
We shall never forget his enjoyment
of observing cichlids in their
native environment.

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Introduction

The reopening of the Mozambiquean part of Lake Malawi has caused quite a stir among cichlid aficionados. The first shipments from Stuart Grant's station at Salima, Malawi, containing wild caught Red Zebra, "*Aulonocara Nyassae*" and *Pseudotropheus socolofi*, the so-called "Pindani", were received with much enthusiasm. Stuart has also enabled me, in the company of Kjell Fohrman (Gothenburg, Sweden) and Frode Fjeldheim (Oslo, Norway), to complete a survey along the entire Mozambique coast of the lake. Not surprisingly, many new species and variants were discovered, details of which will be published, together with those from Tanzanian and Malawian shores in the second edition of "*Malawi Cichlids in their natural habitat*". This book will for the first time cover all the known cichlids from the entire shoreline of Lake Malawi, and will be published in Autumn 1995.

An expedition to the southeastern part of Lake Tanganyika, organised by Frederick Wolff (Mbeya, Tanzania) and undertaken by Laif DeMason, the dive team of LANYAFI, and myself, has lifted the veil from a rarely visited part of the lake and revealed a number of new species and variants of cichlids.

The articles in the Cichlids Yearbook bear testimony to the value of such expeditions, which extend our knowledge of cichlids and nature in general.

Authors who have contributed for the first time are briefly introduced in the same order as their articles appear:

Toby Veall (Lusaka, Zambia) is a well-known collector of Tanganyikan cichlids who has a fish collecting station on the lake, near the Kalambo River. He has dived for thousands of hours in the Zambian and Tanzanian waters of the lake and has thus gathered a wealth of experience with Tanganyikan cichlids. Recently he extended his station with a number of chalets which can be rented by aquarists and sports fishermen. His contribution shows us the very rare "Marmalade Cats" of *Tropheus moorii*.

Dr. Jos Snoeks is an ichthyologist at the Royal Museum for Central Africa at Tervuren, Belgium. He has studied the cichlids of Rwanda and in particular those of Lake Kivu for more than 10 years. His study interest now also includes the cichlids of Lake Tanganyika. His article tells us about the different colour morphs among Kivu cichlids.

Pseudotropheus socolofi photographed at Tumbi Point, Mozambique.



Mark Szot (Clifton, New Jersey) is a dedicated hobbyist specialising in Central American cichlids. He reports on the breeding of *Nandopsis beani*.

Ross Socolof (Bradenton, Florida) hardly needs any introduction. He is one of the pioneer fish farmers in Florida who has bred and raised hundreds of species for the first time. His innumerable expeditions to the interior of Central and South America have yielded many new species and eventful tales. He is a fellow of the American Cichlid Association (of which he has been a member since its very beginning) and organiser of the yearly Florida Fish Farmers Show in Tampa. He tells us the story of the rare *Herichthys bocourti*.

Dr. Anthony Mazeroll and Marc Weiss have contributed a report that may unsettle long-held beliefs concerning Discus. Dr. Mazeroll is assistant Professor of biology at West Texas A&M University and is currently working on the taxonomic status of Discus. He is consultant ichthyologist to the International Discus Association and has also served on the board of directors of the Discus Study Group. He has kept Discus since the age of 14 and specialises in wild Discus in planted tanks.

Marc Weiss (Miami, Florida) is a well-known wholesaler of Discus (World Wide Fish Farm) who has a personal interest in wild Discus. He has himself collected Discus at various localities himself and thus has first hand experience on the variability and distribution of these very popular cichlids.

Without the support and hospitality of several friends it would have been impossible to show you cichlids in their native environment and provide you with first hand information on how they live. I am therefore grateful to Stuart Grant (Salima, Malawi), Fenias Chirinda (Metangula, Mozambique), Frederick Wolff (Mbeya, Tanzania), Gary Kratochvil (San Antonio, Texas), and Juan Miguel Artigas Azas (San Luis Potosí, México).

Ad Konings

LAKE TANGANYIKA CICHLIDS

Fairytale cichlids of the genus *Cyathopharynx*

Ad Konings

The featherfin cichlids of the genus *Cyathopharynx* are among the most striking cichlids of Lake Tanganyika. The iridescent colours of territorial males, the building of large sand-castle nests, and the fact that these species are regularly observed while snorkelling makes them very popular with visitors to the lake. The desire of many aquarists to keep such a fairytale fish in a tank at home has become a reality since the early sixties when the late Pierre Brichard started to ship out

the first featherfins from Burundi. *Cyathopharynx* have now been exported from the lake for many years and since the early eighties geographical races from Tanzania and Zambia, and later from Zaïre, have reached the hobbyists' aquaria. Even though they are fragile, difficult-to-ship fishes, and despite the fact that the males lose their vibrant coloration shortly after they have been captured, they have become very popular among aquarists.



Breeders gaining experience with *Cyathopharynx* have noticed that tank-raised males colour up at a relatively small size and that they acquire the full spectrum of nuptial coloration found in their wild cousins. A prerequisite is, of course, that they are fed low-protein foods, and that the bottom of the tank has an open area with sand or very fine gravel where the male can construct his sand-castle nest.

The cichlid genus *Cyathopharynx* contains one described species, *C. furcifer* which was first described by Boulenger in 1898 as *Paratilapia furcifer*. Although it has subsequently become apparent that there are several different geographical races there was never any suggestion that more than one species would be involved. Not until I found two different forms of *Cyathopharynx* breeding side by side in Moliro Bay, Zaïre, did I realise that there must be at least two species in this genus. As the females of the two species are indistinguishable (at least I have not been able to tell them apart underwater), it is rather difficult to say with certainty which of the two species in Moliro Bay is conspecific with the holotype. Toby Veall, exporter of ornamental fishes in Zambia, tells me that he too is unable to distinguish the females of the two species and

that species are found in Zambian waters as well. Males, however, are easily told apart. One has a golden patch on the head and lighter coloured dorsal and anal fins. The territorial coloration of the other is greenish marbled all over the body and there is no golden patch on the head; furthermore the dorsal and anal fins are very dark. This is the situation in the southern part of the lake, but what is the distribution of both species in the remaining, major part of the lake?

First, however, I would like to discuss the identity of the gold-headed *Cyathopharynx*. Boulenger described *C. furcifer* from two specimens from Kinyamkolo (now known as Mpulungu). He gives the following colour description of the holotype: "Bluish above, white beneath; a few ill-defined yellow streaks along the body; some yellow marblings on the postocular part of the head; fins white, with some yellow streaks on the dorsal and anal, and between the ventral and caudal rays." From this description it is quite evident that Boulenger is describing the gold-headed *Cyathopharynx* and not

Previous page:
Cyathopharynx sp. "dark
furcifer" in Moliro Bay,
Zaïre.
Below: *Cyathopharynx*
furcifer photographed at
the same locality.



the darker species. I have not yet been able to examine the holotype of *C. furcifer* and compare it with the two species known, so there is a very slight possibility that the colour description was made from individuals other than the types — this is rather unlikely but cannot be discounted at this time. Nevertheless I would like to suggest using the name *Cyathopharynx* sp. "dark furcifer" for the second, darker species.

The first photograph of the true *C. furcifer*, taken by Hans-Joachim Herrmann, was published in 1985 by Peter Schupke. It showed a male caught in Nkamba Bay.



Left: A freshly caught *Cyathopharynx* cf. *furcifer* at Resha, Burundi. The colour pattern of this male differed notably from the other *Cyathopharynx* species found at the same locality. Photo by Hans-Joachim Herrmann.

Below: A male *C. furcifer* defending his sand castle nest in Kasanga Bay, Tanzania.

Next page, top: A dark blue race of *C. sp.* "dark furcifer" at Kala Island, Tanzania. Bottom: A male *C. sp.* "dark furcifer" at Kalilla, Tanzania.

On a recent expedition to the southern part of Tanzania I was again able to observe both species side by side at various locations (as far north as Kipili). I noted that the male coloration of *C. furcifer* showed hardly any geographic variation — the anal fin of the Kipili population has more yellow pigment than the one in Moliro Bay — whereas along the same stretch of coastline I found three different colour forms of *C. sp.* "dark furcifer". I further found that in shallow areas with turbid water the gold-headed species was either more abundant or the only *Cyathopharynx* present. On the other hand I found both species side by side at a depth of 22 metres at Mtosi, Tanzania (see map, page 13). Males of both species construct sand-castle nests on top of rocks (see photo) but in the south I found only *C. furcifer* building such nests on the sand (Kasanga and Kipili).

It thus seems that *C. furcifer* is a more flexible species able to breed in various biotopes. This would explain the observation that there are no obvious geographical differences between the

known populations. *C. sp.* "dark furcifer" on the other hand seems to be restricted more to the clearer water found in rocky habitats, which would explain the geographical variation observed in this species.

Now the question remains, to what species do the other known populations of *Cyathopharynx* belong? And are the two species also found in the northern part of the lake? Without a thorough investigation I cannot make a firm statement, but an observation by Herrmann (1994) may shed some light on the issue. At Resha, Burundi — a shallow intermediate biotope — he found two different *Cyathopharynx*: a dark blue male, apparently identical to the ones found at Rutunga, and one with marblings in the fins. He further observed that males of both species



constructed sand castle nests on the sand. Which one of these two is *C. furcifer* (if this species is present at all in the northern half of the lake) can only be guessed, being the assumption that the lighter coloured fins are a characteristic of the northern *C. furcifer* as well.

Herrmann (pers. comm.) has a plausible hypothesis to explain this situation: *C. furcifer* may be polymorphic. The two different breeding dresses would then belong to two different morphs, as is the case in all *Cyprichromis* species. Although this idea cannot be dismissed, a few facts contradict it. First of all there are many localities known where only one of the two species (or morphs) is found. Secondly there is a consistent difference in the habitat preference of the two. The polymorphic colour patterns in *Cyprichromis*—blue tail or yellow tail— may derive from a difference in one or a very few genes. The difference in the colour pattern of the two *Cyathopharynx* species may not be as striking as bright yellow and bright blue, but it seems likely that more genes are involved. Nevertheless polymorphism should still be considered as a possibility to explain the sympatric occurrence of two such similar cichlids.

The *Cyathopharynx* which has been shipped as "Ruziba Furcifer" is very likely a different species from the one collected at Rutunga; it could in fact be the true *C. furcifer*. However, the identity of the gold-headed *Cyathopharynx* in Kigoma Bay, Tanzania, is far from clear. The golden patch on the head may indicate a relationship with the gold-headed *C. furcifer* from the southern regions of the lake, but the dark body and fins point to possible



conspecificity with *C. sp.* "dark furcifer". It is clear that more research needs to be done before these questions can be answered unambiguously.

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The *Tropheus* of southern Tanzania

Ad Konings

In June 1994 Laif DeMason and I completed a survey along the southern part of the Tanzanian coast of Lake Tanganyika. Our main object was to explore this remote and rarely visited area for new species and geographical variants. Although we were very satisfied with the results of our expedition only a handful new species and variants were found.

During our survey we were able to establish the distribution pattern of *Tropheus moorii* and that of *T. brichardi*, and the fact that these overlap over a 10 km-long area. The main purpose of this article is to show you the different geographical races of *Tropheus* found between Karema and Kasanga (see map page 13).

We started our survey in Kasanga, the locality where the so-called "Red Rainbow Moorii" is collected. Even though recent reports have questioned the presence of the Red Rainbow at Kasanga (Zadenius, 1992) we were able to confirm earlier reports (Konings, 1988) that the rocky coast actually at Kasanga (Bismarck Point) and further south harbours this very attractive variant of *T. moorii*. While there we found Toby Veall's divers collecting the Red Rainbow approximately one kilometre south of Kasanga. Toby is an exporter of ornamental fishes based in Zambia, but is licensed to collect in Tanzanian waters as well.

I noticed some variation in the *T. moorii* population between Kasanga and the Kalambo river, the border with Zambia. Although there is a single continuous population some individuals exhibit more blue pigment in the dorsal fin than others. Most, however, show a distinctly red dorsal. I don't think that the blue colour in the dorsal implies two different populations but rather that it is part of individual variation (such as dark or blond hair in humans).

At Kasanga a sandy bay about 4 km long separates the Red Rainbow population from the so-called "Blue Blaze Moorii". The Blue Blaze—the trade name is misleading as it does not have a blue blaze but blue spots in the dorsal—lacks the bright yellow blotch on the body and has more blue spots in the dorsal fin than the Red Rainbow. The females show a little of the yellow colour, especially on the lower half of the body, but its intensity is much reduced compared to that of the Red Rainbow. The distribution of the Blue Blaze is restricted to a few rocky headlands near the village of Muzi, north of Kasanga.

At Samazi, about 12 km north of Kasanga, *T. moorii* lacks any bright colours: the red and blue in the dorsal are much reduced compared to the Blue Blaze Moorii. At Katili *T. moorii* exhibits a brown-green coloration and the dorsal fin lacks the red pigment almost entirely. The head and

chest are still red but this population is probably the least attractive.

At Memalesa Island some *T. moorii* have a few small, vertically elongated yellow spots on the flank. The dorsal is yellow and there is a yellowish grey hue all over the body.



The rocky coast between Samazi and Katili in the southern part of Tanzania is very precipitous. A similar gradient is found under-water where the rocks plunge to a depth of about 40-50 metres before giving way to a sand-mud bottom.



Mamalesa consists of three islands: the main island is about 2 km long and about 500 m wide; a smaller island, approximately 200 metres in diameter, is separated from it by a shallow passage (max. depth about 10 m) with a width of about 100 m; the third island lies closer to the mainland (about 1 km) and has a diameter of about 500 m. The passage between the third and the main islands is about 1 km wide and approximately 25 m deep. Mamalesa is better known as Malasa Island but this seems to be an old name given by European settlers and totally unknown to the inhabitants of the main island.

Due to the turbidity of the water I was unable to take photographs of *T. moorii* at Kala Island but I recorded yellowish fins as the most prominent feature of its coloration. The two islands at Kala lie close to shore and it is very unlikely that they would harbour a *T. moorii* population different to that found at the mainland.

Further north the coastline differs from that south of Kala. Even though there are high mountains close to the lake, over the millennia so much sediment has been washed down by the

Geographical races of *T. moorii*.

Top, left: males of the "Red Rainbow" at Kambwimba; right column: *T. moorii* at Muzi; at Samazi; at Katili; and at Mamalesa Island.

rivers that very flat—and probably fertile—shores have been formed. This flat foreland is more than 1 km wide in some places and has buried the rocky habitat over a long stretch between Kala and Wampembe.

Approximately 3 km offshore at Wampembe there is a small reef made of huge boulders. This reef, known locally as Fulwe, barely breaks the surface and lies at a depth of approximately 25 metres. *T. moorii* at this locality has a yellowish brown colour which is not at all unattractive. Further north the structure of the shoreline is similar to that south of Wampembe:

sandy beaches without rocky outcrops. We first found rocks at Hinde B. These were very large and the sand, at about 12 metres of depth, very coarse. *T. moorii* at Hinde B closely resembles the variant at Fulwe but the narrow bars are yellower and the fish is more attractive in appearance. The variant of *T. moorii* seen at Hinde B differs from other known populations in that even adult male specimens exhibit the narrow vertical barring known from juveniles. Adult females have prominent barring, the bars being



narrow and pale yellow in colour.

Between Hinde B and Namansi the shoreline consists of sandy bays alternating with small rocky outcrops. The coloration of the *T. moorii* found between these two localities changes slightly from brown (Hinde B) to yellowish brown (Namansi) and the first three vertical bars behind the gill cover become more prominent and slightly widened. The *Tropheus* from Kipili—only 30 km north of Namansi—was exported several years ago so I knew that it was greenish brown with two or three yellow bars behind the gill cover. Therefore it was tempting to assume that the *Tropheus* from Kipili were conspecific with the *T. moorii* we now saw at Namansi.

At Mtosi, however, we discovered the truth of the situation: here *T. moorii* is found sympatrically with another *Tropheus*, *T. brichardi*! Between Namansi and Kisambala *T. moorii* and *T. brichardi* are both found at the same locality. I will refrain from saying "side by side" because



Top: *Tropheus moorii* at Fulwe Rocks. Left, large photo: an algae-feeding *T. moorii* at Hinde B. Left, inset: this variant of *T. moorii* lives sympatrically with *T. brichardi* near Mtosi.



there is a clear difference in the habitat preferences of these two species. *T. moorii* is found, sometimes in large numbers in foraging schools, in the upper part of the rocky habitat where there is hardly any sediment. By contrast, at depths of more than 10 metres, sometimes down to 28 metres, where a visible layer of sediment covers the rocks, *T. brichardi* occurs in small numbers. Although it is widely known that adult *T. brichardi* exhibit vertical bars on the body, the population between Namansi and Kisambala does not. Interestingly in this region it is *T. moorii* which shows vertical barring in adulthood. The juveniles of *T. brichardi* at Mtosi have a beautiful orange-yellow colour and brown bars. They are indistinguishable from those of *T. brichardi* at Kipili. North of Kisambala *T. brichardi* occupies the entire rocky habitat because it is the only *Tropheus* present.

There are seven islands offshore at Kipili and their rocky shores are inhabited by the "Kipili *Tropheus*". This geographical variant of *T. brichardi* is better

Right: sometimes algae-feeding cichlids group together in large schools. This school consists mainly of male *Tropheus moorii* which take advantage of their sheer numbers to feed from the algae in the rocky territories of other, larger species. Photo taken in very shallow water near Mtosi.







Previous page; top, left: *T. moorii* at Kisambala where it is sympatric with *T. brichardi*. Top, right: *T. brichardi* at Mtosi; here it is found at much deeper levels than *T. moorii*. Large photo: a displaying male *Tropheus brichardi* at Ulwile Island. Inset: *T. brichardi* at Mvuna Island.

known as "Kipili Moorii" but to avoid confusion regarding its scientific name it is better to refer to it as the "Kipili Brichardi". Its juveniles have such gorgeous colours that it should, like *T. duboisi*, be one of the most popular cichlids from the lake. Adults vary in coloration, particularly in the number and shape of the yellow bars behind the gill cover. At Ulwile, the largest and most southerly island, the juveniles exhibit the brightest orange colour and the adults have two to three bright yellow bars behind the gill cover. At Mvuna, the third most southerly island and about 750 m away from Ulwile, most adult *T. brichardi* show only one rounded yellow blotch behind the gill cover. Most of the *T. brichardi* at the other islands have no yellow barring and are greenish-brown all over. Their juveniles, however, are orange-yellow. Adult females of all these island populations have yellow bars.

In the harbour at Kipili *T. brichardi* has an overall greenish-brown colour and only a very few adult specimens

Top: a few months old juvenile *T. brichardi* photographed at Nkondwe Island. Adult males at this locality do not have any yellow colour. Centre: a few days old juvenile at Nkondwe Island. Note that the orange colour is much intenser than that of the older individual above. Bottom: juvenile *T. brichardi* at Kampemba resemble those at Kipili more than those of the so-called "Mpimbwe Tropheus" which are found about 4 km to the north.





Top: a fishing village on Cape Msalaba (previously Cape Mpimbwe).
 Bottom: a juvenile *Tropheus brichardi* at Msalaba; it lacks the yellow coloration seen in all *T. brichardi* variants found south of this locality.
 Next page; top: an adult *T. brichardi* at Kampemba.
 Bottom: an algae-scraping male of the so-called "Mpimbwe *Tropheus*".

exhibit yellow bars behind the gill cover. A similar population is found near the village of Chongo, along a very shallow —3 metres deep— rocky coast separated from the rocks at Kipili by two small but permanent rivers.

Between Chongo and Cape Kampemba the shores are sandy and in all probability no population of *T. brichardi* is present between these two

localities. At Kampemba juvenile *T. brichardi* are orange like those around Kipili, but the adults do show vertical bars. Females have rather wide yellow bars whereas those of adult males are very thin and pale yellow. There is no orange or yellow patch on the lower cheek.

Separated from the Kampemba population by a small sandy bay of about 4 km wide we found





another geographical variant of *T. brichardi*: the so-called "Mpimbwe Moorii". Again it is not a *T. moorii*, so it is better to speak of the "Mpimbwe Brichardi". However, the name "Cape Mpimbwe" is totally unknown to its inhabitants and is probably a survival from the European occupation a few decades ago. The cape is known locally as Msalaba and the town nearby as Utinta. The geographical variant of *T. brichardi* at Msalaba, a rocky area no more than 5 km in length, is well known for the orange or yellow patch on the lower cheek of the male. The intensity of this coloured patch varies with the mood or condition of the fish. Males chasing conspecifics show the brightest colour. Juveniles are not orange or bright yellow like those at Kampemba or Kipili; they have an attractive pattern of dark brown bars on a white or pale yellow background.

The large rocks at Kabwe, about 10 km north of Msalaba, lie in very shallow water but surprisingly harbour a small population of *T. brichardi*. The males of this population do not show a coloured patch on the cheek but further details of their colour pattern cannot be given owing to the fact that visibility at this exposed site is bad almost all year round. The *Tropheus* I observed at Kalila, north of Kabwe, will be discussed in a future article as it is different from the species at Kabwe and Msalaba.

With regard to my hypotheses explaining the distribution patterns of *Tropheus* species in Yearbook vol. 4, I would like

once again to draw attention to the idea that *T. moorii* inhabited the entire southern half of Lake Tanganyika before it was out-competed by *T. brichardi* in less favourable habitats. Although the coast at Msalaba drops at a very steep angle and borders the deepest part of the lake, the *Tropheus* present at the moment is *T. brichardi* and not *T. moorii*, which is found at the opposite side of the lake. According to my hypothesis *T. moorii* must have been "pushed" to the south by *T. brichardi* after the lake regained its present water level. The reason for the success of *T. brichardi* may be linked with the large amounts of sediment carried down by the rivers between Msalaba and Kala, covering the rocky habitat in most places. During the period in which the water level was rising the rocky habitats in this area may have been rich in sediment and therefore provided better opportunities for *T. brichardi*.

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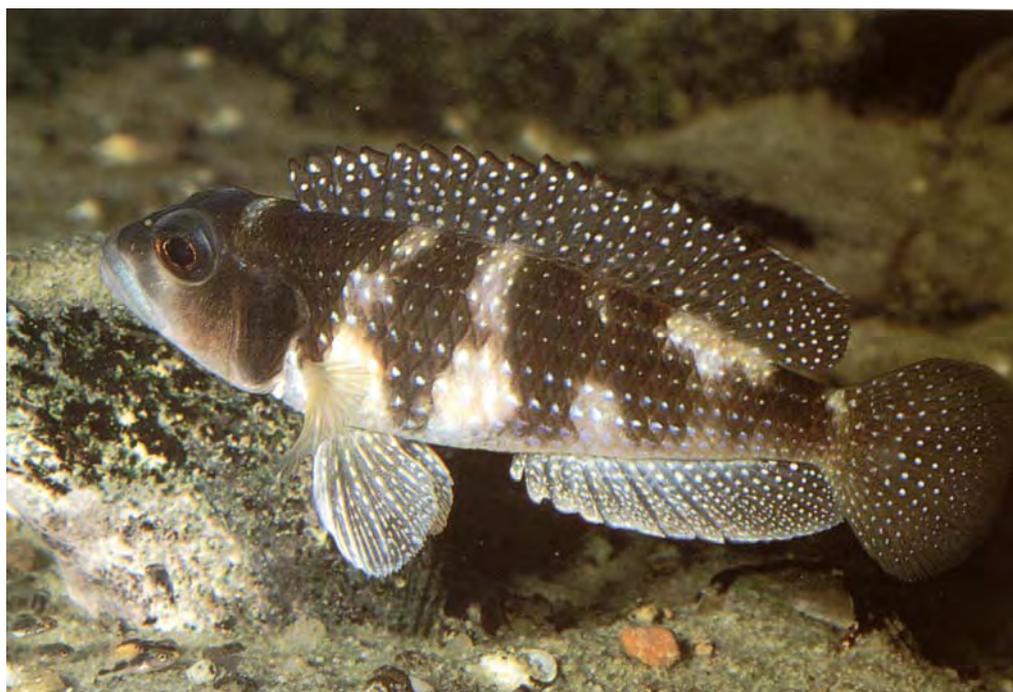
Breeding in *Lamprologus meleagris* Büscher, 1991

Hans-Joachim Herrmann

They are popular cichlids, the so-called shell-dwellers of the genera *Lamprologus* and *Neolamprologus* from Lake Tanganyika. As a rule these tiny fishes measure little more than 4–6 cm and can thus be maintained in a correspondingly small aquarium. *Lamprologus meleagris*, which was not only described by Büscher, but also introduced to the aquarium hobby by him, attains a length of little more than 5 cm in the wild. In the aquarium males often grow a centimetre longer. Adult females are full-grown at 4 cm, but there are no other significant differences between

Thus the *Paracyprichromis* swam around in the upper layers of the water, the *Julidochromis* preferred to remain in close contact with the rock-work, and the *L. meleagris* generally occupied the sandy substrate where there were a few empty snail shells. The males with the exception of one who lacked a permanent territory, were very territorial, and, having once taken possession of a snail shell, and partially buried it in the sand, were generally able to defend it successfully. During the breeding season, which includes several separate spawning episodes, females like-

wise occupy snail shells in the territory of a male. Males will often even relinquish their personal shell for use as a breeding cave. It is interesting to note that a male will breed with two females almost simultaneously, and will defend his now expanded territory against any intruders, while the females remain almost exclusively in the immediate vicinity of their shells.



the sexes. When purchasing these fishes it is best to buy at least 6 juveniles in order to be sure of getting both sexes, or otherwise to compare the genital pores of adult specimens. In males the genital papilla is small and inconspicuous, while that of the female is appreciably larger.

The maintenance and breeding of this extremely pretty species is problem-free, but not lacking in interest, as can be seen from the accompanying photos of the spawning sequence, here published for the first time. My specimens, 3 males and 2 females, shared a 450 litre aquarium with *Julidochromis transcriptus* and *Paracyprichromis* sp. "velifer". The population density allowed each fish an adequate amount of space.

The spawning and fertilisation of the eggs were observed several times. The female now leaves the breeding cave less frequently, and on each spawning pass lays several eggs on the inner wall of the shell, some 2–3 cm from the entrance. The male remains completely motionless and inclined slightly to one side outside the breeding cave, emitting his milt. This is sucked in towards the eggs by the fanning movements of the female's tail. It is not possible to say whether her pectorals also play a part in this process, as all that is visible of her at this stage is the tail and caudal peduncle. Apropos visibility, the cloud of milt—"cloud" is, perhaps, not the most appropriate term—is neither milky nor

whitish, but as clear as the water! The entire procedure is repeated several times, with the male occasionally abandoning his stationary position to chase away imaginary rivals. This accomplished, he returns to his station and once again emits his milt.

The female alone tends the spawn. After some 8 days the first fry can be seen peering inquisitively from the entrance to the shell. Within 24 hours the entire brood will be in view, with up to 73 fry guarded by the female. Initially they move no more than a centimetre out of the shell, disappearing inside again at the least disturbance. Day by day they become bolder, and the tendency to behave in unison grows less, so that before long each one is going off in a separate direction—but invariably returning to the shell entrance when danger threatens. Because on every occasion both my females were guarding fry at virtually the same time, on occasion the latter would "change sides". This exchange of fry was accepted—or perhaps passed completely unnoticed—by the females, whose breeding shells were sited about 8 cm apart. During this period each mother made sure that no other fishes came near to her particular breeding cave. The male in turn endeavoured to protect the territories of both females from intruders, particularly conspecifics, but in the process occasionally found himself between the two solicitous mothers and was gently punished for his pains. Further spawnings take place while the young are still being protected in the territory, so that up to 3 different sizes of fry may be found in the vicinity of the breeding cave. It must be mentioned,

however, that fry losses were rather large in the community tank. The *Julidochromis* were in part responsible, but non-breeding conspecifics were also seen to prey on the fry. Whether or not the parents participated in this cannibalism was not established, but neither was it ruled out.

Lamprologus meleagris exhibits a high degree of intraspecific aggression, but it is nevertheless possible to maintain several pairs together in a somewhat larger, suitably arranged, aquarium. In nature adults feed mainly on mosquito larvae, which therefore form a suitable diet in captivity even if no other foods are used. *Cyclops* and brine shrimp may also be fed if desired. The fry will take newly hatched brine shrimp and grow relatively quickly, although naturally size of tank, population density, and the quality of both water and diet, play an important role.

Reference

- BÜSCHER, H.H. (1991) Neue Schneckenichliden aus dem Tanganjikasee. *Lamprologus meleagris* n. sp. und *L. speciosus* n. sp. (Cichlidae, Lamprologini). DATZ 6/91, Vol. 44; pp 374-382.



Photo previous page: In particular the brilliant spots on *L. meleagris* make this species very attractive. This page, left: while the female deposits the eggs on the inside of the shell the male, assuming an awkward and stiff pose, expels his milt towards the female. Above: exploring fry at the entrance of the shell. Photos by Hans-J. Herrmann.

Neolamprologus meeli, an interesting shell-brooder

Ad Konings



The name *Neolamprologus meeli* is well known among cichlid aquarists even though this species has never been exported by the ornamental fish trade. The species that has incorrectly been sold under this name is *N. hecqui*, a small shell-dwelling cichlid from Zambian waters. I first suggested this idea in 1988 (*Tanganyika cichlids*) but the lack of live specimens has made confirmation impossible until recently.

On a recent expedition to the southern part of the Tanzanian shores of the lake I was able to observe breeding *N. meeli* in their natural biotope. These observations made it possible to distinguish *N. meeli* from other sand and shell-dwelling species by their behaviour. Both *N. meeli* and *N. hecqui* are regarded as shell-dwelling cichlids although it is not certain that outside the breeding period *N. meeli* seek shelter in shells. Both male and female are too large to fit comfortably inside an empty *Neothauma* shell, so this kind of shelter can be used only when the fishes are immature. In the wild *N. hecqui* females always seek shelter in empty shells and males are always found near them. The *Neothauma* shell plays an important role during the breeding

procedure of both species. The eggs are deposited inside the shell and protected by both parents. *N. hecqui*, however, uses the empty shell just as it lies on the sand whereas *N. meeli* conceals the shell completely. Apart from hiding the shell in the sand, *N. meeli* pairs dig a small crater in front of its entrance. The end product is a concealed shell buried in the rim of a crater nest (see photo, next page).

The breeding coloration of *N. meeli* differs noticeably from that of *N. hecqui* in that it exhibits a single distinct spot on the body. Breeding *N. hecqui* females show a distinct spot in the dorsal fin but not on the flank. Both species have a pattern of mid-lateral blotches and short diagonal stripes when not breeding. The best way to distinguish the two species is to compare the distance between the eyes, the so-called interorbital width. The bony roof above the eyesockets in *N. meeli* is much narrower than in *N. hecqui*.

N. meeli, however, resembles *Lepidiolamprologus attenuatus* much more than *N. hecqui* and in fact it is rather difficult to distinguish these two species. *L. attenuatus* grows to a larger size and has different breeding behaviour. Sub-adult

L. attenuatus can be distinguished from adult *N. meeli* by having a longer snout and shorter pelvic fins. Both species are found over sandy substrates in relatively shallow water — depth distribution ranges from 5 to 20 metres — and can be found side by side. Throughout the seasons individuals of both species can normally be seen breeding, and it is then that the two can be distinguished easily. As mentioned before *N. meeli* uses an empty shell to protect the fry, whereas *L. attenuatus*

deposits the eggs on the vertical surfaces between small rocks. The latter species is therefore found near small rocks; *N. meeli*, however, breeds on the open sand floor, usually near large sand-nests (abandoned) of *Oreochromis tanganyicae*.

Brood-guarding *N. meeli* pairs stay close to the substrate and their offspring forage from the sand. Brood-guarding *L. attenuatus* pairs hover above their plankton-feeding brood and are usually seen 60 to 100 cm above the substrate. Their broods usually contain more than 150 fry whereas the number in *N. meeli* broods is hardly ever over 50.

I am convinced that *N. meeli* will exhibit its particular breeding behaviour in the aquarium provided that an empty shell (*Neothauma* or similar sized shell) and sand are present.



Previous page: a fry-guarding female *N. meeli* hovers above the nest (Kipili, Tanzania).
 Top: the shell is concealed in the rim of the crater nest.
 Centre: *N. hecqui* in the aquarium.
 Below: *N. meeli* fry venturing out of the shell; note their characteristic colour pattern.

