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Wilkens,H.; Burns,R.J.

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A NEW *ANOPTICHTHYS* CAVE POPULATION (CHARACIDAE, PISCES),

by Horst WILKENS and Richard J. BURNS.

Analyse.

Une nouvelle forme cavernicole « Micos » et son emplacement sont décrits. Ses yeux et sa pigmentation sont moins réduits que ceux des poissons cavernicoles *A. hubbsi* et *A. antrobius*, et la variabilité de ses organes est plus grande. Donc, la nouvelle population semble être plus jeune du point de vue phylogénétique.

Les autres poissons observés dans la grotte sont *Astyanax mexicanus* (Characidae) ancêtre épigé de la forme « Micos » et *Poecilia sphenops* (Poeciliidae). *Astyanax* et la forme « Micos » se nourrissent de guano de chauve-souris ; la forme « Micos » se nourrit aussi des autres poissons. *Astyanax* et *Poecilia* paraissent sous-alimentés ; ils sont probablement accablé par la forme « Micos » succombant à la concurrence dans l'obscurité.

A new *Anoptichthys* cave form, called Micosfish, and its location are described. Its eyes and pigment are less reduced than in the cave fish *A. hubbsi* and *A. antrobius*, and variability in these organs is greater. Hence, the new population is probably phylogenetically younger.

Other fish found in the cave are *Astyanax mexicanus* (Characidae), the epigean ancestor of the Micosfish, and *Poecilia sphenops* (Poeciliidae). *Astyanax* and the Micosfish feed on bat guano, and the latter also feeds on other fish. *Astyanax* and *Poecilia* appear to be undernourished and the Micosfish probably feeds on them as they succumb from competition in darkness.

⁂

Introduction.

All hypogean derivatives of the normal-eyed and normal-pigmented epigean characin, *Astyanax mexicanus* (Filippi), which have been described (Chicafish, *Anoptichthys jordani* Hubbs and Innes 1936 ; Sabinosfish, *A. hubbsi*, and Pachonfish, *A. antrobius*, Alvarez 1946) are with the exception of *A. jordani*, characterized by almost complete reduction in eyes and loss of almost all melanin pigment (Peters and Peters 1966, Wilkens 1970 a b c). Variability in these features is low in *A. antrobius* and *A. hubbsi*, which demonstrates their being genetically homozygous. This is typical of phylogenetically old troglodyte forms (Kosswig 1960, Peters and Peters 1968). This state, in which there is no complete allelity between the cave forms, has been achieved convergently since the beginning of the pleistocene (Kosswig 1967, Wilkens in press a).

Recent studies demonstrate that the only cave form of *Anoptichthys* with more variability in eye size and pigment, *A. jordani*, is definitely the result of a secondary hybridization between a true cave fish and the epigean ancestral form (Wilkens in press c). It is

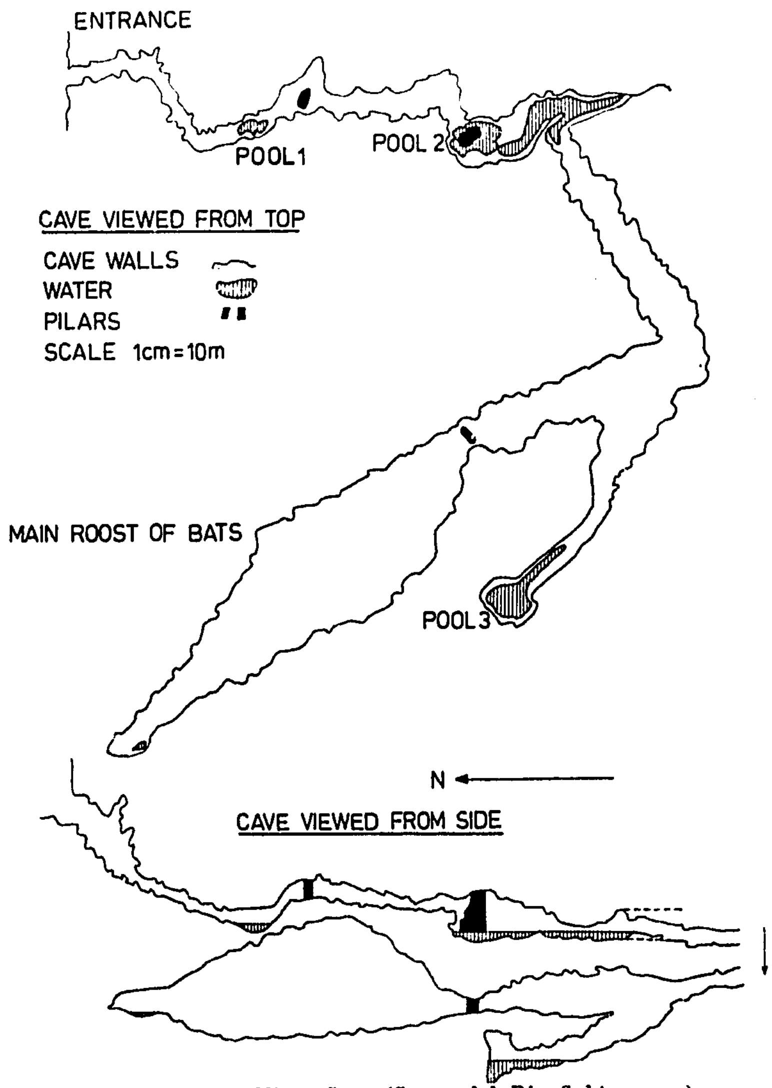

FIG. 1. — The Micos Cave (Cueva del Rio Subterraneo).

not a phylogenetically young hypogean fish. Within the scope of studies concerned with the problems of regressive evolution, the discovery of a new cave population of *Anoptichthys*, which appears to be in *statu nascendi*, therefore deserves special attention. This population becomes even more interesting because it does not occur in the Sierra de El Abra, San Luis Potosi, Mexico, where the other *Anoptichthys* forms have been found (Hubbs and Innes 1936, Alvarez 1946), but in the neighbouring Sierra de la Colmena.

Materials and Methods.

The population was discovered in a cave near Micos, San Luis Potosi, Mexico, during studies concerned with vampire bats. Some of the fish collected in Micos cave were killed and fixed for later studies. Others were sent alive to Germany. In the aquarium at the Zoologisches Institut and Zoologisches Museum in Hamburg they were kept in daylight and genetic and histological studies are done.

The