Mouths full of fry: breeding *Plecodus paradoxus*

Ad Konings

The fish fauna of Lake Tanganyika is under continuous attack from a variety of scale eaters. The most common of these is *Perissodus microlepis* which is found in a variety of habitats but usually in the upper 10 metres. Another common scale eater, *Plecodus straeleni*, occurs mainly in the rocky habitat and its distribution varies from 5 to 50 metres of depth. In terms of total numbers, however, *Plecodus paradoxus* is possibly the most numerous of all. It sometimes occurs in large schools in the northern part of the lake (Brichard, 1978) and has been caught at depths as great as 250 metres!

Plecodus paradoxus is rather common over sandy habitats, often near rocks. It is usually found in groups, rarely on its own. Foraging groups normally swim in a loose formation about one metre above the substrate. Although there are several other silvery-coloured, elongate scale eaters to be found in the lake, *P. paradoxus*

can easily be distinguished from these by the black spot on the caudal peduncle. When observed in their natural habitat non-breeding *P. paradoxus* exhibit a narrow mid-lateral stripe which runs from the edge of the gill cover to the spot on the peduncle.

To the best of my knowledge *P. paradoxus* has never been exported for the aquarium trade, and the chances that it ever will be are rather small. The main reason is, of course, that it will eat the scales of other aquarium inhabitants. In the case of *P. microlepis*, however, it has been found that other tank occupants adapt to the presence of the scale eater and learn how to avoid an attack (Herrmann, 1993). Another reason for importation of this cichlid being unlikely is that adults may reach a total length of about 25 cm. Even though *P. paradoxus* may never be observed in the aquarium it is, like the other scale eaters, a very interesting cichlid.



The main point of interest is not its peculiar feeding habits but the fact that *Plecodus* and *Perissodus* exhibit a breeding behaviour intermediate between maternal mouthbrooding and substrate brooding. I have observed brooding and fry-guarding parents of *P. microlepis*, *P. eccentricus*, *Pl. straeleni*, and *Pl. paradoxus* and found that their breeding behaviour is apparently very similar. Yanagisawa & Nshombo (1983) made a very detailed study of *P. microlepis*, and to my mind the other species behave in the same or a very similar way.

The breeding behaviour of these scale eaters can be described as follows: spawning takes place on a hard substrate; the female picks up all the eggs, which are very small and numerous; after about 9 days the fully developed but tiny fry are released from the female's mouth; a few days later the fry, more and more, seek refuge inside the male's mouth instead in that of the female; both parents guard their offspring for at least three weeks.

I have several times been able to observe how frightened fry of *P. microlepis* were taken up by their parents. This process takes only a few seconds and the fry are then safe inside the parents' mouths. I also observed two fry-guarding *Pl. paradoxus* pairs which had both chosen to make their nest on top of a large boulder at a depth of about 15 metres (Fulwe Rocks, Tanzania). When I disturbed these pairs they started to collect their fry by holding their mouths open among the school (see photo). It took each pair more than two minutes before all of the still very small fry were safe inside their mouths. After about 15 minutes the fry were released at the same site.



Although hardly an attractive cichlid *Pl. paradoxus* is a very interesting fish, the study of which may throw some light on the evolution from substrate brooding to maternal mouthbrooding.

References

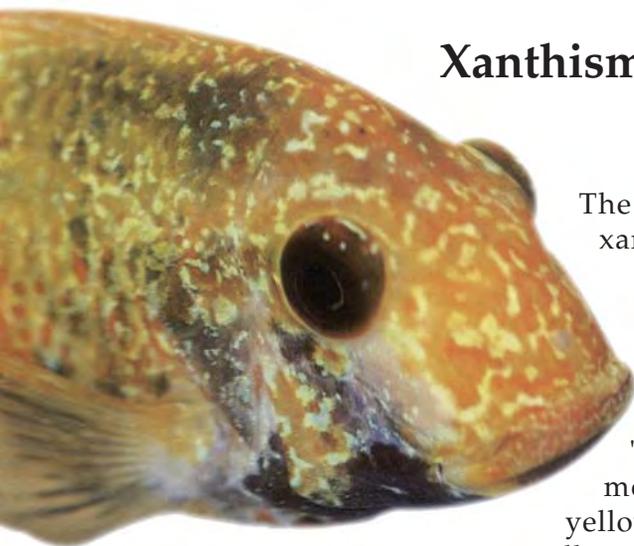
- HERRMANN, H.-J. (1993) *Perissodus microlepis*: Pflege und Zucht eines Schuppenfressers. *Buntbarsch Jahrbuch*; pp 11-16.
 YANAGISAWA, Y. & M. NSHOMBO (1983) Reproduction and parental care of the scale-eating cichlid fish *Perissodus microlepis* in Lake Tanganyika. *Physiol. Ecol. Japan*, 20; pp 23-31.



Previous page: the fry of *Plecodus paradoxus* seek shelter in the mouth of both male and female.
 Top: a pair *P. paradoxus* guarding their few-days-old brood consisting of more than 300 fry.
 Bottom: some of the peculiar teeth are visible in the gape of this individual. Photos taken at Fulwe Rocks, Tanzania.

Xanthism in *Tropheus moorii*

Toby Veall



The word xanthism is derived from the Greek 'xanthos' meaning yellow, and

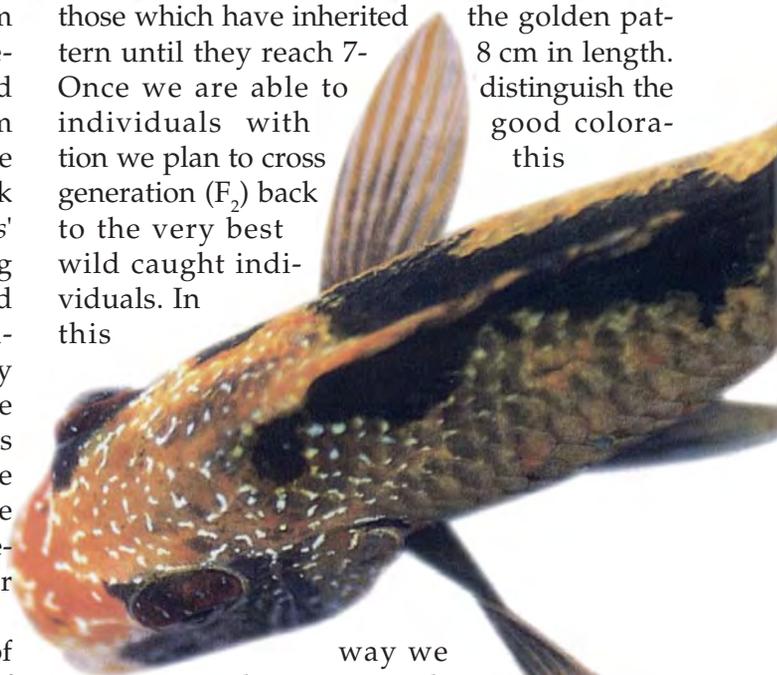
means yellow coloration. This article attempts to show, mainly through pictures, examples of xanthism in the Kalambo race of *Tropheus moorii*. This race is found between the Lunzua river, right at the southernmost tip of Lake Tanganyika, and the Kalambo river, which forms the boundary between Zambia and Tanzania (see page 13 for map).
distinguish fishes with normal coloration from those which have inherited the golden pattern until they reach 7-8 cm in length. Once we are able to distinguish the good coloration we plan to cross individuals with this generation (F_2) back to the very best wild caught individuals. In this

tion. This article attempts to show, mainly through pictures, examples of xanthism in the Kalambo race of *Tropheus moorii*. This race is found between the Lunzua river, right at the southernmost tip of Lake Tanganyika, and the Kalambo river, which forms the boundary between Zambia and Tanzania (see page 13 for map).

The yellow or golden morph of *T. moorii* is of extremely rare occurrence —during six years of fish collection in this area we have found no more than about 20 specimens with strong golden coloration. The strength of colour varies a great deal from individual to individual. Specimens with a small amount of black colour on the body and with fins containing yellow or orange pigment are said to belong to the OB (orange-blotched) morph. Such OB fishes are more common and over the years we have probably found about 50 individuals. The truly spectacular individuals, however, are known as "Golden Kalambo".

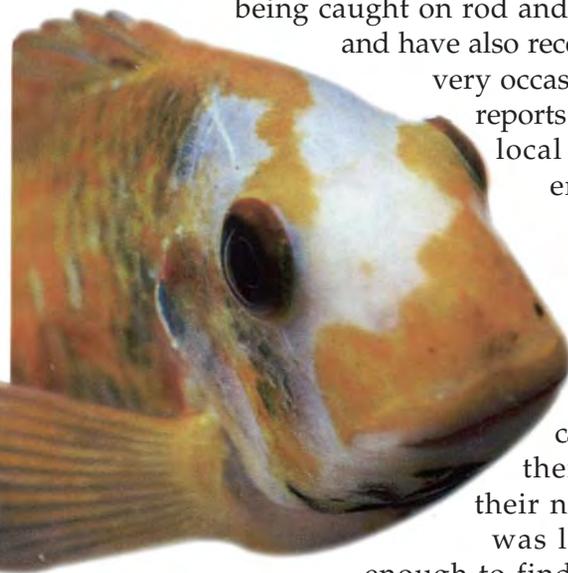
When we first collected two or three specimens of the golden morph, we initiated a breeding programme, crossing a golden male with a golden coloured female. The resulting offspring were largely normal in coloration with only a small percentage showing varying degrees of colour variation —either towards the OB morph or the true Golden Kalambo. This clearly indicates that the gene, or genes, responsible for the golden coloration are recessive in nature.

When the individuals of this first (F_1) generation reached maturity we started to cross the best coloured females back to the best coloured wild caught males. The offspring thus produced include a larger percentage of nicely coloured individuals —probably in the region of 10%. However, it is very difficult to dis-



way we are hoping to produce a pure strain of golden *Tropheus*.

I have never seen xanthism in any race of *Tropheus* other than the Kalambo form. However, xanthism does occur in other species of fish. Perhaps the most spectacular example is seen in *Lates mariae* (one of the four members of the genus found in the lake). A number of golden *L. mariae* have been caught by anglers on rod and line, and the coloration is completely golden —a truly spectacular fish. I have found at least five records of golden *Lates* being caught on rod and line,



and have also received very occasional reports from local fishermen who have

caught them in their nets. I was lucky enough to find and catch one live specimen on a dive near Kasaba Bay in September 1992. I found this fish at a

depth of about 25 metres and it took nearly two hours to catch it. To my knowledge this is the only specimen ever caught and then kept alive in an aquarium. It is currently on display in a large aquarium at Kalambo Lodge, a newly opened tourist lodge on the Zambian shores of Lake Tanganyika, just south of the Kalambo river. The lodge caters for aquarists who wish to see Tanganyikan cichlids in their native habitat, for anglers who wish to catch fish on rod and line, and for people who want to enjoy the impressive scenery and relax away from the pressures of western society.

In addition to the *Lates*, I have seen less spectacular examples of xanthism in two *Petrochromis* species, namely *P. polyodon* and *P. macrognathus*, as well as in *Ophthalmotilapia ventralis* and *Perissodus microlepis*.

Xanthism probably does not confer any natural advantage in the lake environment. In the continual struggle for survival it is more likely that the golden coloration carries a strong disadvantage, making the fish more conspicuous and thus more susceptible to predation. The scarcity of golden individuals means that the likelihood of their interbreeding in the lake is extremely small and they are therefore likely to remain an extreme rarity.

To return to the Golden Kalambo *Tropheus*, as already stated it would appear that individuals carrying the genes for xanthism do not actually develop the yellow

colour until they are nearly mature. This means that we are unable to select the best individuals until we have grown them up to near maturity, which makes the task of trying to breed a pure race that much more timeconsuming. It should be remembered that the Koi carp was originally bred from a normal dull coloured carp, and that the goldfish is likewise descended from drab ances-

tors. The Golden

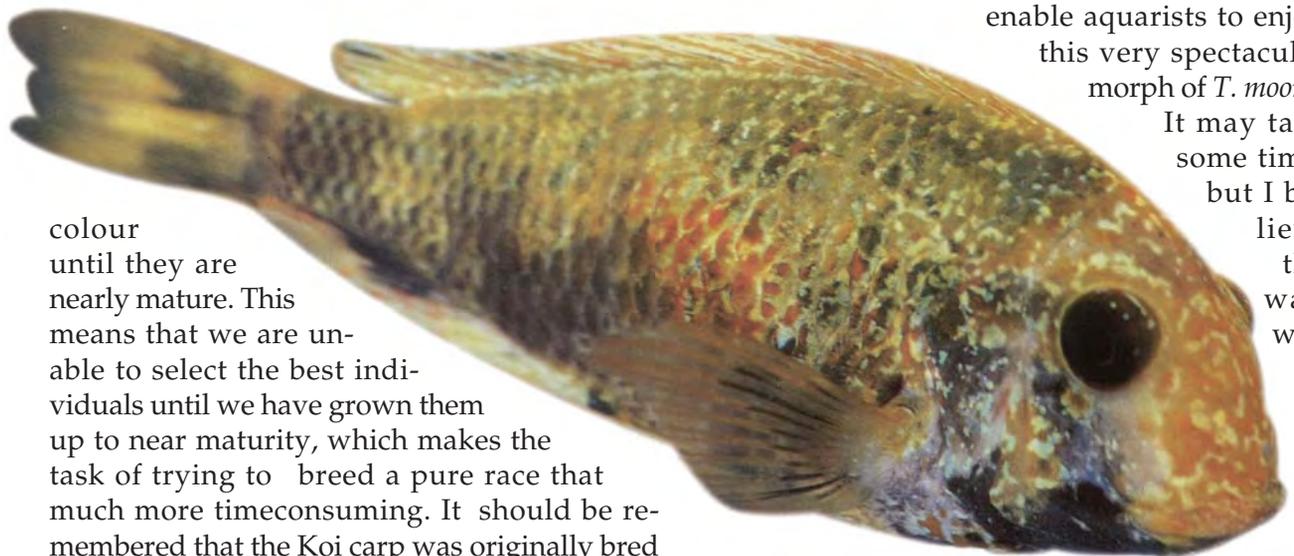
Kalambo presents a very exciting challenge, the chance to reproduce a naturally occurring species in sufficient numbers to



The author's fish collecting station in Zambia.

enable aquarists to enjoy this very spectacular morph of *T. moorii*. It may take some time, but I believe the wait will be

worth it, as the photos bear witness!



LAKE MALAWI CICHLIDS

A review of the sand-dwelling species of the genus *Aulonocara*, with the description of three new species.

Ad Konings

Summary

The genus *Aulonocara* can be divided into several groups, each containing several species with similar morphological and behavioural characteristics. The sand-dwelling species forage and breed in open habitats and the fact that they are caught frequently in beach seine nets led to some formal descriptions in the first half of this century. All the sand-dwelling *Aulonocara* discussed here inhabit the shallow waters (less than 50 metres depth) of Lake Malawi. Females and non-territorial males have a light sandy-yellow to silvery coloration and are in general much lighter than the rock-dwelling species. No gross morphological distinction exists between these two groups.

Introduction

The morphological features that characterise *Aulonocara* are the pigmentation pattern consisting of vertical bars (lacking horizontal or oblique elements), the greatly expanded sensory canal system of the skull (the pores of the preorbital bone are wider than the spaces between them), and a weakly developed chin.

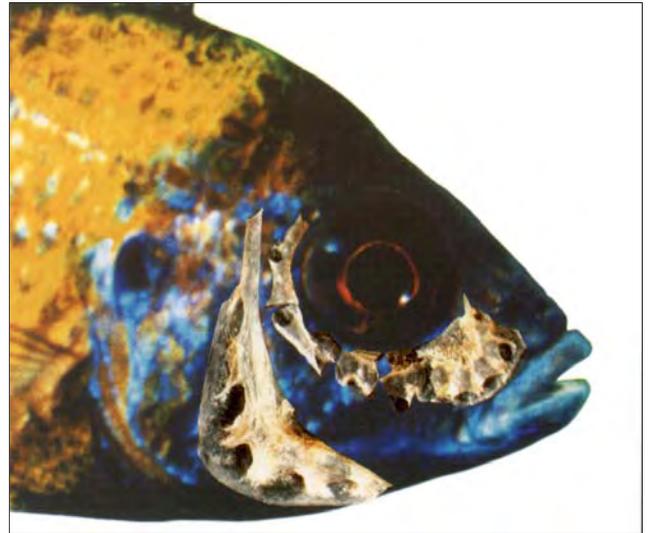
Eccles, in Eccles & Trewavas (1989: 138), further defines *Aulonocara* as having the infraorbital bones so expanded that they exclude scales from most, or all, of the cheek area. In the currently accepted concept of the genus, however, this applies only to the sand-dwelling species. The rock-dwelling species also have enlarged sensory pores in the skull, but in some cases the degree of expansion allows for 2 to 4 rows of scales on the cheek (eg in *A. jacobfreibergi*). Other

rock-dwelling species have just a single row of scales on the cheek (eg *A. stuartgranti*) and share this character with most sand-dwelling *Aulonocara*.

Aulonocara can be better characterised by their foraging behaviour which has been described earlier (Konings, 1989). This behaviour, termed "sonar-feeding", is seen in all the *Aulonocara* species that have been observed in their natural environment. It involves hovering motionless about 5-10 mm above the sandy substrate and an occasional dive with the snout into the sand. While the fish is hovering its enhanced sensory system registers any movement in the sand, and the prey, once located, is captured during the dive. This behaviour is so characteristic of *Aulonocara* —at least of those species that have been observed in the wild— that an individual fish can be assigned to this genus solely by observing its feeding technique.

The sand-dwelling species are characterised by greatly enlarged pores in the bones of the skull. The preorbital (or lachrymal), the preoperculum and the lower jaw (see photo) are distended and almost entirely occupied by the sensory canals. The infraorbital bones in particular (see photo) are greatly enlarged in order to accommodate the sensory system. A similar situation is found in the rock-dwelling members of the genus, but in most species the enlargement of the infraorbitals is less.

There is no clear distinction between the rock- and sand-dwelling *Aulonocara* other than the observation that the sand-dwellers normally forage and breed in open habitats. They do not seem to be restricted to a specific area of (rocky) coast and usually have a wide distribution.



The upper two photographs show the enlargement of the pores in the preopercular, infraorbital, and preorbital bones. Note the difference in the size of the infraorbital bones in the sand-dwelling *A. rostratum* (left) and in the rock-dwelling *A. jacobfreibergeri* (right). Left: Ventral view of the lower jaws (revealing the sensory pores) of two sand-dwelling cichlids: left *A. rostratum* and right *Taeniolethrinops praeorbitalis*.

member of the genus as *A. auditor* (Konings, 1990). This new species is here described as *A. aquilonium*. *A. auditor* does not share the characteristics of the sand-dwelling group, i.e. the infraorbital bones are not so enlarged that the

In 1935 Trewavas described two large *Aulonocara* species which differed from each other in the length of the pectoral fin, the size of the eye, and the depth of the body. She named them *A. rostratum* and *A. macrochir*. The latter was described from a single specimen with a standard length of 149 mm. Later it was found that individuals within a single breeding colony exhibited a rather large variation in morphology (Konings, 1990), with characters overlapping those of the two described species, and that similar variation existed in two different colonies. Some species of the closely related genus *Lethrinops* likewise exhibit wide variation in morphology (Eccles & Lewis, 1978) and this must be taken into consideration when describing species of these genera.

Eccles (1989) discusses the relationships of three other species which have been assigned to *Aulonocara* but whose status within the genus is unclear. One of these is *A. auditor*, whose holotype, a mature female with a standard length of 77.5 mm, was caught near Vua in the north of the lake. A closer examination of the type has led me to the conclusion that I have previously incorrectly identified an undescribed sand-dwelling

cheeks are scaleless or have only a single row of scales. *A. auditor* has three rows of scales on the cheek and in addition exhibits a indistinct pattern of three series of spots on the flank and at the base of the dorsal. This pigmentation pattern is reminiscent of *Protomelas* rather than *Aulonocara*. Not until more (live) specimens have been examined can this species be assigned with certainty to *Aulonocara*; in the meantime it is grouped with the rock-dwelling members of the genus.

Methods

The measurements were made in accordance with Barel *et al.* (1977). Their method gives a more consistent result than the classic procedure whereby length of snout and head are projections and the eye diameter is measured as the inside diameter of the ligamentous ring surrounding the eye. The small morphological differences between many Malawi cichlids can be better assessed when the point-to-point measurements of Barel *et al.* are applied. However, most of the ratios given by Trewavas (1935, 1984) and Eccles &

Trewavas (1989) cannot then be directly compared with the ones given here. The depth of the preorbital bone has been measured according to the methods of Trewavas (1935), and is taken as the length of a line from the centre of its orbital edge, effectively bisecting the bone (Eccles & Trewavas, 1989: 20, fig. 3).

Key to the sand-dwelling *Aulonocara*.

- 1. Eye diameter less than snout length 2
 Eye diameter greater than snout length 4
- 2. Eye diameter fewer than 2.9 times in head length 3
 Eye diameter more than 2.8 times in head length 4
- 3. Eye diameter 1.1 to 1.2 times in snout length *A. guentheri*
 Eye diameter 1.3 to 1.4 times in snout length *A. rostratum*
- 4. Caudal peduncle length more than 2.2 times in body depth *A. gertrudae*
 Caudal peduncle length less than 2.1 times in body depth 5
- 5. 7 vertical bars below dorsal *A. breviniidus*
 8 or more vertical bars below dorsal 6
- 6. Interorbital width 1.6 to 1.8 times in caudal peduncle depth and postorbital 2.6 to 2.7 times in head length *A. nyassae*
 Interorbital width 1.9 to 2.2 times in caudal peduncle depth and postorbital 2.8 to 3.0 times in head length *A. aquilonium*

***Aulonocara nyassae* Regan, 1922**

Aulonocara nyassae (part) Regan, 1922: 726, pl. V, fig. 1; Trewavas, 1935: 116; 1984: 117; Jackson, 1961: 590; Meyer *et al.*, 1987: 18; Eccles & Trewavas, 1989: 139; Konings, 1990a: 74; 1990b: 5.

Diagnosis

A small sand-dwelling *Aulonocara* attaining about 100 mm standard length. It differs from *A. guentheri* and *A. rostratum* in the larger eye, shorter snout, and smaller preorbital; from *A. gertrudae* in the longer caudal peduncle; from *A.*

breviniidus in having 8 to 9 bars below the dorsal; from *A. aquilonium* in the longer postorbital part of the head (see table on p. 36 for the respective ratios).

Material examined

Koninklijk Museum voor Midden-Afrika (MRAC) 94-56-P-24 to -30. Four males with standard lengths 98.0, 97.7, 93.2, and 93.3 mm and three females with standard lengths 87.2, 76.5, and 75.6 mm. Collected in Mazinzi Bay, Malawi, on 3-12-1989 by the author.

Distribution

The holotype of *A. nyassae* is from an unknown locality and was collected by Wood at the beginning of the century. Eccles collected this species south of Boadzulu Island. Mazinzi Bay, where the specimens examined for this paper were collected, is also situated in the southeastern arm of the lake. I have previously recorded this species from Mumbo Island as well (Konings, 1990a) but these specimens subsequently turned out to be another species lacking the much enlarged infraorbital bones; moreover the thick lips and stouter appearance suggest a generic placement other than in *Aulonocara*. More research is required before this species can be properly classified.

Ecology

A. nyassae of the population in Mazinzi Bay were observed in the sandy habitat where small groups of 10 to 25 individuals were seen to for-



age from the substrate. *A. nyassae* was seen only at depths of more than 20 metres. These small groups usually contained one male individual exhibiting territorial (breeding) coloration. When the group was not feeding there seemed to be some territorial action by that male but no spawning site was constructed. This may suggest that spawning takes place at any random site, but since mouth-brooding females were not observed it is not clear whether or not the individuals observed were sexually active.

The name *A. nyassae* has been incorrectly applied to many different species, mainly members of the rock-dwelling group of the genus, by the aquarium trade. Eccles (in Eccles & Trewavas, 1989) found that the three specimens Regan used in 1922 for the description of *A. nyassae* in fact included two different species. Since these three were designated syntypes he had to select one as the holotype for *A. nyassae*. He chose the specimen from which the drawing in Regan's description was made; the other species he described as *A. guentheri*. Eccles recognised *A. nyassae* in a population south of Boadzulu Island and gave a detailed description of its live coloration, which agrees with that of the fishes from Mazinzi Bay.

Aulonocara guentheri Eccles, 1989

Aulonocara nyassae (part) Regan, 1922: 726, pl. V, fig. 1; Trewavas, 1935: 116; 1984: 117; Jackson, 1961: 590; Meyer *et al.*, 1987: 18.

Aulonocara guentheri Eccles, in Eccles & Trewavas, 1989: 141; Konings, 1990a: 59.

Diagnosis

A small to medium-

sized sand-dwelling *Aulonocara* attaining about 120 mm standard length. It differs from *A. nyassae* in the smaller eye, longer snout, and deeper preorbital; from *A. rostratum* in the larger eye and longer lower jaw; from *A. gertrudae* in the longer snout and smaller eye; from *A.*



Left: *A. nyassae* at Mazinzi Reef.
 Top: *A. guentheri*; a male from Kambiri Point.
 Centre: A female *A. guentheri* collected at Thumbi East Island.
 Bottom: A freshly caught *A. nyassae* at Mazinzi Reef.



Aulonocara rostratum at Kande Island, Malawi.

brevinidus in the smaller eye, the longer lower jaw, and the deeper preorbital; from *A. aquilonium* in the deeper body, the longer snout, and wider interorbital (see table on page 36 for the respective ratios).

Material examined

Koninklijk Museum voor Midden-Afrika (MRAC) 94-56-P-31 to -36. Two males with standard lengths 101.9 and 113.8 mm and four females with standard lengths 86.5, 94.9, 96.8, and 108.4 mm. Collected at Thumbi East Island, Malawi, on 2-12-1989 by the author.

Distribution

A. guentheri is common in the southeastern arm of the lake and is occasionally caught in beach seines in Senga Bay. I have observed this species in Monkey Bay, near Kadango, and near Makanjila Point.

Ecology

A. guentheri is a common cichlid of shallow sandy habitats where it is normally seen foraging in small groups of about 10 individuals. Males and females, which both have yellow on the lower part of the head, are found in the same group, and such groups frequently mingle with parties of other sand-dwelling species. Males with territorial (breeding) coloration have not been observed underwater, but some were found

in the beach seine nets of local fishermen in November and December. This may suggest a restricted breeding season, but more observations are needed before a clear picture regarding the breeding season can be obtained.

Aulonocara rostratum Trewavas, 1935

Aulonocara rostrata Trewavas, 1935: 116; Jackson, 1961: 590; Mayland, 1982: 138.

Aulonocara macrochir Trewavas, 1935: 116; Jackson, 1961: 589; Eccles & Trewavas, 1989: 143.

Aulonocara rostratum; Meyer et al., 1987: 20; Konings, 1989: 251; 1990a: 76.

Diagnosis

A medium-sized sand-dwelling *Aulonocara* attaining about 160 mm standard length. It differs from *A. nyassae*, *A. gertrudae*, *A. brevinidus*, and *A. aquilonium* in the smaller eye, longer snout, and deeper preorbital; from *A. guentheri* in the smaller eye and shorter lower jaw (see table on page 36 for the respective ratios).

Material examined

MRAC 94-56-P-37 to -39. Two males with standard lengths 94.1 and 100.0 mm and one female with standard length 107.6 mm. Collected at Mdoka, Malawi, on 26-11-1990 by the author.

MRAC 94-56-P-40. One female with standard length 129.5 mm. Collected in Mazinzi Bay, Malawi, on 3-12-1989 by the author.

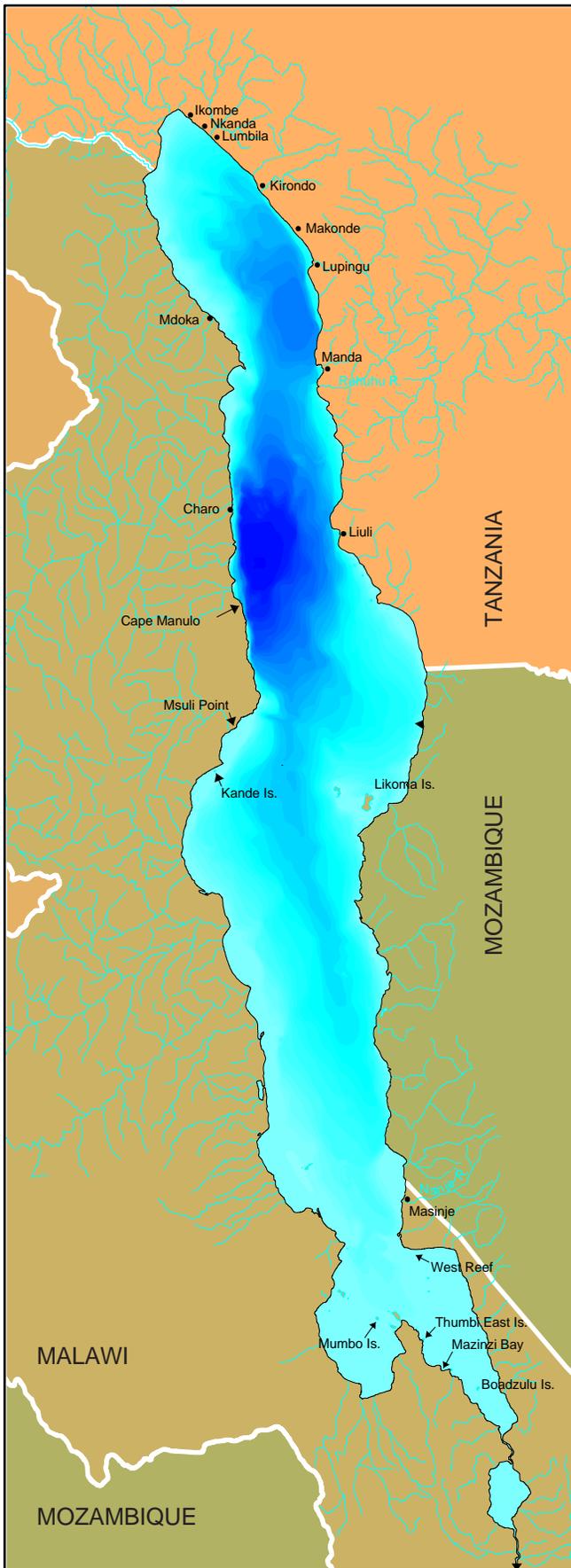
MRAC 94-56-P-41 to -44. Two males with standard lengths 140.9 and 151.4 mm and two females with standard lengths 126.7 and 140.5 mm. Collected at West Reef, Malawi, on 6-12-1989 by the author.

Distribution

A. rostratum has a lake-wide distribution and was observed in its natural habitat at Mdoka, Msuli Point, Kande Island, and West Reef in Malawi, and at Hongi Island in Tanzania.

Ecology

A. rostratum is regularly seen over open sandy substrates at depths varying from 15 to 30 metres. True geographical races are not known but males in the northern population appear to



have a deeper blue colour.

Males in territorial (breeding) coloration group into breeding colonies. Territorial males are

found throughout the year. Each male digs a spawning crater in the sand and defends it against all intruders. Such craters are sited about two metres apart and lack the rim usually seen in haplochromine nests in the lake. Females normally forage in separate groups or are solitary, and apparently visit the otherwise exclusively male breeding colonies only when ready to spawn. Spawning has not been observed in the wild.

Aulonocara gertrudae sp. nov.

Aulonocara sp. "jumbo blue"; Konings, 1990a: 69. This species is sometimes known as the "Multispot *Aulonocara*" in the aquarium hobby.

Etymology

Named in honour of my wife, Dr. Gertrud Dudin, for her moral support, her interest in cichlids, and for her patience.

Diagnosis

A small to medium sized sand-dwelling *Aulonocara* attaining about 110 mm standard length. It differs from *A. nyassae* and *A. brevinidus* in the shorter caudal peduncle; from *A. guentheri* and *A. rostratum* in the larger eye and shorter snout; and from *A. aquilonium* in the shorter caudal peduncle and wider interorbital (see table on page 36 for the respective ratios).

Material examined

Holotype: MRAC 94-56-P-45. Male with standard length 109.7 mm. Collected south of Nsinje River, Masinje, Malawi, on 1-11-1989 by the author.

Paratypes: MRAC 94-56-P-46 to -49. One male with standard length 99.0 mm and three females with standard lengths 85.2, 88.8, and 91.0 mm. Collecting data as for holotype.

Other material: MRAC 94-56-P-50. One male with standard length 97.8 mm. Collected at Cape Manulo, Malawi, on 1-12-1990 by the author.

MRAC 94-56-P-51 to -54. Two males with standard lengths 88.2 and 88.7 mm and two females with standard lengths 69.6 and 70.7 mm. Collected at Lupingu, Tanzania, on 1-11-1993 by the author.

Description

Depth of body 2.4 to 2.9, and head length 2.6 to 2.9, times in standard length. Snout 2.9 to 3.4, eye diameter 2.6 to 2.9, interorbital width 3.6 to 5.0, lower jaw 2.6 to 2.9, premaxillary pedicel 3.2 to 3.7, and depth of preorbital 4.1 to 5.4, times in head length. Premaxillary pedicel 1.1 to 1.4 times in length of lower jaw.



Mouth positioned terminally. Teeth in 4 to 5 rows in both upper and lower jaws. Outer row containing unequally bicuspid teeth, inner rows unicuspid; in some smaller specimens the inner rows may contain several tricuspid teeth. Lower pharyngeal bone of a nonregistered specimen with small bicuspid teeth with the last few teeth of the inner series somewhat enlarged but bicuspid. 8 to 10 gill rakers on the lower part of the anterior arch.

32 to 34 scales in a longitudinal series; cheek with one row of scales.

Dorsal XVI-XVII 9-11. Anal III 8-9. Length of last dorsal spine 2.1 to 2.4 times in head length. Pectoral 2.4 to 3.1 times in standard length, 0.9 to 1.1 in head length.

Caudal peduncle 6.2 to 7.0 times in standard length, peduncle depth 1.1 to 1.4 in its length.

Distribution

A. gertrudae has a very wide distribution and is found on the western as well as the eastern shores of the lake. The most northerly population was found at Ikombe, Tanzania, in the extreme north of the lake. The most southerly population is that at the type locality near Masinje, Malawi, on the east coast. It has been observed at Mdoka, Msuli, and Cape Manulo in Malawi .

Ecology

A. gertrudae seems to forage mainly in the



A. gertrudae exhibits a small degree of geographical variation in the male breeding coloration. Top: an aquarium specimen from Ntekete, Malawi. Bottom left: a male at Lundu, Tanzania. Bottom, right: A male at Lupingu, Tanzania. Centre: a female at Lupingu. Females exhibit the same colour pattern in all populations known.

somewhat muddy sediment on sandy bottoms near river outlets. It is usually found at depths of more than 15 metres, but north of the Ruhuhu River in Tanzania it seems to exploit a different habitat (Konings, 1994). At Ikombe, Nkanda, Makonde, Lupingu, and Lundu (which is south of the river) *A. gertrudae* was found in the intermediate habitat at depths varying between 3 and 30 metres. The fact that the behaviour of these populations differs from that of others may be connected with the paucity of rock-dwelling *Aulonocara* north of the Ruhuhu River. Even though *A. gertrudae* is a non-sedentary sand-dwelling cichlid the outflow of the Ruhuhu River may form a barrier which keeps the northern and southern populations separate. Males of the northern populations have a bright orange patch on the shoulder which is absent in the southern populations, ie at Lundu and further south. Because of this geographical variation *A. gertrudae* may be the sand-dwelling species most closely related to the rock-dwelling members of

all times of the year.

The fact that *A. gertrudae* of the populations north of the Ruhuhu River exhibit a different coloration and behaviour to that of the other known populations may suggest that they represent another species. However, general morphology and the basic colour pattern of male as well as of female—the distinct yellow spots in the anal fin in combination with the yellow coloured ventral fins of the female are useful characteristics for distinguishing it *in vivo* from other *Aulonocara*—permits the grouping of all populations into a single species. The difference in spawning site preference in northern males may well be influenced by the lack of rock-dwelling *Aulonocara* north of the Ruhuhu River.

***Aulonocara brevinidus* sp. nov.**

Aulonocara sp. "blue gold sand"; Konings, 1990a: 54.

Etymology

From the Latin, *brevis* = "short, shallow" + *nidus* = "nest", referring to the shallow spawning pit constructed by the male.

Diagnosis

A small sand-dwelling *Aulonocara* attaining about 95 mm standard length. It differs from *A. nyassae* in having 7 bars below the dorsal; from *A. guentheri* and *A. rostratum* in



Left: Two males *A. brevinidus* in territorial dispute (Masinje, Malawi).
Below: A female *A. brevinidus* at Chiloeolo, Mozambique.

the genus.

Territorial males dig crater nests in the sand or defend a rocky cave (north of Ruhuhu) or may dig a spawning pit against a rock. Spawning pits can be 50 cm deep where the composition of the substrate can accommodate such deep excavations. Females, which can easily be recognised by the yellow spots in the anal fin, forage in small groups in the neighbourhood of the territorial males. Males in nuptial colours were observed at





Left: A male *A. brevinidus* at his shallow nest (Wikihi, Mozambique).
Centre: A female *A. aquilonium* at Mdoka, Malawi.
Bottom: This specimen at Charo, Malawi, may be conspecific with *A. aquilonium*.
Next page: A territorial male *A. aquilonium* (Mdoka, Malawi).

the larger eye, shorter snout, and shorter preorbital; from *A. gertrudae* in the longer caudal peduncle; and from *A. aquilonium* in the shorter preorbital and in having 7 bars below the dorsal (see table on page 36 for the respective ratios).

Material examined

Holotype: MRAC 94-56-P-55. Female with standard length 89.9 mm. Collected south of the Nsinje River, Masinje, Malawi, on 1-11-1989 by the author.

Paratypes: MRAC 94-56-P-56 to -61. Three males with standard lengths 86.2, 86.4 and 91.3 mm and three females with standard lengths 77.0, 81.5, and 86.3 mm. Collecting data as for holotype.

Description

Depth of body 2.7 to 3.0, and head length 2.8 to 3.0, times in standard length. Snout 2.9 to 3.4, eye diameter 2.5 to 2.7, interorbital width 4.9 to 6.3, lower jaw 3.0 to 3.3, premaxillary pedicel 3.5 to 3.9, and depth of preorbital 4.9 to 5.5, times in head length. Premaxillary pedicel 1.2 times in length of lower jaw.

Mouth positioned terminally. Teeth in 3 to 4 rows in upper jaw and 4 to 5 rows in lower. Outer row containing unequally bicuspid teeth, those of the inner rows unicuspid. Lower pharyngeal bone of a nonregistered specimen with small bicuspid teeth with the last few teeth of the inner series somewhat enlarged but bicuspid. 7 to 8 gill rakers on the lower part of the anterior arch.

32 to 33 scales in a longitudinal series. One row of scales on cheek.

Dorsal XVI-XVII 9-10. Anal III 8-9. Length of last dorsal spine 2.0 to 2.6 times in head length. Pectoral 2.6 to 3.2 times in standard length, 0.9 to 1.1 in head length.

Caudal peduncle 5.0 to 5.5 times in standard length, peduncle depth 1.5 to 1.7 in its length.

Distribution

The most northerly localities where *A. brevinidus* has been observed are at Lupingu and Manda, Tanzania. The most southerly population known is at Masinje, Malawi. In Mozambique it has been found at Wikihi, Mara Point,

and at Chiloelo. Reports that this species also occurs at Kande Island on the west coast of the lake have not been confirmed. For the time being, therefore, the distribution of *A. brevinidus* must be considered to be restricted to the east coast of the lake.

Ecology

Males of the northern and southern populations do not differ significantly in their territorial (breeding) coloration. At all known localities *A. brevinidus* was found at a depth of about 20 metres. Males are territorial and defend a very shallow spawning pit no deeper than 2-3 cm with a diameter of about 15-20 cm. Sometimes a male defends a sandy patch between small stones. Territorial males station themselves about two metres from each other in the Masinje population; in the other populations only a few males were observed and these were more than five metres apart.

The gut of a nonregistered specimen contained



sand grains, tiny snails, and rather large (1.5-2 cm) shrimp-like crustaceans.

Aulonocara aquilonium sp. nov.

Aulonocara auditor; Konings, 1991: 33.

Etymology

From the Latin, *aquilonium* = "northern", referring to the species' northerly distribution in the lake.

Diagnosis

A small sand-dwelling *Aulonocara* attaining about 85 mm standard length. It differs from *A. nyassae* in the larger postorbital; from *A. guentheri* and *A. rostratum* in the larger eye, shorter snout, and shorter preorbital; from *A. gertrudae* in the longer caudal peduncle; and from *A. brevinidus* in having 8 bars below the dorsal (see table on page 36 for the respective ratios).

Material examined

Holotype: MRAC 94-56-P-62. Male with standard length 82.2 mm (total length 104.9 mm). Collected at Mdoka, Malawi, on 26-11-1990 by the author.

Paratypes: 94-56-P-63 to -71. Seven males with standard lengths 68.7, 71.0, 76.6, 80.6, 81.2, 82.0, and 84.2 mm and two females with standard lengths 71.3, and 72.6 mm.

Collecting data as for holotype.

Description

Depth of body 2.8 to 3.1, and head length 2.7 to 2.9, times in standard length. Snout 2.9 to 3.3, eye diameter 2.6 to 2.9, interorbital width 5.3 to 6.4, lower jaw 2.8 to 3.2, premaxillary pedicel 3.5 to 4.3, and depth of preorbital 4.4 to 4.8 times in head length. Premaxillary pedicel 1.2 to 1.5 times in length of lower jaw.

Mouth positioned terminally. Teeth in 4 to 5 rows in upper jaw and 5 to 7 rows in lower. Outer row containing unequally bicuspid teeth, teeth of the inner rows unicuspid. Lower pharyngeal bone of a nonregistered specimen with small bicuspid teeth with the last few teeth of the inner series slightly enlarged. 7 to 9 gill rakers on the lower part of the anterior arch.

32 to 33 scales in a longitudinal series. A single row of scales on the cheek.

Dorsal XVI-XVII 9-11. Anal III 8-9. Length of last dorsal spine 2.0 to 2.3 times in head length. Pectoral 2.7 to 3.1 times in standard length, 1.0 to 1.1 in head length.

Caudal peduncle 5.1 to 6.1 times in standard length, peduncle depth 1.3 to 1.6 times in its length.

Distribution

The type material was collected at Mdoka, Malawi; at Charo I photographed a male *Aulonocara* that may be conspecific with *A. aquilonium*.

Ecology

In November and December *A. aquilonium* is



abundant at the rock-sand interfaces near Mdoka and this is the period during which territorial males were observed; in June foraging individuals were seen but in much smaller numbers.

Territorial males defend a small patch of sand against conspecific males only, and were found at a depth of approximately 20 metres. Foraging females and non-territorial males congregate in large schools and were found on the sand between and near rocks at depths varying from 12 to 25 metres. The single male photographed at Charo occurred at a depth of about 40 metres. It could not be caught for positive identification.

Acknowledgements

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The table below gives some ratios which are useful for distinguishing the six sand-dwelling species. The figure between brackets gives the average. SL= standard length, ped.= peduncle, interorb. w. = interorbital width, prem. pedic.= premaxillary pedicel, lower j.= lower jaw.

	<i>A. nyassae</i>	<i>A. guentheri</i>	<i>A. rostratum</i>	<i>A. gertrudae</i>	<i>A. brevinidus</i>	<i>A. aquilonium</i>
SL/body depth	2.6-2.9 (2.7)	2.5-2.7 (2.6)	2.5-2.9 (2.7)	2.4-2.9 (2.6)	2.7-3.0 (2.8)	2.8-3.1 (2.9)
SL/head length	2.8-3.0 (2.9)	2.6-2.7 (2.7)	2.7-2.8 (2.7)	2.6-2.9 (2.7)	2.8-3.0 (2.9)	2.7-2.9 (2.8)
SL/pectoral fin	2.4-2.9 (2.7)	2.5-2.9 (2.7)	2.6-3.1 (2.8)	2.4-3.1 (2.7)	2.6-3.2 (2.9)	2.7-3.1 (2.8)
SL/pelvic fin	2.7-4.3 (3.6)	3.4-4.3 (3.9)	3.4-4.6 (4.1)	3.0-4.0 (3.5)	2.8-4.3 (3.5)	3.1-4.2 (3.7)
SL/peduncle length	5.0-5.7 (5.4)	5.4-6.2 (5.8)	5.3-6.4 (5.9)	6.2-7.0 (6.5)	5.0-5.5 (5.4)	5.1-6.1 (5.6)
SL/peduncle depth	8.2-9.0 (8.6)	8.1-8.7 (8.3)	7.9-8.9 (8.4)	7.3-8.5 (7.9)	8.1-8.5 (8.3)	7.8-8.5 (8.1)
SL/snout	8.4-9.4 (9.0)	6.9-7.3 (7.0)	6.7-7.3 (7.0)	7.9-9.7 (8.3)	8.1-9.5 (9.0)	8.3-9.3 (8.7)
Depth/ped. length	1.8-2.1 (2.0)	2.0-2.4 (2.2)	1.9-2.3 (2.2)	2.2-2.9 (2.5)	1.8-2.0 (1.9)	1.7-2.1 (1.9)
Depth/snout	3.1-3.6 (3.3)	2.6-2.8 (2.7)	2.4-2.8 (2.6)	3.0-3.4 (3.3)	2.7-3.5 (3.2)	2.8-3.4 (3.0)
Depth/eye	2.8-3.2 (2.9)	3.0-3.3 (3.1)	3.0-3.8 (3.4)	2.5-3.3 (2.9)	2.5-2.7 (2.6)	2.4-3.0 (2.7)
Depth/preorbital	4.4-5.8 (4.8)	3.7-4.4 (4.0)	3.5-4.2 (3.7)	4.6-5.3 (5.0)	4.8-5.4 (5.2)	4.1-4.9 (4.5)
Depth/interorb. w.	5.1-5.7 (5.4)	4.3-5.2 (4.8)	4.8-5.5 (5.1)	4.1-5.1 (4.6)	5.2-6.1 (5.5)	5.3-5.8 (5.6)
Head/snout	2.9-3.2 (3.1)	2.6-2.8 (2.6)	2.5-2.7 (2.6)	2.9-3.4 (3.0)	2.9-3.4 (3.1)	2.9-3.3 (3.1)
Head/eye	2.7-2.9 (2.8)	3.0-3.2 (3.1)	3.2-3.5 (3.4)	2.6-2.9 (2.7)	2.5-2.7 (2.6)	2.6-2.9 (2.7)
Head/preorbital	4.3-5.1 (4.5)	3.7-4.1 (3.9)	3.4-4.1 (3.7)	4.1-5.4 (4.7)	4.9-5.5 (5.1)	4.4-4.8 (4.6)
Head/interorb. w.	4.8-5.6 (5.1)	4.4-5.2 (4.7)	4.5-5.5 (5.0)	3.6-5.0 (4.3)	4.9-6.3 (5.4)	5.3-6.4 (5.7)
Head/postorbital	2.6-2.7 (2.7)	2.9-3.0 (2.9)	2.8-2.9 (2.8)	2.7-3.0 (2.8)	2.7-2.9 (2.8)	2.8-3.0 (2.9)
Head/lower jaw	2.8-3.1 (3.0)	2.7-2.8 (2.7)	2.8-2.9 (2.9)	2.6-2.9 (2.8)	3.0-3.3 (3.1)	2.8-3.2 (3.0)
Head/prem. pedic.	3.5-4.0 (3.6)	3.3-3.7 (3.5)	3.3-4.2 (3.6)	3.2-3.7 (3.4)	3.5-3.9 (3.8)	3.5-4.3 (3.8)
Snout/eye	0.8-1.0 (0.9)	1.1-1.2 (1.2)	1.3-1.4 (1.3)	0.8-1.0 (0.9)	0.8-0.9 (0.8)	0.8-0.9 (0.9)
Snout/preorbital	1.4-1.6 (1.5)	1.4-1.6 (1.5)	1.3-1.5 (1.4)	1.4-1.7 (1.5)	1.5-1.8 (1.6)	1.4-1.6 (1.5)
Eye/preorbital	1.5-1.8 (1.6)	1.2-1.4 (1.3)	1.0-1.2 (1.1)	1.4-2.0 (1.7)	1.9-2.1 (2.0)	1.6-1.8 (1.7)
Eye/prem. pedic.	1.2-1.4 (1.3)	1.1-1.2 (1.1)	1.0-1.2 (1.1)	1.2-1.3 (1.2)	1.4-1.5 (1.4)	1.2-1.6 (1.4)
Lower j./prem. pedic.	1.1-1.3 (1.2)	1.2-1.4 (1.3)	1.1-1.5 (1.3)	1.1-1.4 (1.2)	1.2-1.2 (1.2)	1.2-1.5 (1.3)
Ped.length/ped.depth	1.4-1.8 (1.6)	1.4-1.5 (1.4)	1.3-1.6 (1.4)	1.1-1.4 (1.2)	1.5-1.7 (1.5)	1.3-1.6 (1.5)
Ped.length/interorb.w.	2.5-3.1 (2.7)	2.0-2.4 (2.2)	2.2-2.5 (2.3)	1.6-2.3 (1.8)	2.6-3.3 (2.9)	2.6-3.0 (2.9)
Ped. depth/interorb.w.	1.6-1.8 (1.7)	1.4-1.7 (1.5)	1.5-1.8 (1.6)	1.3-1.7 (1.5)	1.7-2.2 (1.9)	1.9-2.2 (2.0)

The "Spilostichus Type"

Peter Baasch

I obtained my first two specimens of this cichlid in 1989. They were imported in a consignment of wild-caught "Gracilis", and they caught my eye because their basic pattern was clearly different. At first glance they resembled "Graci-

This cichlid is an apparently as yet undescribed species, and moreover one whose systematic placement may prove far from simple. The most recent literature refers to it as *Stigmatochromis* sp. "spilostichus type", a designation which is, on



lis", having, like that species, a diagonal band of spots starting on the back above the pectoral insertion and ending at the caudal peduncle. These spots mark the points at which the band intersects vertical bars — which, however, are rarely visible in this species. But the actual composition of this band was quite different to that in "Gracilis": the first third consisted of small regular spots, but the remainder were broader and more accentuated. This type of "break" in the diagonal band is seen in many other species, and is actually the norm in those of the *Mylochromis* genus. But what was really unusual and striking about this fish was the presence, in the accentuated section of the band, of two spots which were especially prominent — so much so that they could virtually be classed as blotches. They were not situated adjacent to each other, but separated by a single "normal" spot.



Although still disputed the "Spilostichus Type" is here regarded as a species of the genus *Stigmatochromis*. Its basic colour pattern is reminiscent of that of *St. woodi*. The upper photo shows a young adult male of an aquarium-bred population. Spots additional to the three large blotches on the flanks of females may form an irregular diagonal line (bottom photo).



the one hand, a contradiction in terms, but on the other accurately describes the similarities involved, while the use of the generic name may even reflect an actual relationship.

The contradiction lies in the fact that neither *spilostichus* nor *gracilis* is a member of the genus *Stigmatochromis*. Together with the true *ahli* (a different species to that usually sold under the name) they formerly made up the genus *Sciaenochromis*, but when Konings (1993) revised that genus both were reassigned to *Mylochromis* on the basis of their pattern of markings.

It is indeed the case that in both body shape and coloration the "Spilostichus Type" bears a very close resemblance to *M. gracilis*, although in that species the diagonal band is composed entirely of regular small spots. I have kept only two individuals of *M. spilostichus*, but these had a rather rounder head and tinges of brown on the body. The diagonal line, at least in one of them, was distinctly interrupted and the spots were more regular than in Spilostichus Type.



Top: A male *St. woodi* in breeding colour.
 Centre: A male "Spilostichus Type" exhibiting the characteristic spots.
 Bottom: The diagonal stripe in *Mylochromis gracilis* is of a regular nature which distinguishes this species from *St. sp.* "spilostichus type".
 Next page: The placement of the true *spilostichus* in *Mylochromis* is questionable. Photo by Peter Baasch.

The two particularly striking spots (blotches) in the diagonal band of the *Spilostichus* Type indicate a relationship with *Stigmatochromis*; their positions correspond to those of the blotches typical of members of that genus. Moreover, as in all *Stigmatochromis* species, the blotches may (depending on mood) join together to form a line. So pattern points to the inclusion of this species in *Stigmatochromis* —but we will have to wait and see! The classification of the *Spilostichus* Type may be problematical, but at least its striking pattern means it can never be confused with any other.

The *Spilostichus* Type is a most rewarding fish to keep. It is robust (although the area around the eyes appears rather delicate) and, with a maximum total length of more than 25 cm, appreciably larger than *M. gracilis*. Body shape, finnage, and the powerful caudal peduncle indicate an accomplished and lightning-fast swimmer. Both inter- and intraspecific aggression are marked, with females often much harassed. They in turn



have their own strict "peck order", each female fighting to maintain her position in the hierarchy. These points must be borne in mind when determining aquarium size and choice of tankmates. The tank should be no less than two metres in length, and only robust species of similar temperament are suitable as companions.

I have repeatedly observed how these cichlids plunge into the substrate when feeding. It may be that in the wild they have evolved a specialised method of hunting; this would explain the rather protrusive lower jaw —another peculiarity of this species. They are greedy fishes which will eat anything in captivity, but even so never lose their predatory tendencies. This becomes apparent whenever fry —whether con- or hetero-specific— are released by a female before she can

be moved to a brooding tank. Growth is governed, at least in part, by tank size: in very large aquaria and with a suitable diet they can easily exceed the normal maximum size. Some individuals may become excessively fat.

My first two fishes were both males, and it was some time before a further individual, this time a female, turned up in a shipment of "Gracilis". Before long they were spawning regularly. Courtship is lively to say the least, "stormy" might be a better term. My fishes have always spawned in the sand, building a kind of crater —sometimes very irregular in shape and often little more than a lopsided heap of sand— as a spawning site. Sand is dug out from the centre, or brought from elsewhere, to build up the walls of the nest, which usually leans with one side against a rock. Sites behind rocks or in the shelter of a cave are preferred, so that it is difficult to get a good view of the spawning act. The eggs are fertilised in the mouth, after being picked up by the female.

Even only half-grown females may produce as many as 80 fry. The latter are relatively small and slender, and after just a few days already exhibit the characteristic pattern; the two oversized spots are clearly visible. Adult coloration may be assumed at a relatively early stage, at sizes of 8-10 cm.

The old adage that fry should be kept "up to their necks" in food should be applied with caution, as otherwise losses are likely —their appetites are boundless and they will, given the opportunity, eat till they literally burst. In my experi-

ence this is the case with many predatory species.

This cichlid has now been bred in captivity for 3 or 4 generations; it can thus be regarded as safely established in captivity, and, thanks to the efforts of Stuart Grant, further wild caught specimens are still being imported from time to time. Their popularity can only increase, as, given suitable tankmates, they represent a real alternative for the larger aquarium.

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The pearl of Tanzania

Thomas Lepel



The moment I saw this very attractive Mbuna during one of my visits to Lake Malawi, I instantly thought of a name that would do justice to the beauty of this little fish: *Labidochromis* sp. "perlmutter". ("perlmutter" means "mother-of-pearl" in German.)

At first glance the head and flanks of the fish appear to be coloured pure white, but as soon as the light strikes this active little Mbuna one immediately notices the characteristic gleam of mother-of-pearl. This characteristic is, as far as I know, unique among Malawi cichlids. To complete its attractiveness for any fancier of Malawi cichlids the dorsal fin of this new species is a bright lemon yellow colour. The intensity and extent of this yellow colour differ from individual to individual and in some males it extends onto the head and the upper part of the body (see photo). Both anal and ventral fins exhibit a black marginal band, and several light yellow eggspots are present on the anal. The caudal fin has yellow streaks on a pearly-coloured background.

At Higga Reef near Mbamba Bay, Tanzania, I was able to observe this species, which grows to a maximum size of approximately 8 cm (TL), in its natural biotope. It inhabits the rocky biotope at a depth of about 12 metres or more, and is very

shy in its behaviour. According to my observations the population of this species is very small, and it was several hours before I could say with certainty what the female looks like. I had to follow the male and only when he didn't feel disturbed by my presence did I have a chance to see his reaction to a probable female.

Although the male didn't appear to defend a breeding territory, it did defend a feeding area. When suddenly a banded Mbuna approached the "territorial" male, he became very excited and started to court this individual, which apparently was a female. I would have never expected the female of this newly discovered species to also exhibit an interesting and attractive colour pattern. Juveniles and females have a pattern of broad dark brown bars on a cream-white background. Sometimes these broad bars are split into two narrow ones and they may also vary in number. Dorsal and caudal fin have a yellowish tinge.

After observing these fishes it was clear to me that it was my "duty" to introduce this extraordinary *Labidochromis* into the aquaristic hobby. Upon my return to the boat I instructed the divers of the Pomonda Fisheries team (the collectors for Maltavi, Germany) to locate and

collect specimens of both sexes. After I explained what they looked like the divers answered with the usual "no problem" and swam off with their nets into the depths of the lake. A short while later they brought me a male and I was very grateful that these local fishermen could do their job so skilfully. However, collecting the female was another story. It took the remainder of the day and a lot of patience before I was finally able to put a female in the holding drum.

Although I spent several more weeks at the lake it proved impossible to collect another female. This left me responsible for a single female (and several males), and I took every possible precaution to keep her alive. I shipped the female to Germany before returning myself, and when



Previous page: *Labidochromis* sp. "perlmutter", a wild caught male in the author's tank.
Above: A juvenile "perlmutter" exhibiting the characteristic bars. Photo by Jochen Steves.
Right: A male "perlmutter" examining the aufwuchs on a rock at Higga Reef at a depth of about 30 m. Photo by Ad Konings.

I arrived my first, nervous question was whether the "perlmutter" had survived the journey and if they were still alive. Marc Danhieux, my employer, answered in the affirmative and gave me the only female in captivity as well as one of the males.

It was, of course, my duty to breed this rarity and to establish it in the hobby. I placed the couple in a 375-litre aquarium together with a group *Protomelas* sp. "Taiwan" (Chimoto Red) which are found in the same biotope at the same locality. The aquarium decor consisted of a few rocks, some plants, and fine sand on the bottom. Within a few days the "perlmutter" had acclimatised to the tank and the male was surprisingly peaceful towards the female —

this is commonplace among insectivorous *Labidochromis*.

A few days after introduction to the aquarium the male staked out a territory alongside a rock. He excavated a small spawning pit half under the rock and removed the coarser sand grains, possibly to avoid confusion with the eggs when the female collects them into her mouth. The female became gravid after about six weeks and spawning took place in the manner usually observed among Mbuna. Even during spawning the male behaved peacefully towards the female and also towards the other fishes in the aquarium.

16 days later I isolated the mouthbrooding female in a small tank where she released the fry after three more days. The brood consisted of 23 fry which all showed the characteristic pattern of broad bars on a light coloured background. They relished one-day-old brine shrimp, and it was a satisfying feeling, and a relief, to see them thriving in the growing on tank. I knew that, if I carefully grew these 23 juveniles to adulthood, I would be able to supply them to several interested aquarists, and this beautiful little Mbuna would then be established in captivity.



Remarkable observations on the Red Zebra

Ad Konings

The Red Zebra is a very popular cichlid and bred in large numbers all over the world. Recently Stuart Grant, the only exporter of cichlids in Malawi, managed to obtain a license to collect fishes in the Mozambiquean part of the lake and was thus able to renew exports of wild caught

are not able to differentiate the males of the two species while collecting. Fortunately the staff in the fish house at Salima are; so we do not need to worry about importing mixed pairs.

When I visited the reef near Meluluca the first time (June, 1994) I followed my usual procedure



Red Zebras (see Konings, 1994).

In the early seventies the Red Zebra was exported from Metangula by Richard Furzer. He collected them at a reef approximately 25 km south of his station although he must have known of their existence at Chilucha Reef which is only a few kilometres from Metangula (see map). The reason is clear: the females at the southern reef (Minos Reef) near Meluluca have a much brighter red coloration than those at Chilucha.

In October/November 1994 I was able to explore the entire Mozambiquean coast of Lake Malawi, which is called Lago Niassa by Mozambiqueans. Now, observing the Red Zebra at various locations for the second time, I discovered that at Minos Reef there are in fact TWO species with almost identical males. This fact had confused me earlier and even now Stuart's catchers

for finding the true females of any species: first I locate a territorial male and take one or more photos; then I wait until he courts passing females (the reaction of the females is also noted). When I am sure about the true female then I try to take some photos of her as well. When I followed this procedure during my first visit I saw one type of light blue male and one blue barred (BB) zebra at the reef. While observing a light blue male I found that he courted blue females and showed no interest in the red ones, which are abundant at the reef. I knew that Red Zebra in captivity produce offspring of two colours: the red are females and the blue are males. Since all other known Mbuna produce offspring with the adult coloration of the female (ie male juveniles have female coloration) I reasoned, since the juvenile males are blue, that the "normal" colour of the Red Zebra female should be blue (Konings,

1989). Previous observations of other species which exhibit polychromatism (ie have individuals of different colour, such as OB (orange-blotched) and O (orange)) indicated that males usually do not immediately recognise the OB and O females and direct all their courting efforts towards "normal" coloured females. For this reason I found it understandable that the Red Zebra

females were not courted by the light blue male I was observing.

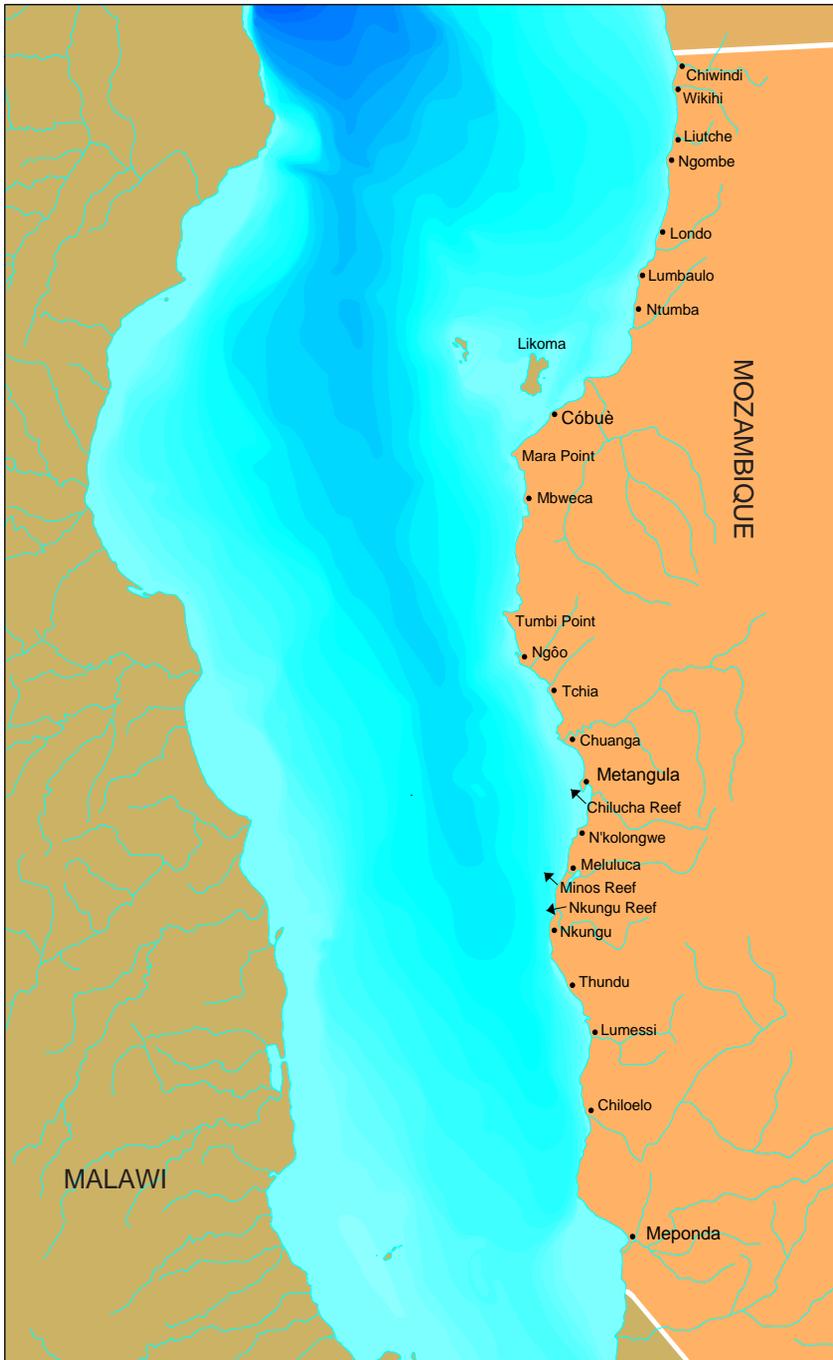
In June I collected some specimens of the zebras at the reef in order to give the Red Zebra a scientific name. During examination of these specimens I found that the blue females I had collected did not have the same morphology as the red and the blotched ones and were thus a



Previous page: A female Red Zebra, *Ps. estherae*, at Minos Reef.
 This page: top: A male Red Zebra at Minos Reef (left) is mainly interested in red coloured females (right).
 Centre, left: A male *Ps. sp.* "blue reef" at Minos Reef. Note the resemblance to the Red Zebra male. The female *Ps. sp.* "blue reef" has an overall blue colour (below).
 Bottom, left: The Red Zebra male at Chilucha Reef lacks the ocellated spots in the dorsal.



different species. For this reason I could not include them in the type series. Furthermore Stuart Grant told me that there was some confusion regarding males as well because Saulos Mwale, his number one at the fish house, had noted that there were two different males: one had yellow spots in the soft part of the dorsal fin and a broad mouth like the red females, while the other had tiny orange spots on the very edge of the dorsal and a narrower mouth.



mined to answer these questions. I observed several males at several places at the reef and only after a long time did I discover the answer. But first let me relate a few remarkable observations. After having dived for more than 500 hours in the lake and having seen most of the rock-dwelling cichlids in their native environment I "know" what happens when two territorial males of the same species meet: the intruder is fiercely chased by the owner of the territory. From my experience as an aquarist I know that males of similar (but different) species take no notice of the differences we can see between them and behave as conspecific males would. In other words similar-looking males behave aggressively towards each other when it comes to defending territory. What I observed at the reef did not concur with my previous experience: in many places I saw two bright blue males peacefully grazing from the same rock, totally ignoring each other, while a third blue male would be fiercely chased by one of them. I could not understand why some males were fighting over territory (see photo) while others totally ignored each other. I decided to

Although the broad-mouthed male was considered to be the true male of the Red Zebra (and only males of this type were included in the type series of the formal description) the origin of the other males remained unanswered, although numerous specimens were repeatedly found among the Red Zebras coming in from Mozambique.

Now, visiting the reef for the second time, I was deter-





watch two males that tolerated each other's presence only centimetres apart. Then I found the answer: one of the males courted only blue females while the other tried to spawn with just red and OB females. The situation was clear to me: there are two species, one with blue females and the other, the Red Zebra, with red or OB females. One question still remains: how can males of these two species identify one another? By looking at the structure of the mouth, I am now able to see the difference under water. The spots in the dorsal may help too, but I have seen several males where these spots had been ripped off (thanks to *Genyochromis mento*) and they were still recognised correctly. This recognition is not a



Previous page: Two males *Ps. sp.* "blue reef" in a territorial dispute. This page, top: An orange-blotched (OB) Red Zebra female at Minos. Centre: A marmalade cat Red Zebra at Minos Reef. Bottom, left: A mouthbrooding "Blue Reef Zebra" female (Minos). Bottom, right: A mouthbrooding Red Zebra at Chilucha Reef.



slow process in which different males assess each other's movements or signals, it is immediate and accurate. A male may be in hot pursuit of a conspecific intruder; then, having reached the outer boundary of his territory, he abruptly turns around and comes face to face with a male of the other species which is totally ignored!

The yellow spots in the dorsal of the Red Zebra are a helpful characteristic for differentiating those populations which share their habitat with the all-blue species, which we will refer to as *Ps. sp.* "blue reef". *Ps. sp.* "blue reef" occurs at Minos Reef and at Nkungu Reef, approximately 10 km south of Minos. Interestingly Red Zebra males in populations north of Minos Reef lack these yellow spots. Another remarkable observation is that at Minos Reef and at Nkungu Reef all Red Zebra females are either completely red or blotched (at least, I did not find other morphs). At other places most Red Zebra females are of "normal" coloration (beige or brown) which I had previously surmised must exist, although numerous red and OB morphs are seen as well.

The segregation of cichlid species in Lake Malawi is probably maintained by female selection of an appropriate mate. The difference in coloration in males of different species guarantees a genetical segregation which keeps the species pure. In the case of the Red Zebra and the "Blue Reef Zebra" it is also remarkable that the females of either species are able to recognise their true mates. On the other hand they may rely heavily on the courting efforts of the male who is, without doubt, able to recognise the right female. But if there were beige/brown coloured females of both species then maybe such recognition by the male would not be guaranteed. This situation may have gradually excluded the beige/brown Red Zebra females (or at least noticeably reduced their numbers) from these two



populations.

It is also questionable whether all males exported in the early seventies were indeed true Red Zebra males. According to a former em-

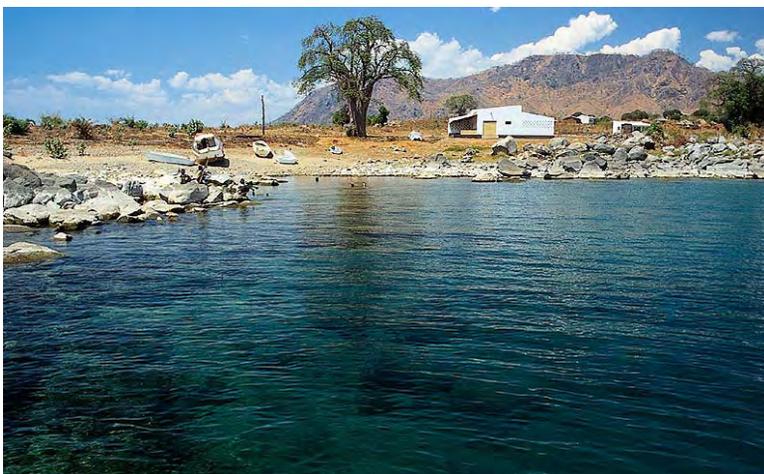


ployee of Richard Furzer almost all the Red Zebras exported were collected at Minos Reef as this population shows the deepest red colour in females. Breeders with a stock of blue males should therefore check whether all have the yellow spots in the trailing part of the dorsal fin, because all males of the Minos population have. So-called marmalade cats, males of the OB or O morph, were seen only at Minos Reef. They are not blotched but have a pinkish, almost white colour on the entire body. Such specimens also have prominent yellow ocellated spots in the soft part of the dorsal fin.

The distribution of the Red Zebra encompasses a larger area than that of the Blue Reef Zebra. It includes, as mentioned earlier, Chilucha Reef and also the southern tip of the Metangula peninsula. The latter locality may not be a natural habitat of the Red Zebra as it is the site where the exporter of ornamental fishes had his station. A visit in November 1994 revealed that the colour of the females was not consistent as is the case in the other three known populations: some females were orange while others exhibited a bright red coloration, again others had a few black blotches on the body (OB morphs); plain beige coloured females were seen as well. At the northern tip of the Metangula peninsula, which is about 2 km away and separated by a stretch of intermediate-type coastline, Red Zebra males were not seen, but a very few OB females, resembling OB morphs of the Red Zebra, were. For the time being I will regard these OB females as belonging to *Ps. zebra*, which is abundantly present at this site.

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A male (top, facing page) and a female (top) *Ps. zebra* at Chilucha Reef. The same species at Minos Reef (male: centre, facing page; female: second from top). At Chuanga, outside the Red Zebra distribution, *Ps. zebra* males resemble those at Chilucha Reef. The photo at the bottom of the previous page shows a marmalade cat. Third from top: A brown coloured Red Zebra female at Chilucha Reef. Bottom: The southern tip of the Metangula peninsula with Furzer's fish house, now in the possession of fisheries.

OTHER AFRICAN CICHLIDS

Polychromatism in Lake Kivu haplochromines: two for the price of one?

Jos Snoeks¹

Lake Kivu— even without having ever seen the lake, one feels that its name better expresses the mystic beauty of an East African rift valley lake than those of various others in this region, eg Victoria, Edward (formerly —briefly— Idi Amin), George, or Albert (= Mobutu). A romantic view, I admit, perhaps even a subjective one, but certainly one that has been marred by the recent tragedies near the beautiful indented shores of the lake.

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Lake Kivu is situated on the border between Rwanda and Zaïre, north of Lake Tanganyika. It is large by European standards (2055 km²), but quite small compared to the "big three" of the East African lakes, viz. Victoria, Tanganyika and Malawi. Lake Kivu is permanently stratified and there is no oxygen below a depth of 50-70 m. Consequently although the lake is very deep (485 m maximum), fishes do not live in the deeper, anoxic regions, which also contain large amounts of dissolved gases such as carbon dioxide and methane. Salinity and conductivity levels are



Early morning sunlight revealing a scenic view of Lake Kivu and its surroundings (photo J. Snoeks).

quite high (respectively 1.115‰ and 1240 µS). The pH in the upper layers varies around 9.0, but drops to about 7.0 in the deeper regions.

The ichthyofauna of Lake Kivu remains largely unknown to most aquarists. It includes fifteen species of *Haplochromis* which are all endemic — this means that they occur only in this lake and nowhere else. Three more cichlid species live in the lake: *Oreochromis niloticus* (Linnaeus, 1758) and the introduced *Oreochromis macrochir* (Boulenger, 1912) and *Tilapia rendalli* (Boulenger, 1896). The lake currently harbours only eight non-cichlid species, viz. the freshwater sardine, *Limnothrissa miodon* Boulenger, 1906, which was introduced from Lake Tanganyika; two species of catfish (*Clarias gariepinus* (Burchell, 1822) and *Clarias liocephalus* Boulenger, 1898), one bariliine cyprinid (*Raiamas moorii* (Boulenger, 1900)), the large *Barbus altianalis* Boulenger, 1900, and three small *Barbus* species (*B. apleurogramma* Boulenger, 1911; *B. kerstenii* Peters, 1868; *B. pellegrini* Poll, 1939).

Although Lake Kivu is currently connected with Lake Tanganyika via the Rusizi river, the cichlid faunas of the two lakes are very different. Only the widespread *O. niloticus* and the introduced *T. rendalli*, are present in both lakes. The reason for this is that Lake Kivu has only recently (in geological terms: 9,000-14,000 years ago) started to overflow into Lake Tanganyika. In all probability

the torrential flow of the Rusizi is responsible for the lack of interchange of cichlid species between the two systems. Prior to the eruption of the Virunga volcanoes, north of the present Lake Kivu, this lake was connected to the Lake Edward system. The cichlid fauna of Lake Kivu is thus more closely related to that of the Edward system than to Tanganyikan cichlids. In fact the haplochromines of Lake Kivu belong to the super-flock which also includes those of Lakes Victoria, Nabugabo, Edward, George, and their associated waters (Greenwood, 1980; Snoeks, 1994). These cichlids have recently attracted a considerable amount of attention because of the catastrophic events in Lake Victoria (Barel *et al.*, 1991). The increased interest in Victoria haplochromines shown by the scientific community has been paralleled by heightened popularity among aquarists.

As with all populations of the Victoria super-flock, the taxonomy of Lake Kivu haplochromines is extremely complex. Of the 23 species so far reported from this lake, only 15 have proved to be valid (Snoeks, 1994). Although territorial males generally have species-specific colour patterns, knowledge of the colour pattern does not always provide an answer to taxonomic problems (Snoeks, 1991). In several species, for instance, territorial males are almost completely black; in others, green-blue is the basic colour of



territorial males. Non-territorial males do not have the often magnificent colours of the territorial males and may even have a quite different colour pattern. The colour pattern intensifies with increasing territoriality and correct identification becomes easier. However, the bulk of the catches consists of non-territorial males, females and juveniles, which all have similar, grey-brown colour patterns, and remain difficult to identify. In such cases the taxonomist often has to rely on small but significant morphological differences (Snoeks, 1991; 1994).

The reader will be relieved to hear that I do not intend to describe all 15 Lake Kivu haplochromines. Instead, I would like to discuss a phenomenon typical of these fishes: a high degree of polychromatism or colour polymorphism.

But first, what is polychromatism? In simple terms it can be defined as the genetically determined occurrence of two or more colour morphs within one and the same species. The differences between individuals of the various morphs are permanent rather than due to geographic, seasonal or ontogenetic (developmental) variation. In Lake Kivu four of the fifteen known species are polychromatic, with a normal coloured and a "piebald" or bicolor morph in each case. The colour pattern of piebald specimens consists of a yellow-white ground colour with black spots and blotches. The two colour morphs are very distinct in appearance and were previously often regarded as separate species, the presence of this polymorphism having led to much confusion in the taxonomy of these fishes. During an extensive morphometric study no differences except for colour pattern were found between the two morphs (Snoeks, 1994).

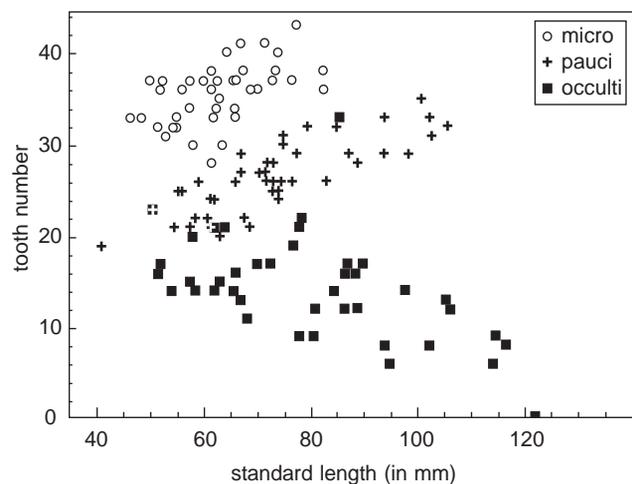
Haplochromis vittatus is the largest species of all. Its name refers to the two longitudinal bands on the body of most specimens. The species can grow to a size of about 25 cm total length. It is easily recognised by its predatory look: the body is streamlined and the head and jaws are relatively large. As in many other haplochromines there is a shift in tooth shape during growth. In *H. vittatus*, specimens smaller than 60 mm SL (standard length) have an almost 100% bicuspid (with two cusps or points) outer dentition; the teeth in the inner rows are tricuspid (with three cusps).



With increasing length, the tooth shape changes, and specimens over 80 mm SL have a predominantly or even an exclusively unicuspid (with only one cusp) outer dentition and a correspondingly higher percentage of unicuspid teeth in the inner rows. In addition all the teeth become more sharply pointed. At this length *H. vittatus* is almost exclusively piscivorous.

H. occultidens may also be classified as a piscivorous species, but of a special kind; it feeds on eggs and larvae. This information is based on stomach contents analysis — its feeding behaviour has

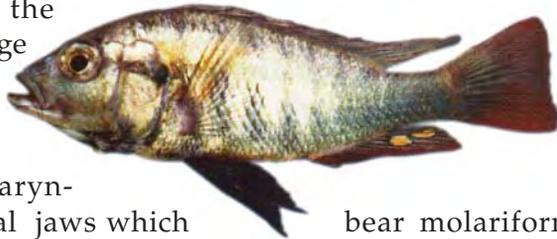
not yet been observed. The presence of thick lips and only few teeth suggests that *H. occultidens* is probably a paedophagous species of the snout-engulfing type (*sensu* Wilhelm, 1980). This means that, having chased a mouthbrooding female, the paedophage is able to engulf her mouth and snout with its own mouth. The brood can then be sucked out of the buccal cavity of the mouthbrooding female. In *H. occultidens*, atypically, the number of outer teeth in the upper jaw decreases with growth, while it increases in all other Lake Kivu haplochromines. This feature is probably related to its paedophagous feeding behaviour as there is no particular need for strong and numerous teeth for either snout-



Scatterplot of the number of teeth in the outer row of the upper jaw (Y-axis) against the standard length (X-axis). Note the decrease in tooth numbers in *H. occultidens* (*occulti*) with increasing length. For comparison, the data of two other species with few outer teeth (*H. paucidens* = *pauci*; *H. microchrysomelas* = *micro*) are given as well (after Snoeks, 1994).

engulfing or processing of the soft-tissued eggs and larvae. This feature is reflected in the specific name which refers to the few teeth (*dens* = tooth) which are deeply embedded in the gums and are difficult to observe (*occultus* = hidden). *H. occultidens* is quite rare and represents less than 0.5 percent of the experimental *Haplochromis* catches in Lake Kivu.

The third species, *H. adolphifrederici*, was named in honour of Adolf Friedrich, Duke of Mecklenburg, the leader of the Deutsche Zentral-Afrika Expedition 1907-1908. It is characterised by the large



pharyngeal jaws which bear molariform pharyngeal teeth. This species is thus well equipped to crush the hard parts of prey items such as molluscs. However, so far not many individuals have been found to have remnants of molluscs in their intestines. The question "Why?" is difficult to answer at this moment. It might have to do with the scarcity of molluscs in the lake, but the situation seems to be more complex. A more detailed discussion on the ecology of this species can be found in Snoeks (1994).

Haplochromis paucidens is one of the most beautiful haplochromines from Lake Kivu. As with *H. occultidens*, the name is descriptive of the morphology of the dentition (*paucus* = few; *dens* = tooth), referring to the low number of teeth in the outer rows of the oral jaws. Adult males have a golden-yellow ground colour. In territorial males the body, in particular the

darker parts, becomes more green-blue coloured. A contrasting orange pigment is present on the dorsal, anal and caudal fins. *H. paucidens* is the only species in Lake Kivu that has a third, rare, grey-coloured morph.

The question arises as to why polychromatism has developed in these species or, to put it another way, what are the possible advantages of having two discrete colour patterns within one species?

The most plausible hypothesis so far is that piebald specimens may benefit by being less conspicuous—the principle of mimicry or camouflage—hence they are less likely to be attacked by possible predators. This offers protection not only for the piebald individual itself, but, in case of a mouthbrooding female, for the eggs and young as well. One could thus postulate that, because of the mouthbrooding habit, natural selection, favouring inconspicuousness through polychromatism,



is likely to have a more beneficial impact for the species when acting upon females than on males.

And indeed, this hypothesis appears to correspond with what we find in nature. Genetic polychromatism is strongly, but not completely, correlated with sex and appears to be genetically linked with that part of the genome that is involved in sex determination. About 90 % of the piebald specimens found in Lake Kivu are females, though this percentage varies considerably

Previous page: Small specimen of the piscivorous *H. vittatus*.

Territorial males become almost completely black (photo J. Snoeks).

Top left: Adult male of *H. adolphifrederici*. When territorial, the blue pigment in males becomes more prominent (photo J. Robben).

Top right: Female of the rare grey morph of *H. paucidens* (photo J. Snoeks).

Right: Female *H. paucidens* with the piebald or bicolour pattern. (photo Ad Konings).



from species to species. In the case of the grey morph of *H. paucidens*, only females have been found.

But the story is more complicated than that and gives rise to further questions. If this colour pattern is so beneficial, then why do not all females have a piebald pattern? Most probably there is a kind of balance between the benefits, for a species, of having inconspicuous individuals and the disadvantages of being polychromatic. One reason may be that being less conspicuous also has its drawbacks. The fact that piebald specimens of the various species have the same basic colour pattern may lead to difficulties in intraspecific recognition and communication. But, more importantly, in haplochromines the specific colour pattern of the male plays a vital role in mate recognition by the female (Greenwood, 1991). Thus the colour pattern constitutes an essential clue for successful reproduction. If females had problems in distinguishing between similarly coloured piebald males of different species this would have a negative impact on the reproductive success of the species. Hence, although the presence of a large portion of piebald females

within a population is advantageous, the presence of many piebald males is not. Since, owing to the incompleteness of the genetic link between polychromatism and sex, a further increase, in females, of the alleles (= one of the several forms of a gene) responsible for polychromatism could produce a less beneficial rise in the number of piebald males, the balance is maintained.

Greenwood (1974) stated that the piebald pattern in Lake Victoria haplochromines did not vary with the emotional state of the fish. In Lake Kivu haplochromines, however, I have observed some variability in the piebald pattern of the males. The pattern of dark blotches appears to be unchangeable in each individual, but the remainder of the colour pattern is subject to intra-individual variability. The blue colour of normal-coloured territorial *H. adolphi-frederici* males was also observed in a piebald male. In piebald *H. paucidens* males the orange pigment in the dorsal and the caudal fins may be present as well, and one piebald male *H. occultidens* was observed which had red pigment on the flanks as in territorial males of the "normal" morph.

One might wonder if these elements shared with the normal coloured pattern are sufficient to provide the female with the necessary clues to recognise one of these rare piebald males as belonging to the same species. Unfortunately this question remains unanswered so far. Perhaps they are, but they will certainly not be optimal, and thus it may be that such males have a reduced, or possibly non-existent, chance of reproduction in the wild.

Greenwood (1974) mentions that in none of the Lake Victoria species does the occurrence of polymorphic individuals exceed about 30 percent of the females in a population, except in *H. chromogynos* Greenwood, 1959, the females of which appear to be all of the bicolor type. In the two Kivu species (*H.*



Top: Selection of piebald females of *H. paucidens* showing the variability of the piebald pattern within a population (photo J. Snoeks).
Bottom: An aquarium raised male *H. paucidens*.
Facing page: A female *H. paucidens* with normal colour pattern.



adolphifrederici and *H. paucidens*) in which the relative abundance of the sexes was further analysed, the ratio of piebald against normal coloured females is about even.

In addition, more than a quarter (four out of fifteen) of the haplochromine species of Lake Kivu are polychromatic, which is remarkable compared to the situation in the other lakes of the Victoria super-flock. In Lake Victoria only 12 of the more than 300 species are polychromatic (Snoeks *et al*, 1989). In the Edward-George system no piebald specimens have yet been found. Why then such a relatively high number in Lake Kivu?

Starting from the hypothesis that piebald specimens are better protected against attacks from predators by their disruptive colour pattern, one may postulate that the need for inconspicuousness is greater in the clear waters of Lake Kivu than in the turbid waters of Lakes Victoria and Edward-George. Such a selection pressure in favour of polychromatism would not only explain the higher proportion of polychromatic species in Lake Kivu, but also the higher percentage of piebald specimens within those species, compared to those of Lake Victoria.

Possibly other factors, such as frequency-dependent (apostatic) selection, are involved in maintaining a balance in the polychromatism of the Lake Kivu cichlids. However, discussion of these phenomena is beyond the scope of this article. One factor worth mentioning is pleiotropy (the phenomenon in which a single gene can have an effect on more than one, seemingly unrelated, characteristic). Hence unknown physiological factors may be involved, as suggested by Fryer & Iles (1972) for Lake Malawi cichlids (but bear in mind that the taxonomy of some of the species discussed in their book has changed, so some of the assumptions made are

no longer valid).

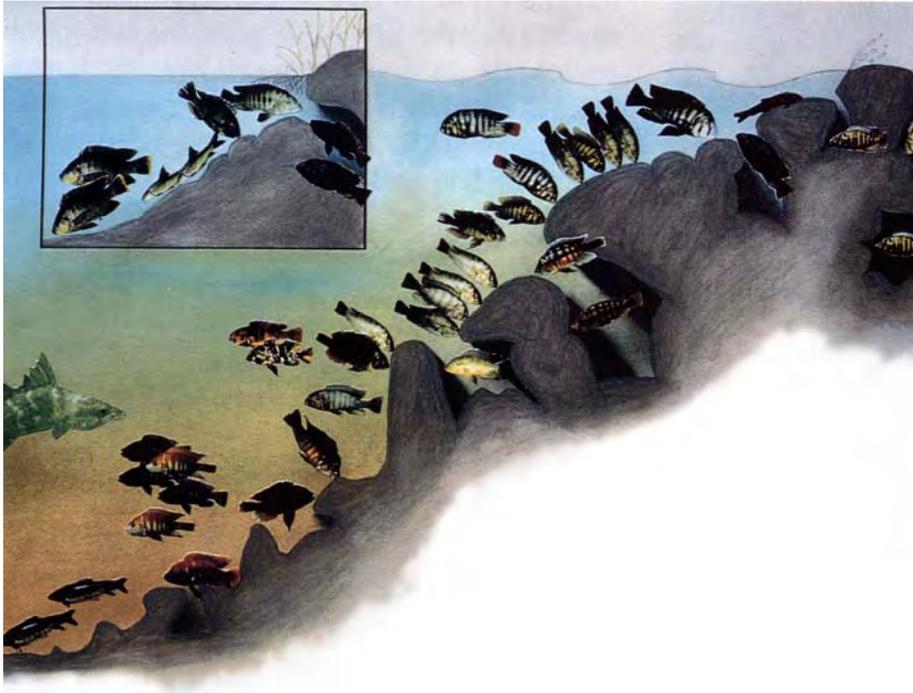
Interestingly, Fryer & Iles (1972) doubt the relevance of male coloration in the evolution of polychromatism and discuss examples of sex-limited polychromatism in other groups of animals in which the colour patterns of males do not appear to be important in courtship. However, the mechanisms that control the occurrence of polychromatism in these groups do not necessarily have to be the same as in the Victoria haplochromine super-flock. Whatever the facts of the matter, it is obvious that we still have much more to learn about this phenomenon before the questions raised in this article can be fully answered.

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Research on mechanisms of reproductive isolation among Lake Victoria cichlids and their importance for conservation

Ole Seehausen¹



Left: Cichlid community at a surf exposed rocky island. The inset shows a non-exposed place at the same island. More than 16 species of haplochromine cichlids coexist within a depth range of only five metres. No details are known about the mechanisms that prevent them from interbreeding. Next page, top: When I caught this fish I thought it might be a hybrid of *H.* "velvet black" and *H.* "rockpicker" but it is an extremely rare new species (*H.* "short snout scraper") which is currently known from three islands. Bottom: A possible hybrid of *H. nyererei* and another species.

When crossed in aquaria the endemic cichlids of Lake Victoria produce fertile offspring. With respect to efforts to conserve the remaining species diversity of this lake, a better understanding of the mechanisms that enhance reproductive isolation in the lake would thus certainly be of great value (Seehausen, 1994a; Seehausen & Witte, 1994; Seehausen & Van Alphen, 1994). I will use the following paragraphs to explain how a particular piece of research proposed in this regard (Seehausen, 1994b), relates to conservation.

Any efforts to protect biodiversity must begin with the identification and delimitation of species. This is difficult in extremely speciose systems like Lake Victoria, where differences between species are subtle. Success depends ultimately on the accuracy of the species recognition concept used. Though the concept generally applied to Great Lake cichlids (Ribbink, 1986; Witte & Witte-Maas, 1987) has often proved useful, it has, with regard to Lake Victoria cichlids, repeatedly been questioned (Crapon de Caprona & Fritsch, 1984; Meyer, 1987). Results of recent

investigations serve to devalue it further. (1) In contradiction to statements in earlier publications, hybridization seems to occur in nature and may not be infrequent (Seehausen, 1994a; Witte *et al.*, in press). (2) Again in contradiction to earlier published works, colour polymorphism (polychromatism) is likewise of not infrequent occurrence (Seehausen, unpubl. data). In the species recognition concepts referred to above, coloration features prominently. It is assumed that females recognise their males by virtue of their specific coloration. It is thus difficult to explain the existence of male polychromatism. (3) Distribution patterns of some cichlids caution us not to dismiss the possibility that parallel evolution may have resulted in several very similar but independent phenotypes.

I believe that it is time to test the accuracy of the species recognition concept in a rigorous manner by means of a combination of ethological, morphological, and molecular genetical work. Frequently discussed strategies for protecting the remaining cichlid fauna of Lake Victoria ultimately depend on accurate species recognition. One major concern in captive propagation is to conserve maximum genetic variability in the species propagated. To achieve this it may be necessary to derive founder stock from more

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than one population. The success of the conservation effort then depends on the reliability of the recognition concept used. However, even a good concept cannot guarantee freedom from error and we need to be able to estimate the



probability of error. To do this we certainly need to improve our knowledge of the patterns of evolution among these fishes. We need to know how probable it is that populations of similar appearance (hardly any two populations are identical) belong to a single species.

Lots of discussion centres on the establishment of fish sanctuaries. Several areas should be selected so that together they harbour maximum diversity. To locate suitable areas, species diversity has to be inventoried on a large scale. Owing to constraints on time and budgets, external characteristics have to be used to identify and delimit species. To use these successfully we need better knowledge of how closely they reflect genetic and ecological diversity.

Part of the problem is the identification of hybrids in nature. In many cases we cannot be sure that a certain fish is a hybrid. It may equally be a very rare species which would then be of the highest conservation priority (see photograph). Molecular genetics have to be applied to analyse apparent hybrids and behavioural work performed to understand the circumstances under

which hybridization occurs.

Hybridization may be a significant force behind changes in the cichlid species composition of Lake Victoria (Witte *et al.*, in press). It is thus important to understand what causes hybridization and what prevents hybridization from happening. Species extinction can be triggered by the reversal of the most crucial step in speciation: the breakdown of reproductive barriers between species. Models for speciation and extinction can be tested by research on the mechanisms of reproductive isolation.

To summarise: (1) research on mechanisms and levels of reproductive isolation and patterns of molecular phylogeny among representative groups of species will test and improve upon the currently utilised species recognition concept, whose reliability determines the efficiency and success of conservation management. (2) Research on mechanisms of reproductive isolation will contribute to understanding modes of change in species diversity —speciation and extinction. This is of major interest for conservation as well as for evolutionary biology.

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Cichlids from Lake Edward and Lake George

Mark Smith

Since a great deal of attention has been directed towards the haplochromine cichlid fishes of Lake Victoria, the haplochromines found in the smaller satellite lakes within relative proximity to Lake Victoria have all but been ignored in large part. The problems caused by man that Lake Victoria is undergoing at present are an obvious explanation as to why this is so. Yet the smaller bodies of water to the west and north of Lake Victoria are worthy of at least a modicum of recognition. From an aquarist's point of view, some of these smaller lakes harbour spectacular cichlids (see e.g. *Cichlid News* Jan. 1994 on *Haplochromis* sp. "zebra"), and they will undoubtedly continue to do so in the future.

During a recent trip to East Africa I had the opportunity to visit two such satellite lakes west of Lake Victoria in southwest Uganda: Lake Edward and Lake George. These lakes have long been known by scientists to have a unique species flock of haplochromines that seem to share a common ancestry with the haplochromines of Lake Victoria. Much of the work by ichthyologists on these two lakes was performed in 1921 and 1925 by Regan, in 1933 by Trewavas, and in 1939 by Poll and Damas. The most recent published work is by Greenwood (1972).

The reason why both lakes are treated as a

single entity lies in their interesting geographical relationship: the two lakes are connected by the Kazinga Channel, a 36 kilometre long "river" that is approximately one kilometre wide at its widest point and about 150 metres at its narrowest, approximately halfway at the town of Katunguru. There is a slow flow of water from Lake George into Lake Edward via this channel, yet it has been reported that on occasion the wind has caused a reversal of the water flow, most likely restricted to the upper layers of water. While travelling up the Kazinga channel to Lake George I could clearly see that the water was slowly flowing towards Lake Edward.

In comparison with many of Africa's great lakes, Lake George is small —approximately 15-18 km in diameter and roughly circular in shape. A major part of the lake is only about 2.5 metres deep with some areas around 4 metres. The bottom is covered with thick organic muddy ooze and underwater visibility is less than 30 cm. Lake Edward, on the other hand, is far larger, approximately 95 kilometres long and 90 wide with a depth of 117 metres at its deepest point. Like Lake George, Lake Edward has poor underwater visibility, again about 30 cm. The pH of the water of the two lakes ranges from 8.7 to 9.9.

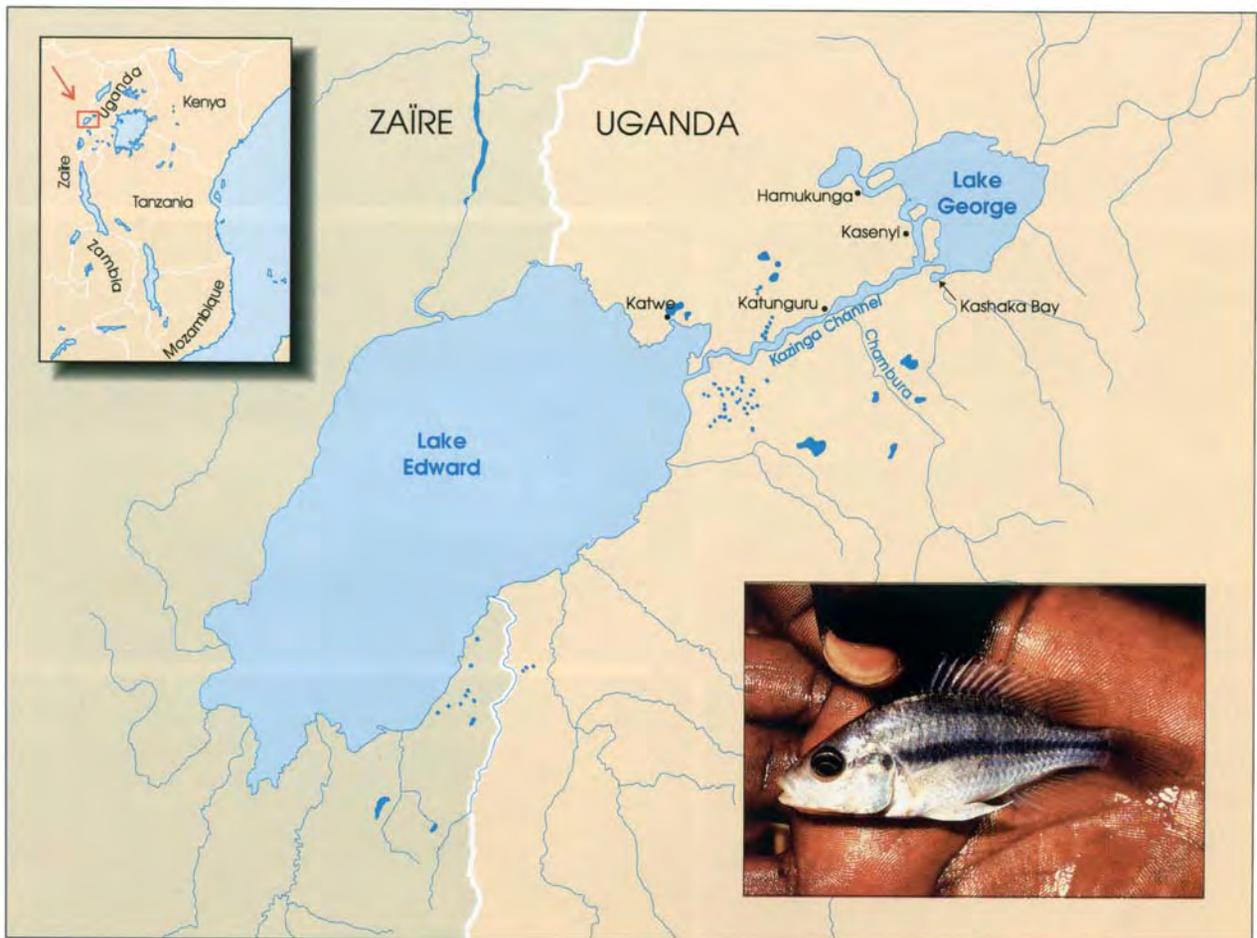
With such poor visibility the question arises as



to how the haplochromines are able to find each other in order to reproduce. It has been suggested that they may possess slightly larger eyes and/or enlarged lateral line systems. However, these possibilities are merely hypothetical explanations, especially as eye sizes and lateral line systems do not significantly differ from those of the closely related species in Lake Victoria, where visibility tends to be better than in either Lake Edward or Lake George. Perhaps chemicals unique to the various species are released into the water and registered by nearby conspecifics.

The whole of Lake George lies within the borders of Uganda (in the southwestern corner) while only the northern third of Lake Edward lies in Ugandan territory. The remaining two

eduardianus (formerly in the genus *Schubotzia* and originally described from Lake Edward specimens), *H. elegans*, *H. labiatus*, *H. limax*, *H. macropsoides*, *H. mylodon*, *H. nigripinnis*, *H. oregosoma*, *H. pappenheimi*, *H. petronius*, *H. schubotzi*, *H. schubotziellus*, *H. squamipinnis*, and *H. taurinus*. To say that the 16 species of *Haplochromis* of Lake George are endemic to that lake is not true. Most of those 16 species are also known to frequent the Kazinga Channel and even enter Lake Edward. The only Lake George *Haplochromis* that most probably does not frequent the Kazinga Channel and Lake Edward is *Haplochromis petronius*. This species is found virtually exclusively in Kashaka Bay, an extinct volcano approximately 1 kilometre wide which, at some time in the past, eventually became con-



Opposite page: the central western shore of Lake George, near Hamukungu. Above, inset: *Haplochromis schubotziellus* from Kasenyi, Lake George. Photos by Mark Smith.

thirds belong to Zaïre.

Lake George contains at least 16 formally described species of *Haplochromis*. This cichlid fauna is composed of the following species: *H. aeneocolor*, *H. angustifrons*, *H.*

connected with Lake George by a narrow opening. This bay is the only region in the lake with a steep, rocky shoreline. Elsewhere the shoreline alternates between areas of tall grasses or papyrus over a sandy/muddy bottom with a gently sloping shoreline. *H. petronius* seems to be the only *Haplochromis* which is restricted to the rocky habitat in Kashaka Bay. Yet it has been found in the open waters of Lake George. It has not been



Top: a male *Haplochromis aeneocolor* in breeding dress. Katwe Bay, Lake Edward.
 Centre, left: *Haplochromis aeneocolor*, a dark morph from the same site as the male above.
 Centre, right: *Haplochromis squamipinnis*, a large female from Kashaka Bay, Lake George.
 Bottom, left: *Haplochromis elegans* from Kashenyi, Lake George.
 Bottom, right: *Haplochromis squamipinnis*, a male in partial breeding dress from Katwe Bay, Lake Edward.
 Photos by Mark Smith.

found in the Kazinga Channel or in Lake Edward.

The cichlid fauna of Lake Edward has been far less studied and there are fewer described species. The *Haplochromis* species of Lake Edward are as follows: *H. eduardi*, *H. engystoma*, *H. fuscus*, *H. mentatus*, *H. pharyngalis*, *H. serridens*, and *H. vicarius* (maybe synonymous with *H. eduardi*)

All the species mentioned so far are endemic to the two-lake system. In addition both lakes and the Kazinga Channel share at least 4 non-endemic haplochromines as well as two tilapiines: *Astatoreochromis alluaudi*, *Pseudocrenilabrus multicolor*, *Haplochromis nubilus*, *H. erythromaculatus* (introduced from Lake Ruhondo and Lake Bulero and the rivers that flow from them in Rwanda), *Oreochromis leucostictus*, and *Oreochromis niloticus*.

One species, *H. dolorosus*, although grouped together with the cichlids of Lakes Edward and George by Trewavas in 1930, has actually been found only in the Chambura River flowing into the Kazinga Channel, and is known only from the holotype.

The fact that a major section of Lake Edward lies in Zaïre, with its never ending political strife, is undoubtedly a contributing factor to the lack of study of the *Haplochromis* flock in the lake. If and when Lake Edward is thoroughly explored, a great number of new species will probably be discovered. That this may already be happening is indicated in "*Cichlid Fishes, behaviour, ecology and evolution*" edited by Miles H. A. Keenleyside. Table 9.1 on page 87 shows at least 60 species of cichlids known from Lakes Edward and George, only 29 of them so far described, leaving well over 30 species awaiting description. Since Lake George has been more thoroughly studied, it seems probable that most of the undescribed cichlids were caught in the larger Lake Edward.

According to Greenwood, a few Lake George haplochromines that have not been recorded from Lake Edward have been found in the Kazinga Channel. They are *H. oregosoma*, *H. macropsoides*, and *H. schubotziellus* (see photo). Since the habitat in Lake George is nearly identical to that in the Kazinga Channel, except for the slight current, and is also similar to that of the region of Lake Edward around the Kazinga Channel outflow, it would be reasonable to assume that these three species of Lake George *Haplochromis* also frequent Lake Edward to some degree. However, seven scientifically known species of *Haplochromis* are apparently endemic to Lake Edward and have yet to be found in Lake



From top to bottom: *Haplochromis* sp. "gold Edward", *Haplochromis* cf. *mentatus*, and *Haplochromis limax*; all three from Lake Edward. The bottom photo shows *Haplochromis petronius* from Kashaka Bay, Lake George. All photos by Mark Smith.



George or the Kazinga Channel —with the possible exception of *H. vicarius* (which Poll considers a synonym of *H. eduardi*). This odd situation continues to puzzle scientists to the present day. A possible explanation is that the haplochromines of Lake Edward require a specific kind of biotope in order to live and reproduce successfully and/or that for some reason they cannot swim against the current of the Kazinga Channel which flows from Lake George into Lake Edward. The fact that visibility is virtually nil makes it impossible to make any underwater observations in either lake or channel to confirm or refute this hypothesis.

The areas where I personally collected a variety of *Haplochromis* species in Lake George lie on the western shore near the towns of Hamukunga and Kasenyi, and in the south at Kashaka Bay. The only place where I collected in Lake Edward was at Katwe Bay. This proved to be a very fruitful collecting area, for over 12 species were collected in water less than 60 cm deep at the shoreline, while several other species were seen and photographed after being fished out of the open waters of the lake by local fishermen. With the help of some locals we combed a two metre long by one metre high minnow net through the grasses along the shoreline, with one person on each end of the net. Approximately 50 to 100 fishes were captured at each pass. The majority of the fishes caught using this method were cichlids, followed by several specimens of a *Barbus* and an *Aplocheilichthys* species. Occasional juvenile *Clarias* catfish and *Ctenopoma* were caught as well. We sampled using this method along approximately 1000 metres of shoreline in Katwe Bay. Some of the cichlids most commonly captured using this collecting method were *Haplochromis squamipinnis* and *H. aeneocolor*. Young *H. squamipinnis*, ranging in size from 3 to 12 cm, were caught with every scoop of the net. They were also found in the Kazinga Channel and Lake George, being somewhat less common in the channel. Regan, describing this cichlid in 1921, gives the largest size as 202 mm standard length. Apparently, males and large non-breeding females occur in the open waters of the lake. We actually saw large, 25 cm total length, specimens in fishermen's boats when they came in

Top to bottom: *H. sp.* "red edge Edward", *H. cf. labiatus*, *H. sp.* "Katwe", *H. sp.* "all red", and *H. sp.* "big eye Edward" (an open water species). All these species are from Lake Edward.

from fishing in open waters. Greenwood states that all individuals examined measuring less than 12 cm standard length were immature, but I caught a brooding female no larger than 7 cm total length with approximately 90 fully developed young inside her mouth.

Haplochromis aeneocolor was also a common catch not only at this location in Lake Edward but also in the Kazinga Channel and in Lake George. *H. aeneocolor* is perhaps the most striking *Haplochromis* collected by us at these locations. Some variations in body shape were seen and one dark variant was found (see photos).

Haplochromis elegans and *H. limax* were caught less frequently while only one specimen of *H. cf. labiatus* was netted. Females of all the stout-bodied *Haplochromis* were so similar in appearance that it was impossible for me to match any of them to any of the males by casual observation.

One exciting find was a *Haplochromis* that may be *H. mentatus*. All 9 individuals caught had a pleasant metallic golden sheen over the whole body, including the fins. They seem to be most closely related to *Haplochromis squamipinnis*, with the most obvious differences between the two being the more slender body, more horizontally angled mouth, and differing body coloration of *H. mentatus*. A less obvious difference is tiny scalation on the base of the dorsal and anal fins in *H. squamipinnis*, a feature absent in *H. mentatus*. We caught only four specimens of *H. mentatus* in the central area of Katwe Bay.

I have been unable to identify several other *Haplochromis* netted out of the shallows of Lake Edward at Katwe Bay and shown in the accompanying photos. Because the work done so far on the haplochromines of this lake is limited in scope and lacking in detail and illustrations, it is very difficult to key out most of the species found there.

The most interesting finds were those which local fishermen caught in the open, deeper waters of northern Lake Edward. Most appeared to have a piscivorous nature as can be seen from the photos. *H. sp.* "big eye Edward", a small black specimen with a small, short, pointed mouth (photo page 60) may be a representative of the open water planktivore community of *Haplo-*



Top to bottom: *H. sp.* "yellow snout predator", *H. sp.* "brass", *H. sp.* "red fin predator", *H. sp.* "large mouth Edward", and *H. sp.* "open water predator". All these species are from Lake Edward and were caught in the open water. Photos by Mark Smith.

chromis. Once again, it seems abundantly clear that the open waters of Lake Edward harbour a significant number of new species of *Haplochromis*.

My collecting in Lake George yielded a smaller variety of haplochromines. *Haplochromis squamipinnis*, Lake George's only truly piscivorous *Haplochromis*, and *H. aeneocolor* were the most commonly captured species, as in Lake Edward. One surprise discovery was made at Kashaka Bay where a large —20 cm total length— female *H. squamipinnis* brooding 200 young was captured (see photo) in less than 60 cm of water. Another interesting find at Kashaka Bay was *H. petronius* (see photo). A strange situation exists regarding this species: scientific collections of this cichlid consist only of males. Even with extensive collecting throughout Kashaka Bay and the rest of Lake George, no females have yet been located. This *Haplochromis* is the only known species from this lake that develops a steeply sloping forehead as it matures.

Unfortunately, due to my limited collecting equipment, I was unable to collect any of the open water *Haplochromis* from Lake George. One open water cichlid, *Haplochromis oregosoma*, is perhaps the most spectacular cichlid at present known from Lake George, at least according to Greenwood's description in 1972. He describes its coloration as having metallic purple on the back, shading to turquoise on the sides, with a silvery belly, black pelvic fins, and a scarlet-coloured caudal fin. Obviously a strong candidate for the aquarium hobby. Perhaps a sufficient amount of interest will be generated in the future to make such unknown and beautiful cichlids available for us all to enjoy in our aquaria.

During our brief excursion to these two lakes it was very rewarding to observe first hand a neglected group of cichlids overshadowed by the better known and more popular species of Africa's great lakes.

My sincere thanks go to Mr. Kaana Mbagi of the Fisheries Department at Kasese for permission to collect and photograph the haplochromines of Lakes Edward and George. I am also grateful to the Masereka family for providing me with lodging near Kasese and for their generous hospitality.

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Katwe Bay in Lake Edward, Uganda. Photo by Mark Smith.

CENTRAL AMERICAN CICHLIDS

Thorichthys meeki in the wild

Juan Miguel Artigas Azas

Introduction

Ever since I saw the cover of "*Encyclopedia of Tropical Fishes*" (Axelrod & Vorderwinkler, 1974) showing a superb photograph by Hans Joachim Richter of a glorious male *Thorichthys meeki*, with his gill covers and membranes complete extended in a menacing pose, I wanted to know more about this fish. I was astounded to find out that it is found in Mexico, my own country. From that moment I was determined to go collecting it one day.

Years have passed, and to this day my admiration for this fish, which is commonly known as the "Firemouth", has never ceased, and I have actually collected and observed it many times in

several parts of its natural range. Even now I have a breeding pair of this magnificent cichlid, which I collected in the Río Candelaria, Campeche, swimming in my aquarium.

Taxonomy

The genus *Thorichthys* was erected by Seth Eugene Meek in 1904 for a group of small (no longer than 15 cm) Central American cichlids with a deep and laterally compressed body, a small mouth, and dorsal and anal fins produced into long filaments, which are also present at the outer corners of the truncate caudal fin. A distinctive feature of this genus is the presence of a black ocellated blotch on the sub-opercular



Previous page: A Firemouth male in his territory in a Río Pichucalco tributary.
 Right: A pair of *T. meeki* guarding eggs laid on a leaf.
 Below: Aqua Dulce, a tributary of the Río Pichucalco.
 Photos by Juan Miguel Artigas.



area although such blotches are absent from one of the species, *Thorichthys callolepis* (Regan, 1905), found in the upper reaches of the Río Coatzacoalcos. These blotches are used by the fishes to deceive their potential enemies into believing that they are much larger than in reality. They do this by extending their gular pouches downwards and gill covers forwards. The ocellated blotches now resemble large eyes which are registered, by the other fish, as belonging to a much larger individual than expected.

The type species of the genus was designated by Meek as *Thorichthys ellioti*. Meek states that the name *Thorichthys* derives from the Greek and means "leaping fish". However, I must confess that during the many years I have collected and kept these fishes I have never seen them leaping. The local people refer to *Thorichthys* species as "Toritos", a Spanish word meaning "little bulls" referring to this cichlid's offensive behaviour in which the gill covers are pushed open and forward, accompanied by repeated short advances and retreats. It is interesting that "Toritos" resembles the word "*Thorichthys*".

Thorichthys meeki was described as *Thorichthys helleri meeki* by Brind in 1918 on the basis of aquarium specimens collected in "cenotes" (sinkholes) near the city of Progreso, Yucatán (Hubbs, 1936). The fish was called the "scarlet chanchito" and Brind describes its life coloration as "a brilliant scarlet suffusion and striping extending from the throat and lower gill covers back and beyond the extremities of the pectoral fins".

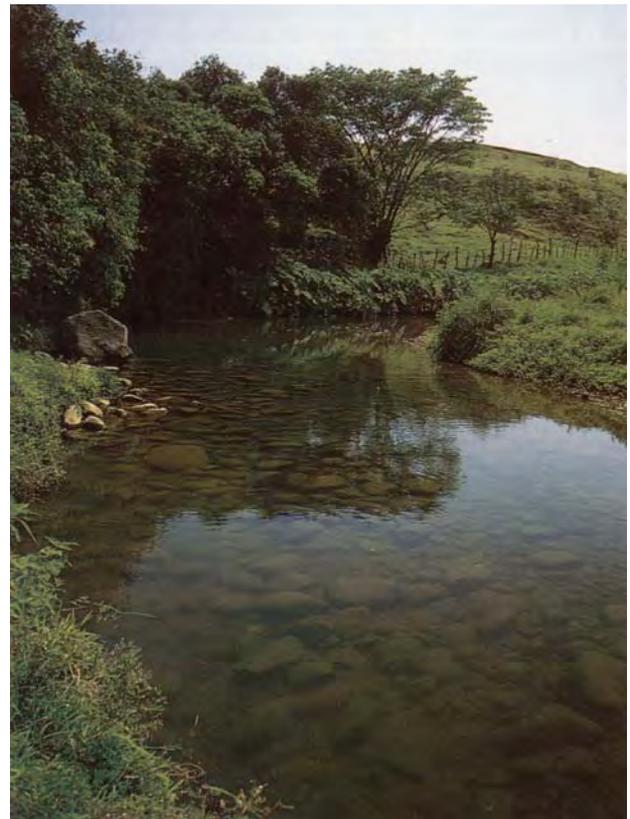
Distribution

T. meeki has a wide distribution, and can be found from the tributaries of the lower Grijalva to the upper part of the Yucatán peninsula along the Mexican Gulf. This area includes Río Pichucalco, the lagoons around the lower Grijalva and Usumacinta near the city of Villahermosa, Río Usumacinta, Río Chompán,

Río Candelaria, and the Río Champotón. Its most northerly distribution is restricted to "cenotes" on the western and northern part of the Yucatán peninsula. *T. meeki* lives in the lowlands, presenting geographical variations in several parts of its range.

Environment

The habitat of the fish is slow flowing sections of muddy rivers or lagoons with very low visibility, but also small rivers with rather clear flowing water, the clear water of deep, open natural sinkholes (cenotes), and even the shallow brack-





ish lagoons near the sea, the so-called "cienegas".

The distribution area of *T. meeki* is characterised by tropical forest, although in the areas around Villahermosa (Tabasco) large sections have been cut to create space for cattle raising, an important economic activity in the area. In this region water is abundant, but sometimes some of the ponds in which the firemouth is found—frequently in great numbers—dry out during the dry season. Such ponds fill again in the rainy seasons and are re-stocked with fishes from overflowing neighbouring ponds. The ponds are normally shallow, most of them no more than one metre deep, with muddy bottoms and murky water, and temperatures ranging from 28° to over 32° C. The only vegetation found is floating plants, most of them water lilies. The bottom of these ponds is littered with leaves and branches.

The density of fishes found in these ponds is astonishing: a throw of the casting net usually yields tens of fishes, mainly cichlids. Besides *T. meeki* the following cichlids were found in the ponds around Villahermosa: *Amphilophus robertsoni*, *Nandopsis octofasciata*, *N. salvini*, *N. friedrichsthali* and *N. urophthalmus*, *Paratheraps cf. bisfasciatus*, *Petenia splendida*, *Thorichthys pasionis*, other fishes present in the ponds are livebearers (*Poecilia velifera* and *Belonesox belizianus*), catfish (*Rhamdia guatemalensis*), characins, gobies and an assortment of representatives of other fish families.

It is in this habitat that perhaps the most beautiful geographical form of *Thorichthys meeki* is found: a fish with an intense red colour on the lower half of the body, a deep body, and a beautiful red dorsal fin. It rarely exceeds 10 cm in total length. It is also in this area that some *T. meeki* individuals (regardless of sex) show no red at all. Why this is so is unclear, but could be connected with the mood of the fish.

Riverine *T. meeki* show a slightly more elongated body form and more blue shining speckles on the flanks. The red is intense but not as much so as in those of the lagoons. In rivers *Thorichthys* are found in the slower-flowing areas over sandy bottoms littered with leaves and driftwood. In the dry season visibility in these rivers can range from one to five metres. Also in the rivers of Campeche (Chompán, Candelaria and Champotón) we find *T. meeki* together with other cichlid species: *Amphilophus robertsoni*, *Herichthys pearsei*, *Paratheraps heterospilum*, *P. synspilum*, *Nandopsis salvini*, *N. friedrichsthali*, *N. urophthalmus*, *Petenia splendida*, *Thorichthys pasionis*, and *T. helleri* (this geographical form was originally described as *Cichlasoma champotonis*, Hubbs, 1936, but later



Top: One of the many lagoons near Villahermosa, Tabasco.

Centre: *T. meeki* in the upper Río Candelaria.

Bottom: *T. meeki* freshly caught in a lagoon near Villahermosa. This population shows the deepest red colour on the chest.

Next page: A female watching over her eggs which are stuck to a leaf.

Photos by Juan Miguel Artigas.

synonymised). Representatives of other fish families are mostly the same as in the ponds of Tabasco.

T. meeki also inhabits the clear water of the "cenotes" (the word is derived from the Mayan "tzonot") and salty "cienagas" (brackish lagoons near the sea) on the western Yucatán peninsula. These sinkholes are mostly interconnected by large subterranean rivers and can be very deep — it seems that the farther they are from the sea, the deeper they are. Cenotes normally have colder water than the rivers, precipitous walls and sandy to rocky bottoms. Sometimes a weak current can be felt. A few cenotes do not seem to be interconnected and the water in these is stagnant and thermally stratified with low visibility. Hydrogen sulphide is found in the deeper areas of

to 25° C).

Biology

The observations that follow were made mainly in the Pichucalco, Candelaria, and Champotón. No observations were made in the Tabasco ponds because of the impossibility of seeing underwater. The cenotes have not been visited by me so far.

T. meeki inhabit the slow or stagnant waters of rivers and ponds, where they are normally found in groups in shallows although not actually schooling; they normally seek out the cover of overhanging vegetation or driftwood. Adult males usually hold small territories regardless of whether they are breeding or not. These territories are defended against cichlid intruders by



the stagnant cenotes, so that few fishes can be expected there. The Firemouth that we know in the aquarium hobby comes from a cienaga near the city of Progreso in the northern coast of Yucatán. I must add that this is not the most colourful variant: the red of the flanks is more like deep orange and fishes' maximum length is close to 15 centimetres.

Water chemistry in the Firemouth's habitat can be alkaline with the pH in many cases over 8.0, and hardness varies from hard to very hard. Temperatures are higher in the ponds near Villahermosa (28° to 32° C), lower in the rivers (25° to 28° C) and still lower in the cenotes (20°

showing the typical gill "flaring" pose. Physical aggression rarely takes place as the male normally manages to intimidate intruders. Females and smaller males wander quietly through the shallows looking for food. This is done by pushing their large snouts into the soft substrate and filtering anything edible out of the debris. Most of the matter taken up is expelled through the gills. *Thorichthys* are mainly carnivorous fishes feeding on small invertebrates found in the sediment.

Breeding activity normally takes place in the dry season from February to May. However, occasional heavy rainfall during this period

may "wash" away the fry and breeding efforts will have to be started all over again. The territories of males are usually found among protective cover such as water plants (water lilies or *Vallisneria*-like plants), driftwood, or rocks. Passing females are courted by the male who displays his flanks with undulating movements and open gills. A ripe female may respond to his courtship and join him in his territory. Spawning does not, however, always take place at the first encounter, as females may repeatedly respond to the male's advances then leave the territory. Once a pair has formed they start cleaning a surface—they seem to prefer a large leaf—on which the female deposits the two-millimetres long, clear yellowish eggs, numbering in the hundreds. The eggs are laid spaced from each other in typical *Thorichthys* fashion and immediately fertilised by the male. The spacing of the eggs may be to allow for maximum oxygenation in the normally low oxygen level of the *Thorichthys* habitat. Spawning may take up to two hours, and the eggs are then fanned and guarded by both parents until they hatch (two days under aquarium conditions at a temperature of about 25° C). The wrigglers become free-swimming fry after several days (four to five days in the aquarium) and at this point they swim around together under the close supervision of the parents, which lead and signal to them with spasmodic movements of the body and fins. Normally one parent stays just above the free-swimming fry while its consort scares away intruders. Should one of the couple be absent then the other will take over the breeding responsibilities alone.

T. meeki breed in colonies of several neighbouring pairs and the fry are rarely taken far away from the spawning site. They feed on organic matter lying on surfaces in the habitat, under the close supervision of the parents. Males do not abandon their fry, not even in the presence of larger threats such as a curious human. Once the fry reach about

one centimetre in length they leave their parents and go to the extreme shallows where they are found in large numbers foraging on the bottom.

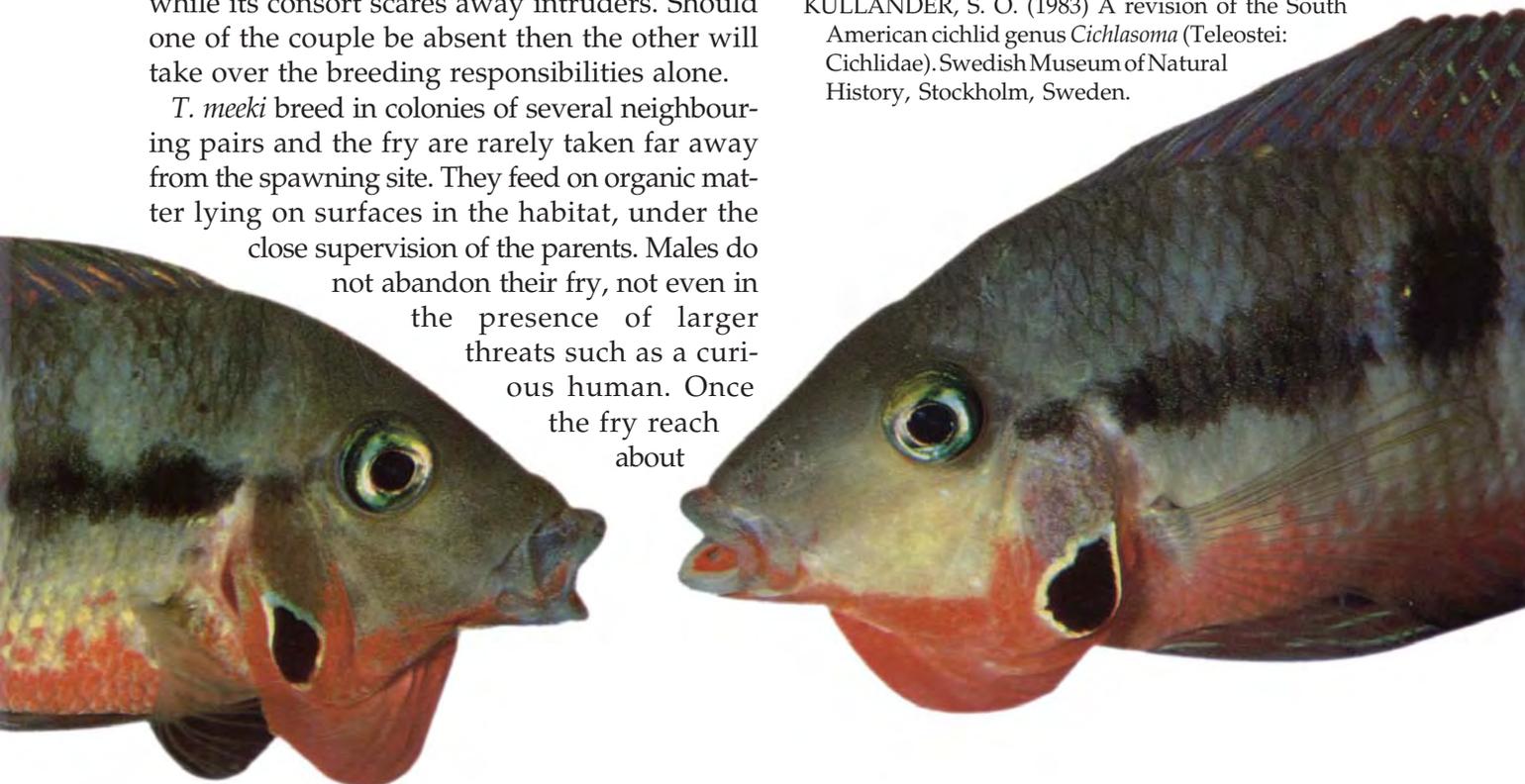
Conclusion

This fish has been popular in the aquarium hobby for more than seventy years. Its beautiful colours and interesting behaviour, as well as the relatively small tanks it demands for its wellbeing and control of aggression, will surely keep it a favourite for many years to come. Its popularity was shown last year at the American Cichlid Association's annual convention, in San Antonio, Texas, where a beautiful male *T. meeki* won best in show. The introduction of colourful geographical variants will surely help in keeping this fish around in aquarists' tanks.

I am also glad to mention that up to now the Firemouth doesn't seem to be endangered in its natural habitat, though potential dangers are on the horizon: oil exploitation, untreated industrial wastes, habitat destruction by deforestation. These potential dangers need to be closely monitored in order to keep these "little bulls" alive in their natural range as well as in captivity.

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The Champotón Firemouth

Willem Heijns

Thorichthys meeki, also known under the name of Firemouth Cichlid, is one of the most popular cichlids of Central America and is sometimes even kept in a community aquarium. Its popularity has made it a commercially attractive fish and for this reason most of the *T. meeki* available in pet shops nowadays are bred in the Far East. Aquarists who confuse "imported" with "wild caught" are duly warned.

With the start of the "cichlid-expeditions" to Central America—in the early eighties— wild caught *T. meeki* were among the trophies brought home. Only then did we realise the differences between inbreds from Singapore and wild-caughts. These differences lie mainly in the ability of the fish to demonstrate its mood by changing its colour pattern. "Import" *T. meeki* always show the red colour but wild caught individuals only during courting or breeding. However, when fed appropriately and given suitable accommodation and conditions, wild caught Firemouths also exhibit the colours which justify the popular name.

T. meeki was first described, by Brind (1918), as a subspecies of *T. helleri*, but later received full specific status, and when *Cichlasoma hyorhynchum* (Hubbs, 1936) was designated a synonym, the distribution of the Firemouth extended from the north of Yucatán to a large area in the south

of Mexico, as well as Belize and a part of Guatemala. There are several geographical races known from this rather large area.

In March 1994 I accompanied Ad Konings and Juan Miguel Artigas on a trip to southern Mexico. The aim of the expedition was to photograph the cichlids in the Río Candelaria and surrounding drainages. One of these was the Río Champotón (see map page 73). We arrived at Ulumal, a small village on the river, as it was getting dark. We followed some teenagers who were going to the river to cool off. Their splashing around obviously did not frighten the cichlids as Juan Miguel was able to catch some *Paratheraps bifasciatus* and *T. helleri* with the cast net. All the cichlids we caught showed a pale unattractive coloration. The casting gave rise to some hilarity among the teenagers, but whenever the net got stuck they jumped in and released it. It was impossible to see in the water: the visibility must have been less than 10 cm. Because of the high conductivity—more than 2000 $\mu\text{S}/\text{cm}$ (the maximum on my meter)—salt crystals floated in the water and had also covered the submerged substrate.

Next morning we decided to investigate a small tributary of the Río Champotón. On the road to Ulumal we had seen a small bridge made of steel piping and we found that the water in the stream flowing underneath was much clearer than in the main river. There was a convenient parking place alongside the stream and before long both Ad and Juan Miguel were dressing themselves for a dive. Because I had caught a bad cold I restricted myself to photographing above water. Since I had to wait I measured the water chemistry (which we usually do after diving) and found that it differed from that of the main stream; the conductivity was still



very high: 1840 $\mu\text{S}/\text{cm}$; the pH was 7.5 and the temperature 25° C (at 10 am). The bottom of the stream consisted of gravel and rock covered with a layer of leaf litter. There were waterplants as well. I found hornwort (*Ceratophyllum*) and some water lilies.

After the photographic session it was time to catch some of the cichlids which were found in this stream. Juan Miguel, our specialist with the cast net, quickly landed some *Paratheraps synspilus* (some of them with blue spots), *Nandopsis salvini*, *Amphilophus robertsoni*, and two *Thorichthys* species. One of these was a variant of *T. helleri* (or is *T. champotonis* (Hubbs, 1936) a true species?). The other species was a Firemouth with a colour I had never seen before: the red colour was found on almost all of the body in some specimens and in others it was more orange than red. The background coloration was grey-blue and there was a distinct black blotch on the body. There was no doubt in my mind: I had to have these fishes and I was able to bring home five of them.

In my fishroom wild caught usually spend several weeks in quarantine, but all the Mexican cichlids I brought home proved to be too aggressive among themselves after they had acclimated to the confines of my tanks. I had to separate them more and more and I spent months moving the fish around from aquarium to aquarium. In the end practically every individual had its own tank or was confined to part of one by a divider. Two of the Firemouths that initially tolerated each other in the same tank turned out to be both males, so peace reigned for only a short time. One of the two was exchanged for an individual with shorter fins and a somewhat stockier build —both characteristics of female *Thorichthys*— and the result was successful. A few days later I removed the divider and everything

seemed well (even so I kept a close watch on them). They spent the first few weeks fighting their reflections in the glass and it looked as if one was fighting the mirror image of the other. During such displays both male and female showed their best coloration.

The pair spawned without any visible form of courtship. The eggs were deposited on the far side of a stone where I could not see them, but the typical fanning of the female betrayed her having eggs. Despite the lack of target fishes in the tank the pair harmonised very well and both transferred the larvae to a brooding pit as is commonly the case in many substrate brooders. This pit was likewise invisible to me but again their behaviour betrayed them. Not until the fry were free-swimming did I realise the size of the spawn: to my immense surprise I estimated that there were at least a thousand fry! This unexpectedly high number was even more surprising considering that it was their first spawning. During the first few days many fry died, so in order to try and save this attractive variant of *T. meeki* for the hobby I fed them copious amounts of brine shrimp nauplii. Three weeks later I tried switching the fare to frozen *Cyclops* —I have had problems doing this with other cichlids— and the juvenile *T. meeki* accepted it without blinking an eyelid. Nevertheless I decided to farm 500 juveniles out to a professional breeder. I hope this will suffice to ensure the survival of the Champotón Firemouth.



Previous page: A male *T. meeki* from the Río Champotón drainage.
Right: The collecting site of our Champotón Firemouth (Ulumal, Yucatán).
Photos by Willem Heijns.

Nandopsis beani (Jordan, 1888)

Mark Szot

Mexico is the home of many beautiful and interesting cichlids and *Nandopsis beani* (Jordan, 1888) is one such fish. *N. beani* is rarely imported as an aquarium fish, but through the breeding efforts of cichlid enthusiasts this species is now more readily available.

N. beani was first described as *Heros beani* by David Starr Jordan in 1888 from specimens collected by Alphonse Forrer from the Río Presidio, near Mazatlán, Mexico. Jordan named this species in honor of his friend and fellow ichthyologist, Dr. Tarleton H. Bean, in recognition of his researches in American ichthyology. *N. beani* is commonly referred to as the "Sinaloan cichlid" (Mojarra Sinaloense in local terminology).

Nandopsis beani occurs along the Pacific slopes of Mexico. In its natural habitat, it occupies the quiet waters of mainstream rivers, creek mouths, sloughs, and backwaters of the federal states of Sinaloa and Jalisco. More specifically, *N. beani* occurs in the Río Chico and the Río Elota. The range extends from the Río Grande de Santiago to the Río Yaqui. Of the cichlids of the Pacific rivers of Central America, *N. beani* has attained the greatest northern penetration.

Most species of *Nandopsis* are renowned for

their aggression, and *N. beani* has to be grouped with the most aggressive of the genus. Despite its aggressive behaviour, *N. beani* is gaining popularity among the fanciers of "Guapote" species. This attractive predator is capable of reaching 38 cm in total length; and its size may appeal to many. *N. beani* may not be one of the largest of the Guapotes, but it makes up for it in attitude.

This deep-bodied species has a fairly typical Guapote profile. The head is broad and the snout short and pointed, and the mouth sports an impressive set of large, red, conical teeth. *N. beani* is an attractively marked sexually dimorphic cichlid. Captive aquarium-raised males can reach 30 cm total length, while females tend to attain a smaller total length of 20 cm. The base colour is copper with a beautiful mosaic-like pattern of black spots and metallic bronze markings. After courtship, when the eggs hatch, the female undergoes a dramatic colour change. The dorsal fin and the flanks display a distinctive charcoal-black coloration.

N. beani prefers slightly alkaline water with a pH range of 7.0-7.4 and a water temperature ranging from 24° to 27° C. In its natural habitat it is a generalised feeder and its diet probably



Left: A male *N. beani* guarding over a clutch of eggs. Right: A female guarding fry. Photos by Mark Szot.

consists of detrital matter, invertebrates and aquatic vegetation. A captive *N. beani* has a healthy appetite and will accept a wide variety of prepared foods. A typical diet should include flake and pelleted foods as a base. Supplemental feedings of freeze-dried and frozen foods are beneficial, especially when conditioning for breeding. Occasional feeder goldfish are eagerly welcomed.

N. beani is a substrate-brooding species. Spawning occurs in the fashion characteristic of Central American cichlids. Once two *N. beani* have paired a spawning site is selected and cleaned rigorously, with large amounts of gravel being moved. The female deposits the eggs on a flat horizontal surface and the male then fertilizes them. The bulk of the brood care is performed by the female, while the male patrols and defends the surrounding territory. The eggs hatch in three days at 26° C and are moved by the female to a pre-dug pit. The wrigglers are free-swimming five days later. The fry grow quite rapidly with regular feedings of crushed pellets, flakes, and newly hatched brine shrimp. Fry can reach 2.5 cm by two months post hatching. At this time females are generally ready to produce a new clutch of eggs.

Obtaining a pair of *N. beani* is best achieved by beginning with six juveniles and allowing pair selection to occur naturally. In view of their potential size, juveniles ranging from 10-13 cm in total length, should be housed in at least a 250 litre aquarium, as the risk of fatalities is high among conspecifics. Keeping adult individuals will require the incomplete divider method which entails separating the pair with a clear divider raised 2.5 cm from the aquarium bottom by placing a piece of slate under the divider.

The female will use the piece of slate as the spawning substrate and the male will fertilize the eggs from his side. Although the fertilisation rate is lower employing this method it is popular among cichlid breeders because there is no

risk to the female. I prefer to allow my divided pair together, but only after the ovipositor of the female is clearly visible. I remove the male after spawning has taken place.

Due to the extremely aggressive behaviour of *N. beani* it is recommended that pairs be observed closely after spawning commences. Female *N. beani* are zealous in caring for their eggs and are notorious for killing their mates during this period.

An interesting observation regarding *N. beani* has been made a few times by Ken Winton of the Arizona Sonora Desert Museum. Two different pairs of *N. beani* were observed breeding and once the fry became free-swimming the female would quickly ripen with a new clutch of eggs and spawn again with the previous fry present. The interesting part of this observation was that the male and female would each select a different brood to protect and eventually would turn on each other and each others' brood. Subsequently this behaviour lasted until one parent was killed. This is consistent with the zealous parental behaviour demonstrated by *N. beani* when fry are present.

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In quest of the Golden Mojarra (*Herichthys bocourti*)

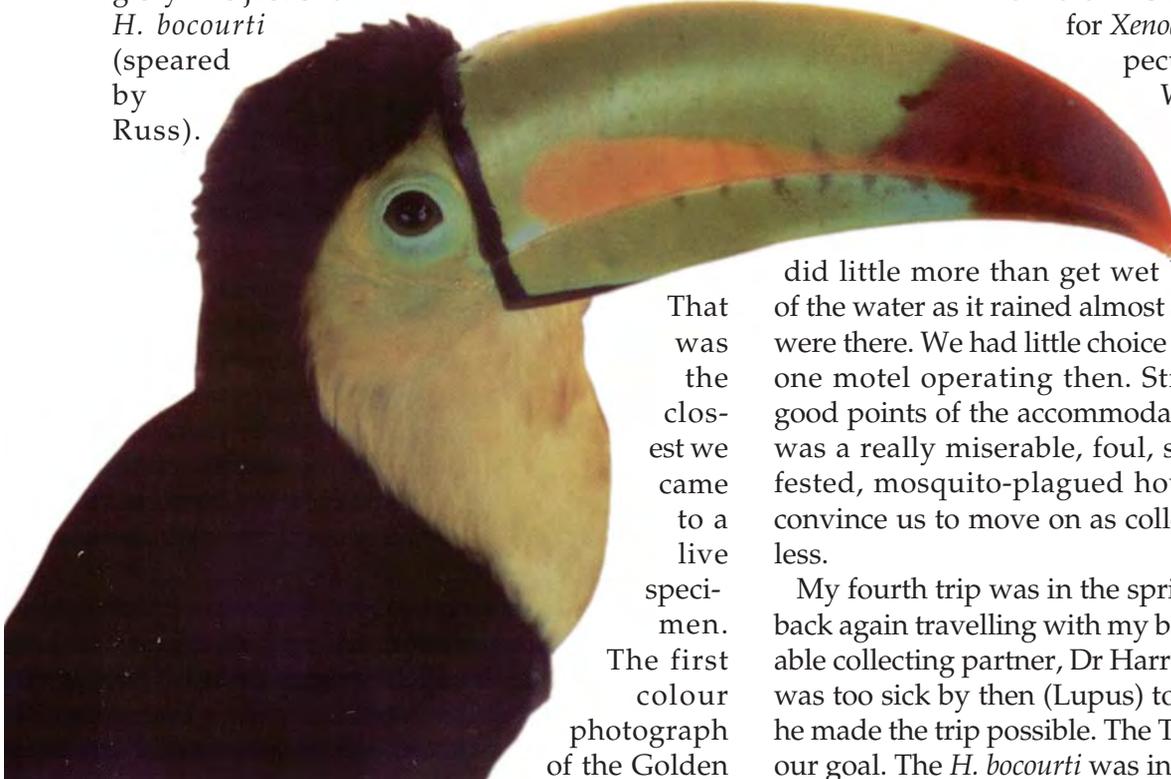
Ross Socolof

In 1978 the late Russell Norris of Belize sent me a black and white photograph of an unknown Belizian fish. He was near the village of San Antonio in the Toledo section of Southern Belize, and had stopped his car to look at a string of fish a young Mayan boy was carrying. I knew the fish was almost certainly a cichlid. It was one I had never seen and not on any list of fish to be found in Belize. I sent the photograph to Dr Robert R. Miller telling him that the fish had come from the Moho River near San Antonio in southern Belize. He promptly identified it as *Cichlasoma* (*Herichthys*) *bocourti* Vaillant & Pellegrin, 1902 and noted that its previously known range extended north only to the Sarstoon River which borders Guatemala and Belize. The Sarstoon was more than fifty miles south of the Moho and the Temesh River was between them. It was not supposed to be where it was caught.

It was not until 1982 that I wrote and asked Russ if he could join me in April of 1983 (the dry season) in an effort to obtain this fish. We would collect in the Moho River. *H. bocourti* had never been seen alive outside of its limited habitat. He agreed. I invited Dr Harry Specht and the late "Red" Nichols and both agreed to join us.

We got to the Moho river with the help of a stout 4-wheel-drive vehicle. The crowning glory was just one

H. bocourti
(speared
by
Russ).



That was the closest we came to a live specimen. The first colour photograph of the Golden

Mojarra (that fish) appeared in Freshwater and Marine Aquarium (FAMA, April 1984). It was a beauty with a spectacular gold-black striped body.

Our second attempt to collect the Golden Mojarra was two years later. This time Russ Norris and I went alone to the Lake Isabel - Río Dulce area in Guatemala where all of the relatively few preserved specimens had been captured. Much help on this project came from Dr Miller and Dr Reeve Bailey at the University of Michigan where there is an enormous collection of preserved Guatemalan fish—over fifty thousand—in the Zoological Museum. Russ and I spent a week working hard with no results. The only progress made was locating one adult specimen in a native market in Puerto Barrios, Guatemala. Puerto Barrios is on the Caribbean coast and apparently *bocourti* enters brackish waters as does *Vieja maculicauda*, which I know from experience can do well in sea water. I left discouraged, but never for a moment considered abandoning this self-imposed task. I intended to keep trying until somehow we could get the fish into the hobby. It is a very unusual and handsome species.

My third try was in 1989 with another wonderful friend and companion, Jaap-Jan De Greef.

We were in Guatemala looking for *Xenodexia ctenolepus* (a peculiar livebearer).

We set aside two days to try and catch the Golden

Mojarra. We

did little more than get wet both in and out of the water as it rained almost all of the time we were there. We had little choice as there was only one motel operating then. Stressing only the good points of the accommodation I must say it was a really miserable, foul, smelly, roach-infested, mosquito-plagued hovel. This helped convince us to move on as collecting was hopeless.

My fourth trip was in the spring of 1991. I was back again travelling with my best and most capable collecting partner, Dr Harry O. Specht. Russ was too sick by then (Lupus) to come along, but he made the trip possible. The Temesh River was our goal. The *H. bocourti* was in the Moho and in



the Sarstoon and the Temesh was between them. As far as I know it has never been fished.

The Temesh River is a difficult spot to reach. The area is mostly unexplored and very inhospitable, with great amounts of bog and savannah land. It is inhabited by Quiche Mayan indians. They speak only Mayan and a little Spanish. The Temesh River could not be reached by road. Some years earlier the most important bridge had washed out and had never been repaired. It had to be reached by water. Russ knew the Bishop of Belize. He also knew that the only people who regularly visited the indian villages were the Catholic lay preachers and teachers sent there by the bishop. Russ set up a meeting with the bishop who solved all of our problems.

A lay preacher named Benito Juarez would meet us in Punta Gorda—the last settlement in southern Belize—in two days. The meeting place would be at the Beatrice Motel. He would, before we met, arrange a boat with a competent guide. It all happened. The motel was clean and had indoor plumbing. After we had unpacked we were both jolted by a fearful din. Outside our window, which faced the town square, a scaled-

down replica of Big Ben had just been erected. It had a clock on each face. It banged every fifteen minutes night and day. Our room was less than 50 feet from the "banger". As if that wasn't enough torture, one of the four clocks was off by five minutes.

This resulted in a double dose of the infernal clanging. Amazingly we somehow managed enough sleep with our heads under instead of atop the pillows.

We were up and ready by 6 am. We would be leaving at first light and would enter the Temesh River after running south for two hours. We should have many hours for collecting before leaving in time to get back before dark. This was really important as we would be navigating among, above, and around coral heads. These were well known to Antonio who knew the way through, but only a madman would try it after

dark. It all sounded too easy and rightly so, as we had embarked on a collecting nightmare.

We reached the river and started up. It was calm and hot and we expected to get quickly away from the mangrove jungle that completely concealed the shoreline. We ran for hours (three) and then finally the mangroves started to thin and soon disappeared. It was then just past noon and we hadn't got wet. The shoreline was unique and totally inhospitable; the water murky. There was never anything like a beach. Getting out of the boat where the land and river met resulted in a plunge into cold cream, which is what we call the thick mud-like detritus that builds up in some places. It makes it impossible to work. I have been in it when it was five feet deep. It is terribly dangerous. Harry hung on to me as I probed over and over, and exhausted himself pulling me out of the thick, sticky, smelly glop.

That is the end of the story. We never got a real opportunity to even try. The river had very few small streams entering it. We tried all of them with the same dismal result. All this time we never saw a living soul. We kept going west trying to find a place to collect and finally had to

turn about in order to return before dark. We got back to Punta Gorda with no time to spare. We had run into headwinds, pounding seas —we had a large dugout— and lots of rain. I had a death grip on an empty gas can all the way back as I was sure we would get dumped any minute. We made it back totally wiped out. To make the day complete, when we got to the motel the water was off. My body was caked with stiff grey itchy Temesh cold cream mud topped with loads of dry salt spray. The water came on at 3 am. I didn't tell Specht until I had cleaned myself. We are such close friends that I didn't want to have to fight him to the death for first use of the water. I know the bell was banging that night, but we never heard a thing.

The Temesh deserves to be collected and if you do go, prepare to make it all the way up the river to the largest of the indian villages where I am sure collecting would be possible and probably

great. You must prepare yourself for an over-night stay, and ear plugs, mosquito netting, and repellents must top any list of supplies. Our guide was a fisherman named Antonio who was half Mayan and half Spanish. He spoke both languages perfectly as well as English.

We were back in Guatemala in April of 1994. This time Harry Specht and I added a new weapon to our arsenal. The weapon was Rusty Wessel. He is a relatively young (Specht and I together are 140 years old!), six foot three, flaming red haired native of Louisville, Kentucky. Rusty is also an irrational cichlid fancier who supplied the energy we have been losing in recent years. At my urging he had, with Thom Grimshaw of Belize, collected the area for just one day in 1993 with no success at all.

It was my fifth attempt to capture *Herichthys bocourti*, the Golden Mojarra. The original Spanish version of the common name, "Mojarra de Oro", comes from the commercial fishermen at Agua Dulce. I had now been at this task for sixteen years. We were armed with new collecting site information and, surprisingly, I was still convinced we would finally succeed and get living specimens.

We stayed at a new place called Marimonte. It was a wonderland compared to the wretched place Jaap and I had been forced to take in 1989. It had been built on the site of the motel Russ Norris and I had been at 11 years earlier. It is located on the shore of the Río Dulce just



Above: Eating size *Vieja maculicauda*.
 Right: The locality where *H. bocourti* was collected.
 Photos by Rusty Wessel.
 Next page: The author (right) and Rusty Wessel taking a break under a giant jungle tree. Photo by Dr Harry Specht.

half a mile from the entrance to Lake Isabel. The shoreline at Marimonte is hospitable. It was one of the locations where *H. bocourti* had been taken many years before. Dr Miller told me that he had been there 25 years earlier and collected and preserved *H. bocourti*. They had at that time employed a six hundred foot (180 m) seine and even with that they had captured only a few specimens. Our seine was twenty feet long (6 m). We arrived and checked in at dusk. Before doing anything else we headed for the shoreline with a combination of our cast net, a seine, hand nets, and push nets and came up with a good collection.

Besides the elusive Golden Mojarra we caught the following cichlasomines in this area: *Thorichthys aureus*, *Archocentrus spinosissimus*, *A. spilurus*, *Nandopsis octofasciata*, *N. managuensis*, *N. salvini*, *Vieja maculicauda*, and *Amphilophus robertsoni*. The pH was 7.8 to 8.2 and the water temperature about 26° C (80° F). There are not many areas in Central America where nine species of cichlids can be caught. Harry was happy as he managed to catch one female *Carlhubbsia stewarti*, an unusual and seldom seen livebearer. This was one of his target fish.

We cleaned up and went to supper. The Marimonte had a wonderful open-air, thatched-roofed restaurant. There were very few guests. The two tame raccoons in residence seemed to own the restaurant. They put on a great show. The best fun was when they attacked the only other table and stopped stealing from ours.

Aqua Dulce supports a native commercial fishery for Black Belt Cichlids (*Vieja maculicauda*). There are at least 25 families engaged in catching huge Black Belts for a ready local market. They grow larger there than we ever would have imagined and adults get to three pounds. The biggest were 14 inches (35 cm) in length. The Marimonte restaurant served a whole large Black Belt baked in an ambrosia-like sauce. It was wonderful and we ate it



every night.

In the morning when Harry found his one female *Carlhubbsia* dead I started to get bad vibrations. We fished hard all day long and did not catch another *Carlhubbsia* which should have been easy. We also did not see anything like *bocourti*. We had a couple of extra beers that night and determined to break the jinx the next day.

We had hired a boat to take us to areas we could not reach any other way. We left before the sun was up. The most important collecting tool turned out to be the colour picture of the 1984 specimen. We had no luck for hours and started checking the local boats that we passed to see what they had caught. We found one larger (3-man) boat using a gill net instead of the usual hand lines. They had eight large Snook and a five foot Tarpon aboard plus some grown *Rhamdia* catfish and several *Dormitator* gobies (the very large sleeper gobies). I showed them the photograph. From that point on things happened fast. They knew the fish. They hadn't caught any in a long time. They said we might find some at the bay near town where all the commercial fishermen unloaded and sold their catch. It was now almost 9 am. Our boatman knew where to go and we were off to see if we could learn something. We found ten or more dugouts there. The best fishing was over for the day. These commercial fishermen all knew the fish.

We learned it was called Golden Mojarra and was not found often. That information didn't surprise Harry and I. In fact few had been taken in the previous weeks and none had been taken that day. Then the miracle happened. A late boat showed up. He had a good catch. His fish were in a small amount of water in the bottom of the boat. They were dead and dying. There were Golden Mojarra amongst them! The fisherman must have thought we were possessed. We were rude and loud and moving in all directions at the same time; in seconds all the *bocourti* had been separated from the catch which consisted mostly of *V. maculicauda*. We had nine half-dead specimens fighting for life in plenty of fresh water. We paid eighteen Quetzals

Above: A prized catch: a young adult *Herichthys bocourti*. Photo by Ross Socolof. Below: A juvenile *H. bocourti* in the aquarium. Photo by Rusty Wessel.



(almost three dollars) for the nine fishes. We then hired a young man to guide us to the area opposite the Castillo (old fortress) where these had been caught. This is the entrance to Lake Isabel. We wanted to try to get more as the nine we had were in a very bad state. First we raced back to our room to keep the fish cool. We medicated and had airstones going vigorously. Not surprisingly four were already dead. They were quickly preserved.

Our attempt to catch more specimens failed. We felt we had to rely on the five we hoped would survive. Many times we had speculated as to what juvenile Golden Mojarra would look like. I do not think any had ever been caught.

We were leaving early in the morning to drive to Coban where we would try to collect from the western side of the lake where the Golden Mojarra had been recorded in the past. The Río Polochic is a feeder stream entering Lake Isabel from the west and that was where we were going.

I had been nursing an infected ear and reluctantly agreed to help Harry catch *Carlhubbsia stewarti* which had not turned up again. Rusty showed up just as we were leaving and volunteered to take my place. The five adult *H. bocourti* looked like they might make it as all but one were erect with fins in action. In less than thirty minutes Rusty and Harry floated in. Their feet did not touch the ground. Their faces glowed with excitement. They had caught what were undoubtedly baby *bocourti*. I looked and agreed.

These juveniles were a half to three quarters of an inch (1.3 to 1.9 cm) in length. They are completely unlike their parents and again a very different and very attractive fish. Before the seine pull that yielded the juvenile Golden Mojarra Harry had got a large number of *Carlhubbsia stewarti*. It was an extraordinary day that I had waited for for sixteen years.

When we left in the morning for Coban we had four adults still alive and all of the babies. Rusty Wessel has them now in Louisville, Kentucky, where they are prospering. If our plans work out young will shortly be available for distribution into the hobby.



SOUTH AMERICAN CICHLIDS

The state of confusion in *Discus* taxonomy

Anthony Inder Mazeroll¹ & Marc Weiss²

In a paper that appeared in *Tropical Fish Hobbyist* in 1991, Dr. Warren Burgess posed two questions on the taxonomy and systematics of *Discus*: 1. Could the *Symphysodon discus* Heckel found outside of the Rio Negro be evidence for a much greater historical range of this species? 2. Could *S. discus willischwartzi* be a natural hybrid between the two *discus* species, viz. *S. discus* and *S. aequifasciata* Pellegrin?

We have in our possession wild fish that have the body coloration of a blue or brown *Discus* (*S. aequifasciata*) but also the wide accented 5th bar as is seen in the so-called "Heckel" *Discus* (see photos pages 78-81). What do these signify in the taxonomy of *Discus*? Are they natural hybrids of the two species or do they represent a new species or subspecies of the genus? In this article we want to examine these questions and then begin to describe the techniques involved in answering them.

Let us first look at the present status of *Discus*. At the present time two species of *Symphysodon* are recognised with the taxonomy based almost exclusively on colour and locality. *S. discus* has 9 vertical bars on the body with the 1st, 5th, and 9th bar being predominant, and the 5th the widest. The other bars tend to be very faint and at times not present at all. This species is found primarily in the tributaries of the Rio Negro. *S. aequifasciata* is found primarily in the western portion of the Amazon River drainage. Body counts (scale counts, number of fin rays, and

number of vertebrae) tend to overlap. There are a few differences that will be discussed a little later. With only two species in the genus the taxonomy should be very clear-cut. Nothing could be further from the truth. The primary reason for this is that the full ranges of the two species and their described subspecies are still unknown. And in some cases the localities that have been published may be false. If you have found a beautiful wild *Discus*, would you want everyone else to know exactly where that fish came from? Also, locality data may be hard to actually pin down. One tributary looks like another in the Amazon basin. To pinpoint exactly where one morph is found may be close to impossible. This is one piece of the puzzle that we need to answer any questions on the taxonomy of *Discus*, and the information is hard to come by. Collections in every tributary of the Amazon basin will be needed to get a proper answer. This will take time, lots of time!

What is a species anyway?

This is a question that has perplexed science since the days of Linnaeus. You ask a number of people what a species is and you may get as many answers back. Science has recognised 5 basic species concepts. The Typological Species Concept says that species are entities that differ from all other entities. They have also been unchanged since the beginning of time. But this concept leads to much confusion in describing complex species: if a species has two different colour varieties, two different species names can be given to the two different forms.

Morphological Species are entities that differ

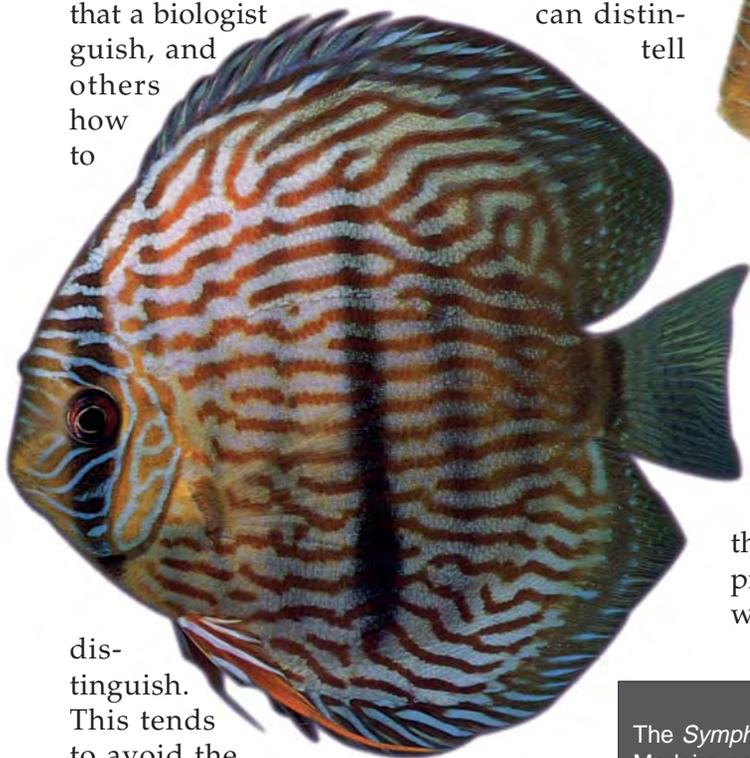
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sharply from others in structural characteristics (eg number of scale rows, number of vertebrae). How sharply do they have to differ before they will be considered two separate species? How many characters do you use? In reality, the more differences you find the more robust your argument is. So what about two characters? Is that enough?

For many years the standard species concept was the Biological Species Concept. This states that a species is a group of interbreeding natural populations that are reproductively isolated from other such groups. But what about those that reproduce by asexual means. There are many Poeciliids (livebearers) that reproduce by means of asexual reproduction (parthenogenesis). How can we relate these to this concept? Every individual could be considered a species. Also, how fertile or infertile do hybrids have to be? Many closely related species can produce some fertile offspring or offspring whose fertility is slightly reduced. How much fertility is needed to be considered a "good species"? So science had to come up with a concept that would take these species into account. That being the Evolutionary Species Concept. This states that a species is a lineage evolving separately from other species and with its own unitary evolutionary role and tendencies.

The concept that tends to be the most widely used nowadays is the Practical Species Concept. This concept says that species are those samples that a biologist can distinguish, and others how to

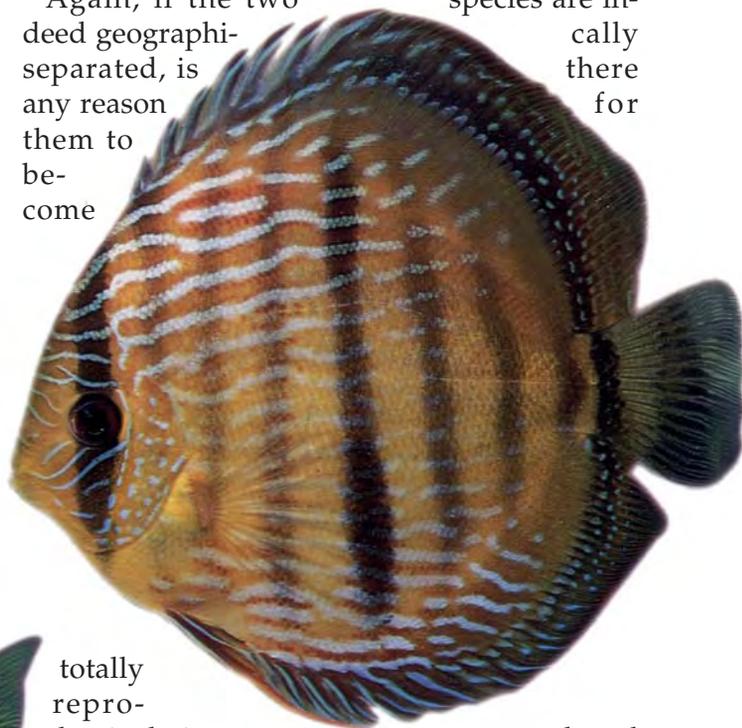


distinguish. This tends to avoid the basic issues and

says nothing about the mode of reproduction of the organism or how closely related it is to others in the group.

For sexually reproducing organisms one of the basic tests to determine if two species are indeed distinct is whether or not "naturally" occurring hybrids exist. If hybrids do exist, are these as fertile as the parental species? It has been known since the time *Discus* first appeared in the aquarium trade that, when crossed, the two species may produce fertile offspring. So again, is *S. discus willischwartzi* a natural hybrid? In order to test this using supposed hybrids, you must determine whether or not they have statistically the same reproductive viability as the parental species. If *S. discus* x *S. discus* have on average 150 viable offspring and *S. aequifasciata* x *S. aequifasciata* have on average 200, what does it mean if *S. discus* x *S. aequifasciata* have on average only 140 offspring? Is this enough of a reduction in viability to maintain the taxonomic *status quo*?

Again, if the two species are indeed geographically separated, is there any reason for them to become

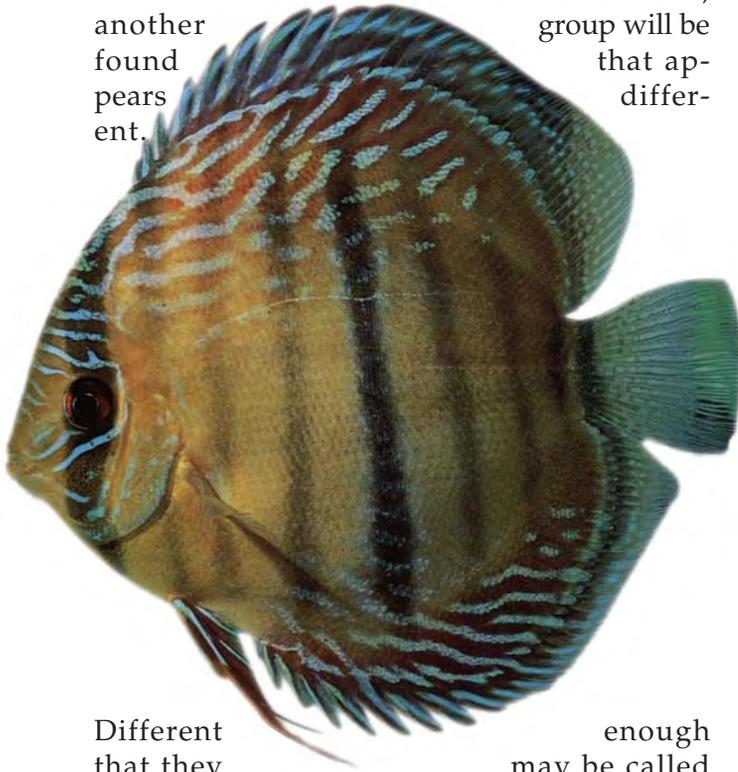


totally reproductively isolated when there is no likelihood of them coming into contact with each other? Traditionally, these two species have appeared to be geographically separated from each other in their distribution: *S. discus* has been described primarily from the tributaries of the Rio Negro whereas *S. aequifasciata* is found in the western

The *Symphysodon* on these pages were all caught in the Rio Madeira and represent intermediate forms between *S. discus* and *S. aequifasciata*. Photos by Lo Wing Yat "Sunny".

portion of the Amazon River drainage. But recent collections appear to put these original distributions in doubt.

Preliminary observations of Discus in their natural habitat have not yielded any evidence that more than one species of *Symphysodon* exists. These fishes appear to live in "family" groups and seem not to leave their immediate areas; the individuals in each group tend to look similar over a limited area. A short distance across open water in a suitable habitat, another group will be found that appears different.

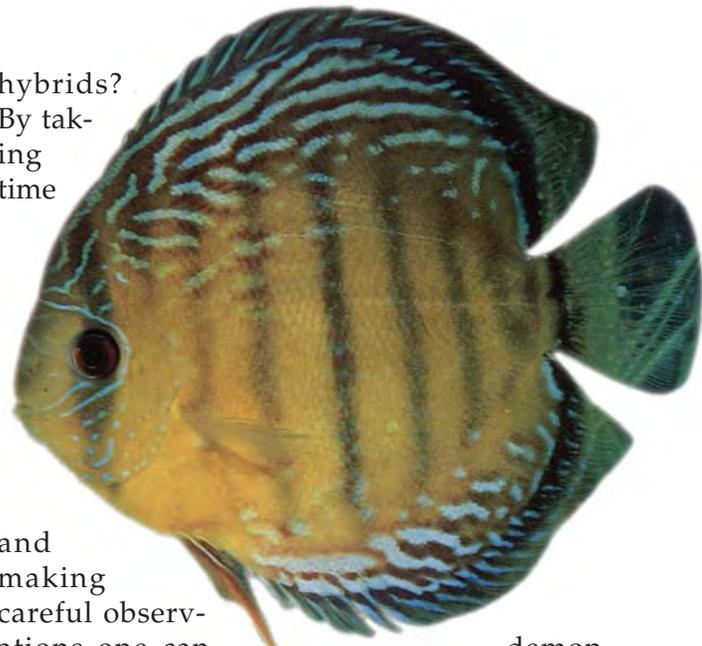


Different enough that they may be called something different. A similar observation can be made in other cichlids such as *Mesonauta festivos* and *Heros severus*. These differences arise because traits are much more easily fixed in a small breeding population. In biological terms this is referred to as the founder effect. If two populations differ slightly to begin with, then within a few generations, they may be dramatically different.

To give you an example using some simple numbers. You have one population of fishes with 20 individuals. This population then somehow gets separated into two. Sub-population 1 is composed of 6 typically blue fishes and 4 brown. Sub-population 2 has 9 browns and 1 blue. If each individual has an equal chance of breeding, within a few generations the two sub-populations will diverge even more. Thus if we collect the two sub-populations in, say 5 years, they may have diverged enough to call them different varieties; but in fact they are not.

But what about the fishes that appear to be

hybrids? By taking time



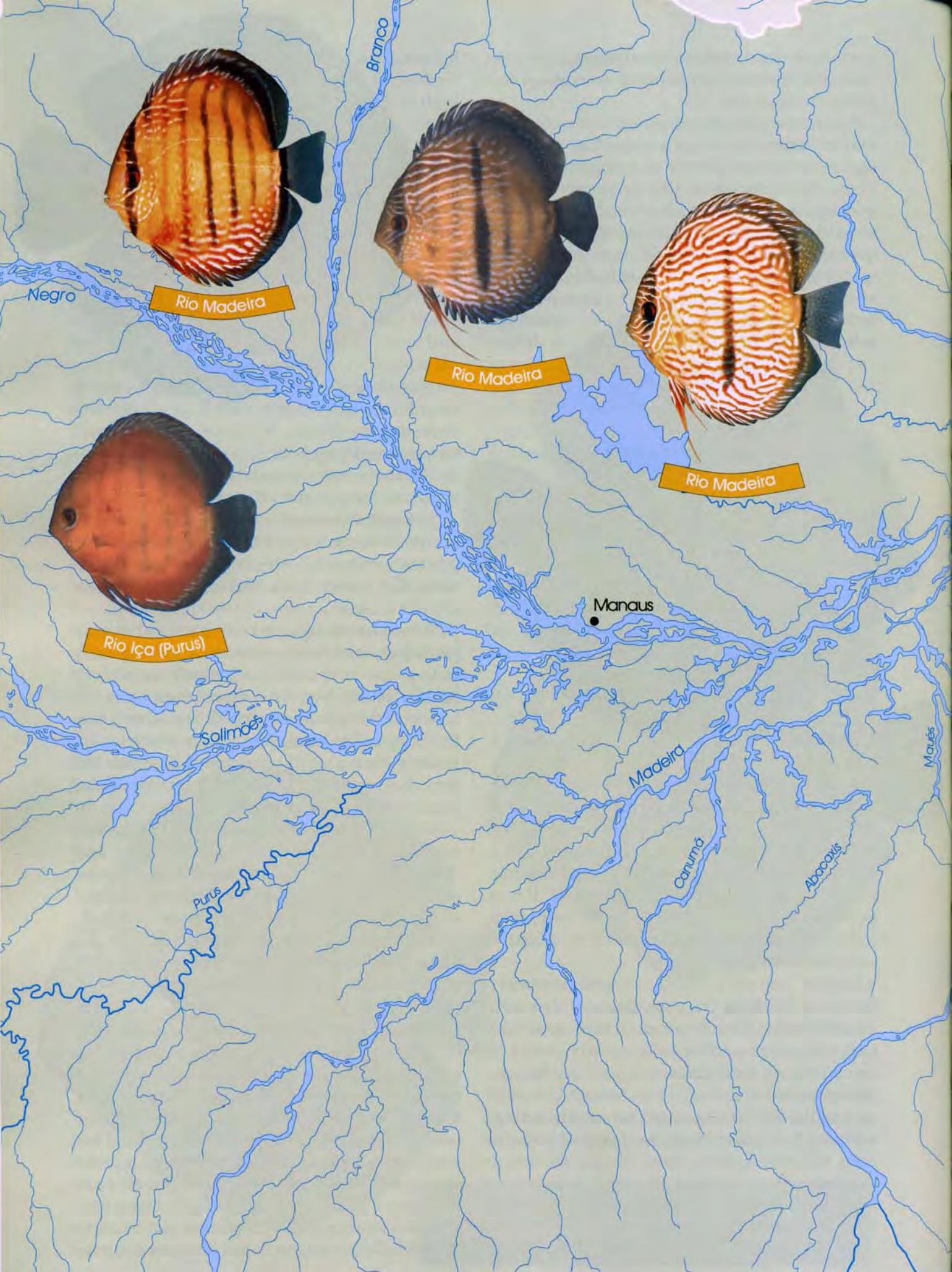
and making careful observations one can demonstrate that intermediate forms are not uncommon, living both between groups as well as among them; quite contrary to what most literature indicates.

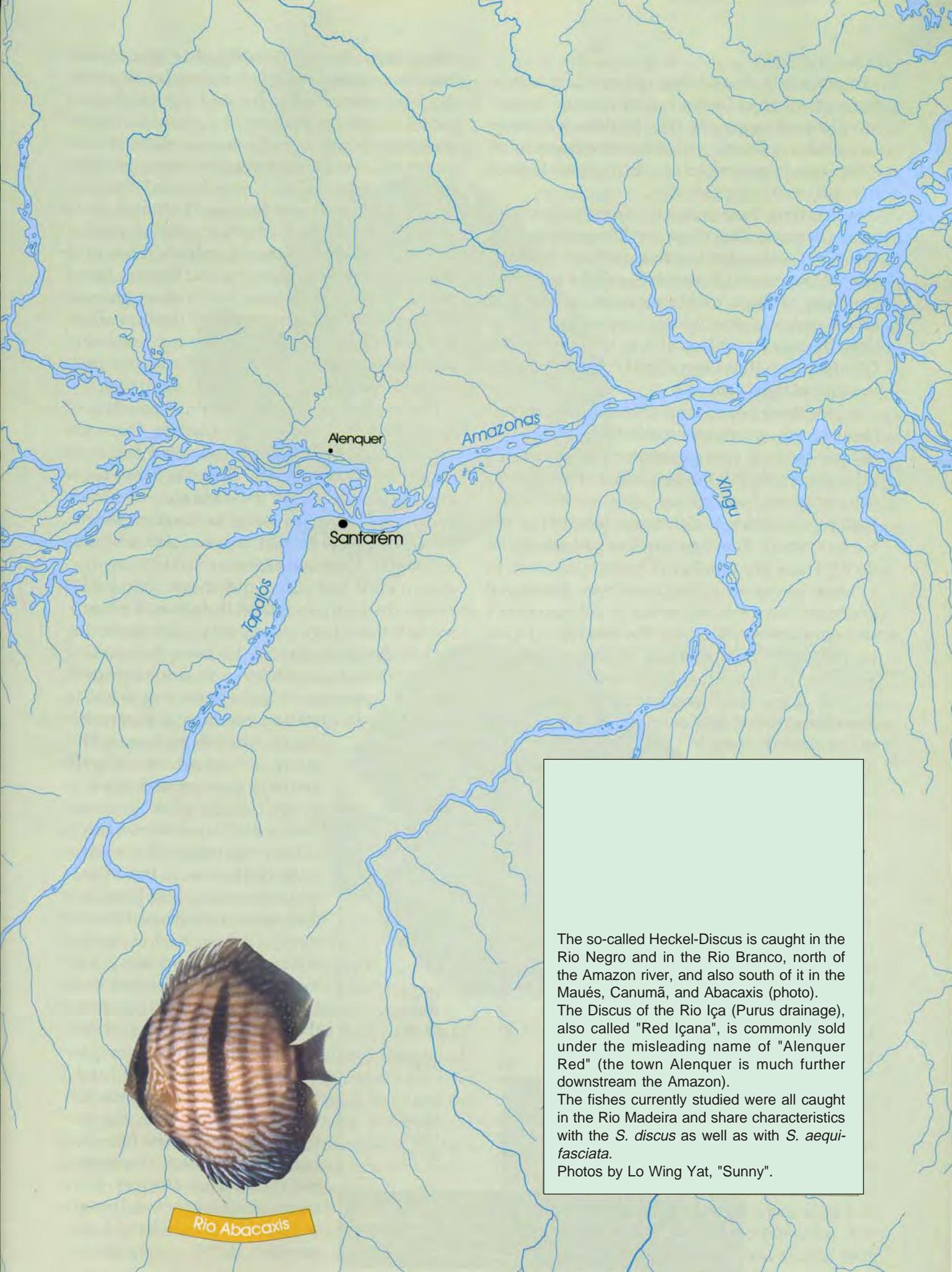
Confusion abounds for hobbyists as well as scientists due to the fact that fishermen and exporters artificially categorise and sort Discus when they collect them. This is mainly to protect collecting sites.

Many well-intentioned scientists and aquatic journalists have been misled by these false collecting reports. Indeed, the *S. aequifasciata haraldi* Schultz (1960) based his description on is not typical of the type locality cited. The same is true for the so-called "Alenquer" Discus which is supposedly from a small town called Alenquer but very likely collected in the Rio Purus a vast distance away (see map pages 80-81).

Heckel Discus without the central bar are also not hard to find. Similarly "Blue", "Red", and "Brown" Discus with a prominent central bar are quite common in some areas. "Hybrids" abound in certain drainages and are scarce in others. When collected, some are shipped as Heckels, others as Blue or Royal Blue, and some as plain old Brown Discus. Four different types; one forest stream!

Attempts have been made to categorise wild caught as well as domestic forms of Discus, but a few days in Amazonia will demonstrate that all the Heckel morphs purported to be from all over the Amazon can be found under one log! Blue heads, yellow fins, with or without a central bar—all in one batch of fishes. It is obvious that the idea of delineating subspecies on the basis of colour is more fantasy than good science. Some geographic variation does indeed exist and needs to be properly investigated, but it seems easier to





The so-called Heckel-Discus is caught in the Rio Negro and in the Rio Branco, north of the Amazon river, and also south of it in the Maués, Canumã, and Abacaxis (photo). The Discus of the Rio Iça (Purus drainage), also called "Red Içana", is commonly sold under the misleading name of "Alenquer Red" (the town Alenquer is much further downstream the Amazon). The fishes currently studied were all caught in the Rio Madeira and share characteristics with the *S. discus* as well as with *S. aequifasciata*.
 Photos by Lo Wing Yat, "Sunny".

Rio Abacaxis

prove it doesn't.

Interestingly, knowledge of biotic and abiotic factors that affect *Discus* can be used to "create" morphs even using one fish! Unilateral damage can result in a *Discus* with different coloration on either side, photographs of which appear to be of two different "subspecies".

By breeding these fishes in captivity, recombination of genes takes place and allows them to be saved by the breeder. In nature perhaps piranhas or even the parents themselves cull the spawn so that some of these "odd" specimens are lost. Not all are and occasionally they popped up in our nets. In captivity it is easier to observe "Green *Discus*" beget "Blue *Discus*" and Heckels produce Browns *ad infinitum*.

So, are there two species of *Discus* or just one? How do you go about establishing whether or not two fishes in your possession are the same or different species? If the two fishes are dead and preserved we have to use some method other than reproduction to determine whether or not we have more than one species. So how do we do it? There are number of techniques used in modern taxonomy. Some have been developed gradually since the beginning of fish taxonomy and some are very modern. The first type of comparison is by their meristic values, which are anything on the fish that can be counted: number of scale rows, vertebrae, lateral line pores, etc. Meristic values (body counts) are traditionally the preferred characters used in taxonomy of fishes because they tend to be the most reliable; they tend to change very little over time. With *Discus* a distinct picture does not emerge when utilising meristic characters. Heckel's original description of *S. discus* was based upon only **one** specimen. When Schulz reevaluated the genus in 1960 he again relied on only **one** specimen of *S. discus*, but used more than 50 specimens of *S. aequifasciata*. Of the ten characteristics that Schulz used (see

table) only one can be utilised to distinguish these two species: the number of scale rows from the operculum to the base of the caudal fin (table). If more specimens of *S. discus* had been evaluated would there be more variation in the counts and would this variation overlap with the variation observed in *S. aequifasciata*? This is a very important concept because all animals show variation. If you look at any species identification, the authors will always state such things as dorsal fin rays 9-14, meaning that the number of dorsal fin rays varies from 9 to 14 in members of the species. Thus demonstrating that not all individuals of the species have the same number of rays. But no variation can exist if only one individual is examined.

The second taxonomic method consists of measuring morphometric characters. These are measurements that can be made on a fish: total length, snout length, etc. Because fishes grow throughout their lives these measurements are usually expressed as ratios to standard length. There are many problems associated with this technique. A major problem is that in many species overall body size and shape (and hence ratios) changes throughout their lives. Comparison of different age groups may yield conflicting and confusing results. So it is best when making comparisons between fishes to compare specimens of approximately the same size —just in case there is variation between different life stages. Another problem is that many species are sexually dimorphic: there are differences in overall body plan between males and females, so intersexual comparisons may also yield confusion. A third problem, especially with *Discus*, is that specimens from different types of habitat, such as flowing water or still backwaters, may have completely different body shapes. Hanel (1981) compared the different species and subspecies of *Discus* using morphometric characters. He found overlap in all of the characters examined. However, the pictures provided of the fish used in the research show the typical pointed-noses (longer than higher) and large-eyes that are indicative of weakened diseased fish. Apparently

	<i>S. discus</i> *	<i>S. aequifasciata</i>
Fin rays		
dorsal (spinous)	9	8-10
(soft)	31	31-34
anal (spinous)	7	7-9
(soft)	29	26-32
pectoral		
(unbranched)	2	2
(branched)	7	8-9
(unbranched)	4	3-4
Lateral line pores		
anterior	19	18-23
caudal	12	10-14
total pores	31	28-36
No. scale rows	44	50-61
No. vertebrae		
abdominal	13	12-14
caudal	17	17-20
total	30	30-33

Table. Meristic values of *Symphysodon discus* and *S. aequifasciata*. Modified from Schultz (1960). * only one specimen examined.

individuals used in this research were wild fish which had been kept in captivity for many months. Thus they may have lost their natural body shape due to inadequate diet.

The third taxonomic technique used involves anatomical characteristics: shape, completeness and position of the lateral line, position and size of internal organs, and secondary sex characteristics such as breeding tubercles. These characters can be definitive characteristics for a species but closely related species tend to have similar anatomical features. These characters are also very hard to quantify because there is so much variation between individuals of a single species.

Another group of characters which is sometimes used to distinguish species is colour patterns. These can be some of the most variable characters of all for any species. As we all know, there are many different colour varieties of wild Discus and the two different species have their own basic pattern. We have in our possession wild specimens of *S. discus* that have the front half of their body striated, but the back half (posterior to the fifth vertical bar) lacks striations and looks like that of a Brown Discus. What would you call these specimens, *S. discus* or *S. aequifasciata*? What do subtle variations between individuals signify? As stated previously, we also have wild *S. aequifasciata* with a very striated body and the accentuated 5th bar as in *S. discus*. What should we call these? Are they wild hybrids of the two species or are they a completely new species?

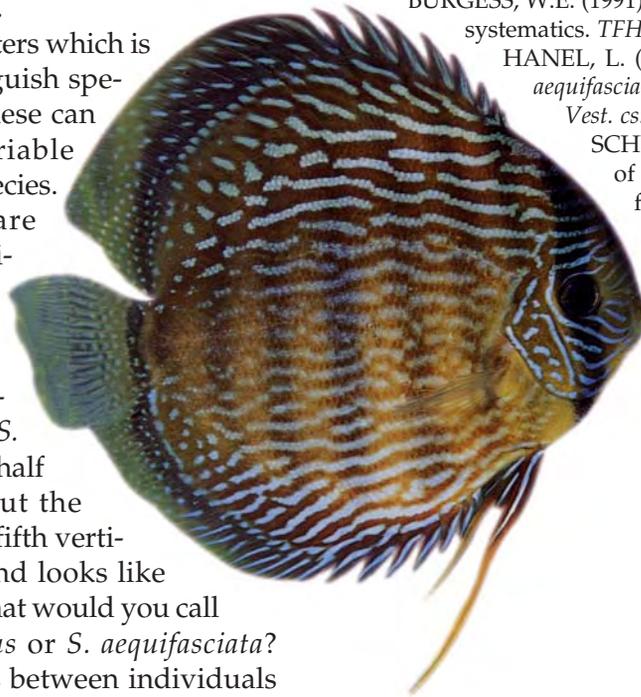
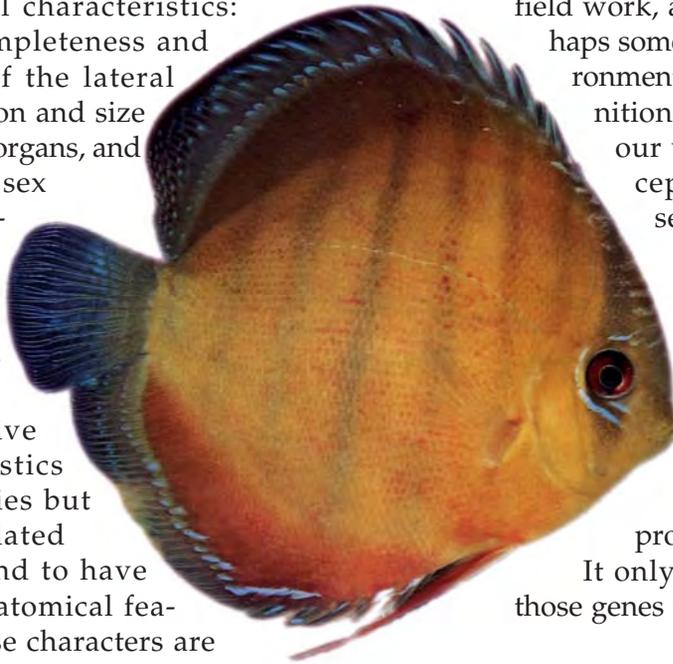
In one of the authors' (AIM) research laboratories, we are investigating the taxonomy of the two species of Discus. We are using 2 modern techniques to do this: karyotyping and

electrophoresis. Both of these techniques involve the use of tissues and cells from fishes and tend to be labour intensive; they take time. In another 6 months to one year we should be able to finalise our results. In addition, there is need for more field work, as well as laboratory research. Perhaps some more breeding experiments. Environmental influences may need better definition. These studies are in progress. To our way of thinking, the currently accepted taxonomy of *Symphysodon* seems to be in error. In the end we may have to face being proved wrong as well. Time will tell. We will keep you informed.

So what does all this mean for the Discus breeder and hobbyist? Well, the fish that you have in your tank or in your breeding program may have the genes to produce an infinite varieties of Discus. It only takes time (much time) to bring those genes to expression.

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In contrast to previous reports, different colour morphs of *Symphysodon* are found sympatrically (above), questioning the validity of the subspecies and also that of the two nominal species *S. discus* and *S. aequifasciata*. Photos by Lo Wing Yat, "Sunny".

Old wives of Surinam: *Guianacara owroewefi*

Jaap-Jan de Greef

In the early years of the aquarium hobby, from the 1930's to the 50's, Surinam and British Guiana occupied an important place in the supply-line of fishes, especially to Europe. Common fishes such as *Hemigrammus ocellifer* (head- and tail-light tetra), *Nannostomus beckfordi* (pencil-fish), *Gasteropelecus sternicla* (silver hatchet), and small cichlids such as *Nannacara anomala* were shipped in large quantities to Western Europe. With the opening up of new sources in the Amazon, Zaïre, and the Far East, these two countries lost their prominence due to political difficulties and other

factors.

One cichlid that did not show up very much in those days was a species common in Surinam and known locally as "owroewefi", which, literally translated from Sranatongo, means "old wife". It is interesting that this name is used, because *Aequidens*-like cichlids are often called "viejas" in Spanish-speaking South American countries; a word that means exactly the same.

Guianacara owroewefi was recently described by Kullander and Nijssen (1989), and closely resembles *G. geayi* (formerly in *Acarichthys*). Both *Guianacara* and *Acarichthys* form part of the geophagine complex.

It is a rather small cichlid, the males reaching a length of a little over 10 cm and the females remaining a bit smaller. The colour pattern varies according to the mood of the fishes. They are at their most beautiful when they are in breeding colour. They then exhibit a striking black vertical belt, with a light coloured edging along either side, roughly halfway along the body. A further pronounced black stripe runs from the top of the head, through the eye, to the anterior lower part of the operculum, whose posterior part is edged in black as well. The fins have a faint light bluish sheen and in the Surinam River this iridescence is more pronounced. The basic body colour is a light-brown tan.

When the fishes are stressed all the black stripes disappear and a mottled pattern is visible. This pattern is seen when the fish is not dominant or not displaying. A third pattern consists of only part of the black belt which then appears as a round spot. This pattern sometimes appears when parents are leading fry.

I made a collecting trip to Surinam in March 1993 and collected *G. owroewefi* from three different river systems: the Tapanahoni River (a tributary of the Marowijne River which forms the eastern border between Surinam and French Guiana), the Surinam River, and the Coppename River (see map).

The water in these rivers is generally very soft and the pH measured about 6.2; the temperature was around 28° C.

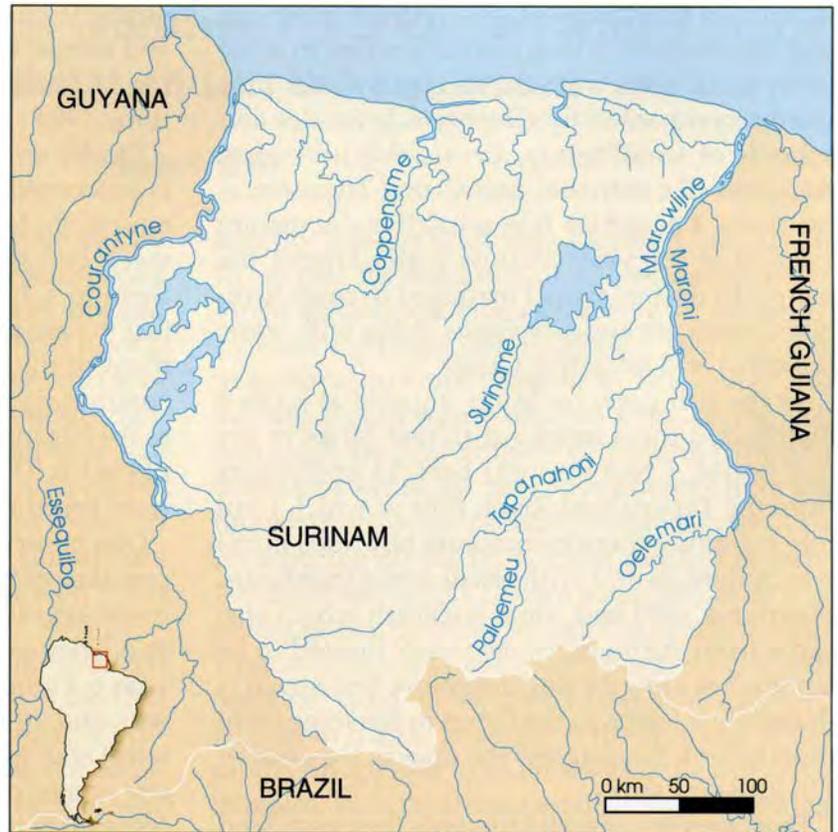


Previous page, top: A female *Guianacara owroewefi* (from the Tapanahoni River, Surinam) guarding her few-days-old fry. Bottom: *G. owroewefi* from the Surinam River.

This page: The rock-strewn Copenname River follows a winding course through the Surinam jungle. Photos by Jaap-Jan de Greef

I observed the fishes underwater in the Tapanahoni River while I was collecting. The adults swim along the bottom in the quieter parts of the river. The bottom consisted of fine sand and piles of detritus that quickly clouded the water when stirred up. They would pick through this and sieve out what was to their liking. Branches, tree trunks, and rocks were plentiful in this habitat. The water had a slight yellow tint, but was clear enough to see about 5 feet. In some places where there was a tree trunk underwater, a *Guianacara* would cautiously emerge from behind the trunk and observe me. Having decided I wasn't a direct threat it would come nearer, swimming close

to the trunk, and start working through the substrate stirred up by my hands and feet. Other cichlids swimming with them were *Geophagus surinamensis* and *G. harreri*. The latter looks a lot like the *Guianacara* but has a more elongated body. Among the branches I could see some small *Crenicichla albopunctata* and/or *Cr. multi-spinosa*. The larger specimens of these predators were seen in deeper water (about one metre or deeper). I saw *Characidium* at close quarters on the gravel riffles on the bottom, as well as in the



current; *Plecostomus* and other *Loricarids* were on the wood, and every now and then I saw a Pimelodid catfish or a *Leporinus* species swimming by. *Leporinus* species are very strikingly coloured in this river. Most of the time there were tetras such as *Moenkhausia oligolepis* swimming in the open water above the cichlids, likewise *Metynnis*, and every now and then a school of small piranhas (*Serrasalmus* sp.) came to take a look at what was going on.

Juveniles were found much closer to the banks

foraging in the clumps of grass, stands of *Mayaca*, and *Heteranthera*, which were abundant in some of the small inlets with still, stagnant water. They were accompanied by *Geophagus* juveniles and schools of small tetras, *Crenicichla* juveniles, *Ancistrus*-like catfishes and young *Hypostomus* catfishes. I caught a few attractive *Nannacara anomala* in the very shallow water among the plants. In deeper areas I managed to catch juvenile *Guianacara* and *Geophagus* along with some *Leporinus* and attractive tetras.

As the fish grew on in my aquaria at home I distributed them among different tanks in my fish house. I had brought back 11 specimens from the Tapanahoni River, four of which I put into my living room community tank (500 litres) which they shared with small tetras (cardinals, phantoms, etc.) and some angelfish which also came from Surinam. *G. owroewefi* proved to be somewhat slow in development, but space is definitely a factor as the fishes in the large community tank far outgrew the ones in the smaller 120 litre-size tanks.

They are very peaceful towards their own kind and other tankmates are never bothered at all. Territorial disputes in this size of tank are minimal. The tank is heavily planted with live plants and there are some terraces made with stones and driftwood.

The *Guianacaras* prefer to live in caves and this is where problems arise in a tank decorated as described above. As the fishes grew they started to dig under the driftwood and eventually rearranged one half of the tank in the process. The sand from the upper terrace at the rear of the tank was levelled with the lower terrace at the front. Plants were not dug up, but on the upper terrace the roots became visible and the ones on the lower level were partly buried. This was the total extent of the damage to the tank's decor, and I figured that it was worth it since, after being 8 months in the tank, one pair rewarded me with a batch of about 35 fry. It isn't quite clear exactly where they deposited the eggs, but my feeling is that they were laid on the sides of the cave they had made, using the wood as substrate. The territory was defended but no damage done to other tankmates. The territory was rather small; its surface area on the bottom had a diameter of about 30 cm. Other fishes were tolerated beyond that area. The parents—leading the fry—swam carefully around the tank, but never strayed very far from their cave. The black edge on the operculum seems to be used as a signal in guiding the

young. I have removed the parents since then and turned them loose in a pond outdoors, hoping to catch more offspring by the end of Autumn 1994.

The fry are problem-free as far as raising them is concerned. The community tank gets *Artemia* nauplii daily and this supplied them in the first week before I siphoned them out and placed them in a 120-litre tank filled with rain water, just in case water chemistry affects the development of the sexes. The water conditions in my community tank differ from natural conditions as the hardness measures around 13° GH and the pH is 7.6. This, obviously, didn't stop the fishes from breeding.

One observation I made is that the *Guianacara* population from the Surinam River seems to be more aggressive than the ones from the other two. They are housed in a 500 litres tank together with 6 *Theraps irregularis*, 4 *Amphilophus robertsoni*, and 10 *Pseudochalceus kyburzi* (a territorial tetra) and are doing fine—they actually control one corner of the tank. Their colour pattern differs a bit in that the iridescence in the fins and on the body is a little more noticeable than in speci-



Juvenile *G. owroewefi* exhibit a characteristic colour pattern. Photo by Jaap-Jan de Greef.

mens from the other two populations.

G. owroewefi is a highly recommended cichlid and as numbers grow they will be more readily available to hobbyists in the near future.

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Crenicichla acutirostris Günther, 1862: Observations in the natural habitat and in the aquarium

Frank Warzel

Crenicichla acutirostris, which was described by Albert Günther in the last century, is a species which can be easily identified at first glance and without detailed examination. As well as having an extraordinarily slender body shape, this species can be recognised above all by the strongly contrasting pattern on its back, consisting of 9-10 dark dorsal bars on a gold-yellow or yellow-orange background. At spawning time, or when the fish is in dominant mood, these dorsal bars are deep black, producing a pattern seen in no other *Crenicichla* species.

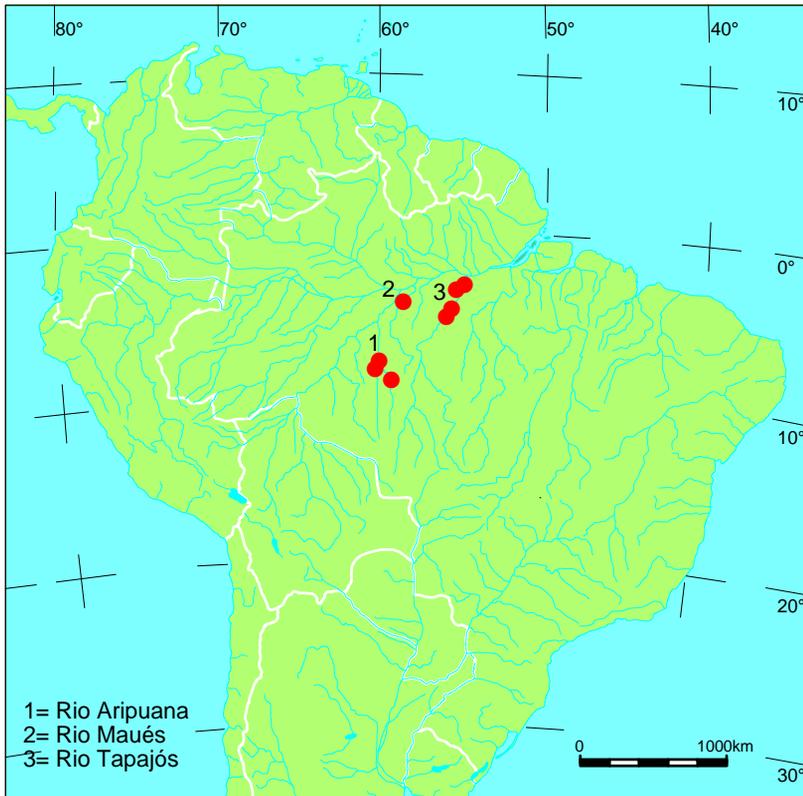
C. acutirostris was first discovered and collected for zoological purposes in the middle of the 19th century —by Bates and sold to the British Museum in London by his agent, Stevens. The locality for the single specimen collected by him was in the Rio Cupari, a tributary of the lower Rio Tapajós, whose waters are clouded with sediment, at least in the region of its mouth. One might well expect that a cichlid attaining more than 20 cm in length would not be restricted to a relatively small tributary. Nevertheless for more than a century this preserved specimen remained the only known representative of its species. More recent collections during the 70s have confirmed that *C. acutirostris* is indeed not confined to the lower Rio Tapajós region, although the distribution of this species does seem to be limited to a relatively restricted area. According to Ploeg (1991) *C. acutirostris* is found only along the right-hand side of the lower Rio Madeira, in the Rio Maués, and, of course, in the lower Rio Tapajós. A specimen collected in the lower Rio Xingú, and identified by Ploeg as *C. acutirostris*,

actually belongs to another species (*C. sp. Xingú II*), so that the existence of *C. acutirostris* in the Xingú drainage remains a matter of conjecture.

According to our observations *C. acutirostris* is in general not uncommon in the lower Rio Tapajós region where one can even distinguish two separate populations exhibiting different coloration. While the back in specimens from the Rio Arapiuns appears rather yellowish, the area beneath the dorsal fin is more reddish in individuals from the Rio Tapajós itself. Sexual dimorphism is relatively slight: females remain somewhat smaller and have a very narrow light submarginal band on the posterior dorsal, a feature lacking in males. In addition the spotting of the caudal fin appears to be finer and more extensive in males. We saw almost exclusively half-grown specimens of up to 15 cm total length along the areas of river bank visited. On only one occasion were we able to observe a pair, leading about 40 juveniles in the mouth region of a small, slightly tea-coloured, clearwater stream. These fry were a good 5 cm total length and must have been at least 2½ months old —further confirmation of the observation that several *Crenicichla* species, especially the larger ones (including *C. acutirostris*), look after their brood for considerably longer than is normally the case in cichlids.

Our observations clearly indicated that *C. acutirostris* is not restricted to any particular type of habitat. Along a stony section of the bank of the Rio Arapiuns, a left-bank clearwater tributary of the lower Tapajós, we saw half-grown specimens of various ages in the immediate vicinity of rocks, while in another place they were





sheltering exclusively under large stones lying on the bottom at a depth of 2-3 metres. We observed similar secretive behaviour in a lagoon in the lower Tapajós, where the fishes were using exclusively fallen trees and large accumulations of driftwood as cover. Half-grown individuals are apparently solitary and defend a feeding territory against conspecifics. Every time we caught a specimen from beneath an approximately 5 metre long section of tree trunk, another individual would occupy this hiding place within a few hours.

The biotopes listed above all had slightly acid water (pH about 6.5) and a temperature between 28 and 30° C, and there was as good as no current. *C. acutirostris* found in the area of rapids near Barburé, some 200 km upstream, behaved like those in the first-mentioned locality. Half grown juveniles were swimming around adeptly among the jagged rocks close to the shore, and were thus easy to observe. In the vicinity of another rocky bank we were able to make out a small group of individuals measuring about 20 cm, swimming around in the open water in a loose shoal. These observations indicate that this is an extremely adaptable species. Moreover the comparatively small mouth clearly suggests that *C. acutirostris* is not a specialised piscivore, as is the norm in the

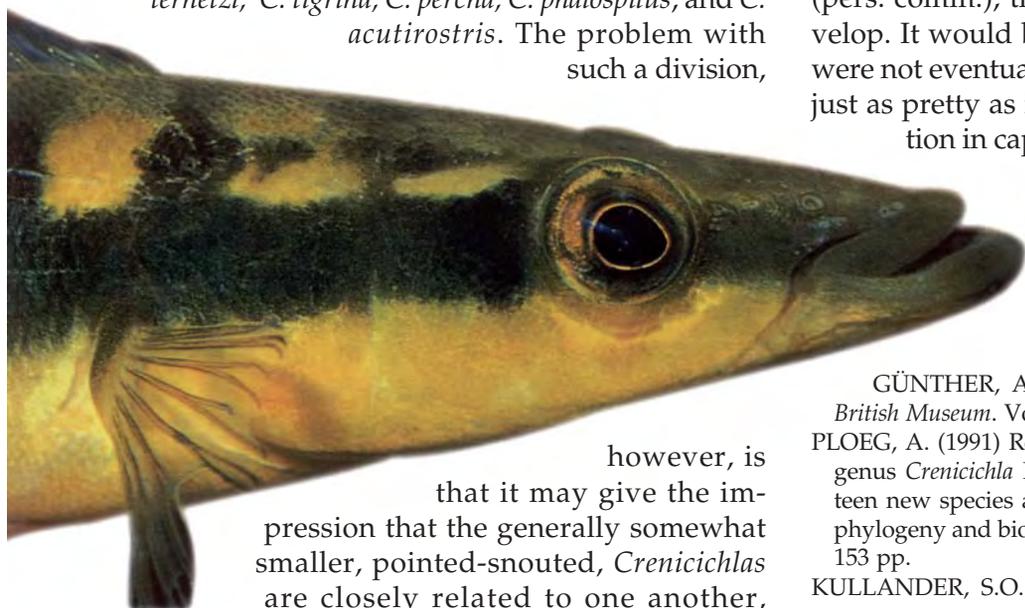


Previous page: *Crenicichla acutirostris*, a female from the lower Rio Tapajós exhibiting the neutral colour pattern.
Top: The map indicates the various collecting sites of *C. acutirostris*.
Photo above: A characteristic section of the bank of the lower Rio Tapajós, collection site of *Crenicichla acutirostris*.
Right: A juvenile *C. acutirostris* (TL 14 cm) with dominant colour pattern, from Cachoeira do Barburé.
Photos by Frank Warzel.



majority of rheophilic *Crenicichlas*.

On the basis of its extremely small scales and maximum body length of some 35 cm, *C. acutirostris* clearly belongs to one of the groups of large *Crenicichlas*, but it is impossible to establish a closer relationship with any other members of this complex. Kullander (1991) has suggested that the blunt-nosed, robustly-built, species such as *C. lugubris*, *C. lenticulata*, *C. marmorata*, *C. johanna*, *C. strigata*, and *C. cincta* should be regarded as separate from those species with a more pointed snout, eg *C. multispinosa*, *C. ternetzi*, *C. tigrina*, *C. percna*, *C. phaiospilus*, and *C. acutirostris*. The problem with such a division,



however, is that it may give the impression that the generally somewhat smaller, pointed-snouted, *Crenicichlas* are closely related to one another, whereas in point of fact this appears plausible in only a few cases. Nevertheless one can reasonably assert that within the *C. lugubris* group (Ploeg, 1991) a few species such as *C. multispinosa* and *C. ternetzi*, or *C. lugubris*, *C. marmorata*, and *C. strigata*, exhibit many similarities, while the situation regarding others is by no means as clear. For example, as far as markings and habitus are concerned, *C. acutirostris* is rather more reminiscent of the so-called "dwarf *Crenicichlas*" such as *C. notophthalmus* and *C. regani* than it is of other large species.

As experiences with other large *Crenicichla*

species have shown, the breeding of *C. acutirostris* in captivity is unlikely to be easily achieved. It is possible that in the natural habitat seasonal influences, such as periods of high and low water, play an important role in bringing the fishes into breeding condition. Perhaps the key lies in significantly lowering hardness and pH when the female is filled with eggs and displaying. To date partial success has been achieved by Christoph Seidel of Bonn, whose pair have spawned twice in an aquarium of some 400 litres capacity with optimal water quality (pers. comm.); the eggs, however, failed to develop. It would be a pity if successful breeding were not eventually achieved, as *C. acutirostris* as just as pretty as it is elegant. Its wider distribution in captivity would enrich our hobby, the more so because such fishes always represent something of a challenge.

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Above: *C. acutirostris*, adult female.
Centre: A juvenile (TL ca.10 cm) from Cachoeira do Barburé.
Right: A male *C. acutirostris* from unknown origin.
Photos by Frank Warzel

Observations on *Crenicichla* sp. aff. *jegui*

Frank Warzel

Our decision, in the Autumn of 1990, to travel to the Rio Tocantins in northern Brazil, was prompted by two recent publications in which several very interesting-looking cichlids were pictured and described for the first time. One of these, *Crenicichla jegui*, from Itupiranga, Jatobal, Breu Branco, and Tucurui, immediately caught the eye because of its very unusual appearance, with a long snout and the eyes positioned extremely high on the head. A few years previously the staff of the Instituto Nacional de Pesquisas da Amazonia (INPA), including a certain Michel Jegu, had busied themselves with collecting the highly diverse and in large part endemic fish fauna of the Rio Tocantins and storing it in museum archives, so that at a later date it would be possible to gain at least a partial insight into its specific diversity.

The reason for this activity soon became obvious: the former swift-flowing river has subsequently been superceded by one of the largest reservoirs in the world. Nevertheless in 1990 we were still able to find a number of cichlids, including *C. jegui*, upstream of the artificial lake which has swallowed up the major part of the original habitat of this species.

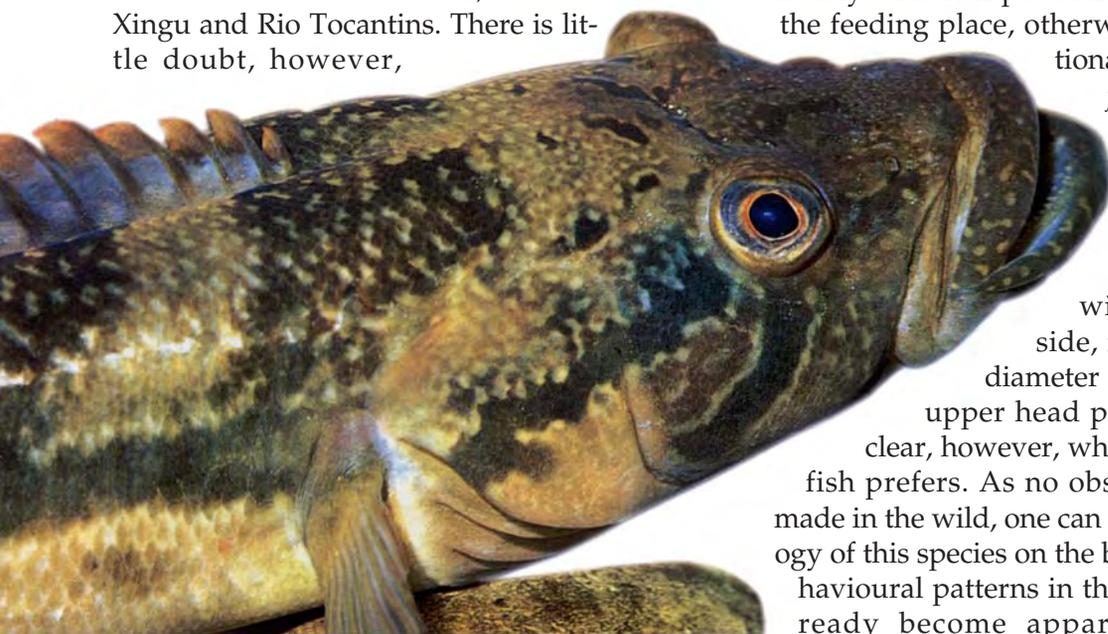
In January 1991 the appearance in the aquarium trade of a further *Crenicichla* species, very similar to *C. jegui* and without doubt very closely related (Stawikowski, 1991), created quite a stir. The only available information regarding its origin was that it had been imported, together with some sucker-mouth catfishes, from the Rio Xingu and Rio Tocantins. There is little doubt, however,

that the species derives from just one of these two rivers. *C. jegui* and the undescribed species are, taxonomically speaking, relatively isolated within the genus, although on the basis of several typical characters they can be assigned to "Batrachops" sensu lato. But no other known *Crenicichla* has cheek stripes developed to the same extent or a pattern of light spots on the back. It would be interesting to know whether these two sibling species are sympatric and have developed different specialisations in the natural habitat, or, as is normally the case with very closely related species, originate from totally separate river systems.

Then, last year, the problem was finally solved by an enquiry to the exporter of the fish, Marco Lacerda of Rio de Janeiro. The undescribed species not only originated from the same river as *C. jegui*, but it was sometimes found in the same place! This was a real surprise, as the area he mentioned had been intensively fished by INPA staff 10 years previously. It may have been pure chance that a few *C. jegui* were found there, but not a single specimen of *C. sp. aff. jegui*. Further confirmation that there may still be new discoveries to be made even in a comparatively well-researched section of Amazonian river.

Without question *C. sp. aff. jegui* is a rheophilic species, adapted to fast-flowing rivers. Apart from *C. jegui* there are hardly any other large South American cichlids which swim so clumsily in open water. At mealtimes they "paddle" laboriously with their pectoral fins in the direction of the feeding place, otherwise they prefer a stationary existence. As in *C.*

jegui the anterior part of the body is visibly broader than deep. In addition the eyes are set very high on the head, with, viewed from the side, more than 1/3 of the diameter extending beyond the upper head profile. It remains unclear, however, what type of biotope this fish prefers. As no observations have been made in the wild, one can only guess at the ecology of this species on the basis of some of its behavioural patterns in the aquarium. It has already become apparent that the other



specialised Rio Tocantins species (*C. compressiceps*, *C. cyclostoma*, *C. cametana*, *C. jegui*) are very different in their lifestyles and feeding habits. *C. compressiceps* lives mainly in water with a gentle current or in calm sandy or stony areas; *C. cyclostoma* lives in the shelter of stones and may be specialised to feed on caddis fly larvae; while *C. cametana* lurks under the larger rocky overhangs carved out by the current, lying in wait for passing fishes. Finally, *C. jegui* is the embodiment of the rather less sedentary lurking predator, which may use cover, but is quite happy to vary its hiding place. On the basis of its attractive cryptic coloration *C. sp. aff. jegui* most closely resembles the last of these, but it is much more sturdily built and in



addition apparently lacks the "sprinting ability" of *C. jegui*. It is noticeable that the species greatly enjoys hollowing out and enlarging caves under flat stones lying on the bottom. Admittedly the other species exhibit this behaviour, but not to the same extent. Be that as it may, a suitable sand/gravel substrate and stone slabs positioned horizontally are two items which are clearly to the liking of these cichlids.

Although the Rio Tocantins is a slightly acid river, poor in minerals (pH 6.6, 40 µS/cm, June 1986 (Mayland, 1988)), all the *Crenicichlas* found there are very tolerant of harder water and in some cases (*C. compressiceps*, *C. cyclostoma*) can even be maintained at an alkaline pH. Unfortunately the larger species require very roomy aquaria with a length of at least 1.5 metres before one can hope for a reasonable insight into their natural behaviour. If the aquarium is too small then one is unlikely to have much success with these very interesting but territorial species. As regards breeding biology, the only significant observations made to date concern female breeding coloration (Warzel, 1993; Stawikowski & Warzel, 1989). It is my opinion, however, that breeding these larger species represents a real challenge for the aquarist.

Great caution should be exercised in the event of any breeding attempt with *C. sp. aff. jegui*. Even the importers have bemoaned the inordi-

nate greediness of these fishes, which sometimes results in them regarding conspecifics as an additional food supply. I myself have learned the hard way—a 24 cm, not yet fully grown, individual of this species supplemented its daily ration with a well-fed *Crenicichla lucius* female measuring at least 18 cm (see photo)! Perhaps herein lies the "trick" *C. sp. aff. jegui* employs to

Proof of the inordinate greediness of *Cr. sp. aff. jegui* is this 24 cm-long specimen swallowing a 18 cm-long tank mate! Photos by Frank Warzel.

surprise its prey—quite simply, its capacity for food is underestimated. In these circumstances it is essential to house only individuals of similar size together. How to ensure the female gets enough to eat, in the presence of a probably larger male of this extremely predatory, and also clearly cannibalistic, species, is another question entirely, and one for which there is at present no answer.

I would like to thank Roland Numrich, of Mimbon Aquarium, Cologne, for supplying me with specimens free of charge; and Marco T. C. Lacerda, of TROP RIO, Rio de Janeiro, for taking the trouble to obtain more exact information on the origin of these fishes.

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Malawi cichlids: a different perspective

Martin Geerts

Morphological characteristics are often the result of convergent evolution. For this very reason phylogenetic trees based on such characters are not always reliable. It is therefore evident that biologists need to look for characters which are not influenced by convergent or parallel evolution. Molecular biologists are now of the opinion that they have found such characters and that phylogenetic trees constructed using these are more reliable than those based on morphological features. However, as is shown by Ad Konings (1992, 1993), their methods too have their shortcomings. John Avise discusses in depth, in a recently published book (1994), the various methods molecular biologists have at their disposal, and for more information about these methods I refer the reader to this publication. In the following columns I shall discuss the suggestions and hypotheses which some American cichlid-specialists deduced from their molecular research.

Recently these ichthyologists published a paper in which they aired their ideas regarding the phylogeny of Malawi cichlids on the basis of molecular research. This publication, by Paul Moran, Irv Kornfield, and Peter Reinthal (1994), includes some very remarkable theses. For instance, it suggests that representatives of the genera *Aulonocara*, *Alticorpus*, and *Lethrinops* should be regarded as Mbuna. It is clear that this point of view strongly deviates from the currently accepted belief of morphologists (see eg Eccles & Trewavas, 1989). But Moran *et al.* have more in store.

They discuss in depth the phylogeny of the endemic haplochromine cichlids of Lake Malawi. For some time ichthyologists have questioned whether the Malawi species flock is monophyletic (descended from one ancestor) or derived from multiple separate colonisations. According to Moran *et al.* their research demonstrated that the endemic Malawian haplochromines, seen in relation to the cichlids of the other East African lakes, form a monophyletic group. However, as a consequence of this Moran *et al.* are confronted with a problem. In order to explain the molecular variation they found among Malawian haplochromines they have to accept that the lineages which are farthest apart today must have come into existence at least 4 million years ago. In the same publication, however,

these authors hold that Lake Malawi cannot be older than 1 to 2 million years. They refer to a study by Keith Banister & Margaret Ann Clarke (1980) who published a revision of the large barbs of Lake Malawi, in which they tried to reconstruct the history of the southern rift lakes. They concluded that Lake Tanganyika could not be older than about 2 million years and that Lake Malawi was probably the same age or slightly younger. If these suggestions prove to be true and if the endemic haplochromines of Lake Malawi form a monophyletic group then the different lineages must have started long before Lake Malawi came into being. In that case we may even find the sister group of one of these lineages outside Lake Malawi. The former existence of such sister groups cannot be excluded, as they may have become extinct. In any case, one cannot conclude with certainty from the observations of Moran *et al.* that the species flock of Lake Malawi is of monophyletic origin.

Recent investigations, however, suggest that Lake Malawi is much older than the 1 to 2 million years Moran *et al.* took as their starting point. The paleo-limnologist Daniel Livingstone (1993: 455-456) believes, like Banister and Clarke, that Lake Malawi is approximately the same age as Lake Tanganyika, but he estimates the age of the latter at about 20 million years. From this it appears that the East African lakes are much older and have a much more dramatic history than has generally been accepted. According to Amy McCune (1987: 452) it is very difficult for evolutionary biologists to imagine the impact regularly recurring climatic changes may have. This is especially true of long periods of drought. Their enormous size may have been insufficient to protect even the Great Lakes of East Africa from the effects of drastic climatic changes. In these huge bodies of water many lineages have undoubtedly evolved to subsequently become extinct. This may be the reason why Moran *et al.* postulate that their research suggests that the major part of the specific radiation among the endemic Malawian haplochromines is of recent date and has taken place in the lake itself.

In most of the available literature it is suggested that the species flock of Lake Malawi is descended from *Astatotilapia calliptera*, or from a closely related species (see eg Fryer & Iles (1972: 478, 491)). Although Humphry Greenwood

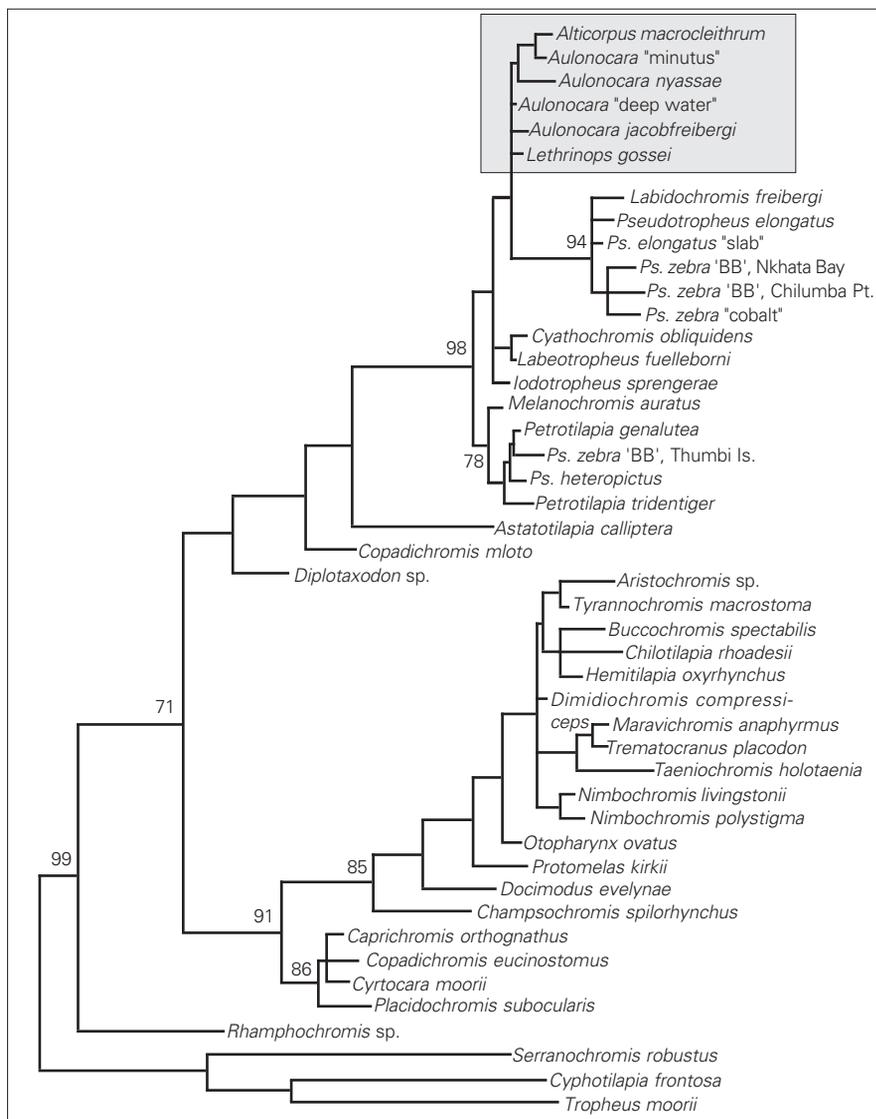
(1979: 317) clearly states that the haplochromines of Lake Malawi very likely form a polyphyletic group, Dennis Tweddle (1982: 11) has remarked that "The genus *Astatotilapia* is an obvious candidate for an ancestor". It is therefore interesting to note that Moran *et al.* place *A. calliptera* —even though regarded as a separate, oligotypic lineage— among the Malawian species flock as an integrated part of it. An interesting observation, because here the molecular biologists seem to disagree. Axel Meyer (1993b: 281) seems to share Tweddle's point of view and regards *A. calliptera* as "a representative of the ancestral stock". However, we must note that the same author declares almost simultaneously (1993a: 27) that *A. calliptera* has a closer relationship with the species flock of Lake Victoria than with the endemic species of Lake Malawi! In any case, it appears from the schematic diagram in which Moran *et al.* demonstrate the relationships among the Malawian haplochromines (see figure this page), that *A. calliptera* is more closely related to the Mbuna

than to the non-Mbuna. This may be further supported by the eggspots on the male's anal fin, a feature *A. calliptera* shares with almost all Mbuna. Males of non-Mbuna usually have a different coloration in the anal fin.

Moran *et al.* have further found that the genus *Copadichromis* in all probability cannot be regarded as a monophyletic group. They investigated the mitochondrial DNA of the species *C. mloto* and *C. eucinostomus* and concluded that these two are not closely related. This conclusion comes not totally unexpected; some years ago Ad Konings (1990: 112) suggested moving several *Copadichromis* species, among them *C. eucinostomus*, to the genus *Nyassachromis*. Konings found that the melanin pattern of *C. eucinostomus* was more reminiscent of that of *Nyassachromis* species and that the same was true of their reproductive behaviour. This point of view was rejected by Jay Stauffer *et al.* (1993), but nevertheless even these authors found it necessary to create a separate *C. eucinostomus*-group within the

genus *Copadichromis*. It is thus obvious that the "significant taxonomic implications" of Moran *et al.* (p. 281) were, at least in part, anticipated by investigators well versed in Malawi cichlids, so that their findings are not totally new. However, this is not the case when it comes to their regarding *C. mloto* as an independent lineage, not included in the group they designate as non-Mbuna. Pending further research they regard *C. mloto* as a separate, oligotypic lineage.

As is clear from the above, it is common practice to divide the species flock of Lake Malawi into two groups: the Mbuna and the non-Mbuna. Moran *et al.* follow the same principle although they recognise several so-called "oligotypic lineages" (*C. mloto*,



According to this cladogram, modified from Moran *et al.* (1994), *Aulonocara*, *Alticorpus*, and *Lethrinops* (shaded box) are firmly embedded in the Mbuna.



Left: Still disputed: is *Astatotilapia calliptera* the ancestor of the Malawian species flock?
 Bottom: *Alticorpus mentale*: is this a true Mbuna!?
 Photos by Ad Konings.

together in a monograph dedicated to the "Kaiserbuntbarsche" of Lake Malawi. In this context it may also be of interest to look at the nomenclatural history of *Trematocranus*

Rhamphochromis spp, *Serranochromis robustus*, *A. calliptera*, and *Diplotaxodon* spp.). Most of the species they investigated, however, are placed either in the Mbuna or the non-Mbuna group. Remarkably, Moran *et al.* place some genera (*Aulonocara*, *Alticorpus*, and *Lethrinops*) which, based on morphological characters, justify placement in the non-Mbuna, among the Mbuna. They emphasise that we are dealing with Mbuna. Earlier publications have mentioned the close relationship between *Aulonocara* and *Alticorpus*. Andreas Spreinat (1989) grouped these two genera

peterdaviesi Burgess & Axelrod, 1973. This cichlid has been variously assigned to *Trematocranus*, *Lethrinops*, and *Alticorpus*, and at one stage the first of these was regarded as a junior synonym of *Aulonocara* (see Meyer *et al.*, 1987). So it is not surprising that these three genera are regarded as a monophyletic group. But the placement of this group within the Mbuna comes as a surprise. Irv Kornfield, one of the co-authors of Moran, does not exclude the possibility that these three genera may turn out to be a sister group of the Mbuna (Ad Konings, pers. comm.), but never-



theless he regards the representatives of these three genera as true Mbuna. In this manner the classical division of Mbuna and non-Mbuna can be maintained and reinforced. In addition Kornfield points to the fact that the difference between *Lethrinops* and *Taeniolethrinops* (see figure page 93), which, before 1989, were regarded as a single genus, can be demonstrated by molecular biologists as well. This is likely to indicate that the methods used by molecular biologists are of practical value in taxonomic investigations.

When the American geneticist Avise (1990) noted that studies on Victoria cichlids led to the conclusion that morphological evolution can be much faster than molecular evolution, he wrote: "Morphological and molecular evolution can march to the beats of different drummers". Something similar can be distilled from the publication of Moran *et al.* although here it appears the reverse process has occurred. Moran *et al.* divide the Mbuna in two subgroups, but they place *Pseudotropheus zebra* "BB" Thumbi Island in one group and *Ps. zebra* "BB" Nkhata Bay in the other. Such a placement involves a molecular evolution which has been faster than the corresponding morphological evolution —both populations belong to the same species. Kornfield (Konings, pers. comm.) emphasizes that this cladogram is based on relationships among mitochondrial DNAs and adjusts this assumption, declaring that we have here an example of incomplete lineage sorting due to the retention of ancestral polymorphisms (Moran & Kornfield, 1993) which results in gene trees which are not congruent with species trees. For this reason we have to be careful deducing phylogenetic consequences from the cladogram (figure p. 93) in Moran *et al.* (1994: 279).

In a recently published and interesting book Tijs Goldschmidt (1994: 46), well versed in Victoria cichlids, writes that the reliability of a tree based on molecular characteristics would increase tremendously in cases where such a tree was congruent with one based on morphological features. In view of the findings of Moran *et al.*, viz the embedding of *Aulonocara*, *Alticorpus*, and *Lethrinops* in the Mbuna-group, we may conclude that molecular biology has not yet succeeded in replacing phylogenetics based on morphological characteristics. It thus seems appropriate to conclude with a remark made by the geneticist John Brookfield (1994: 338) while discussing the aforementioned work by Avise: "...phylogeny estimations based on morphology have

usually turned out to be correct, so further molecular checking could have low priority".

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The CICHLIDS Yearbook



Labidochromis cf. *chisumulae*, Mbweca, Mozambique.



Tropheus moorii, Kasanga, Tanzania ("Red Rainbow"). Photo by Max Bjørneskov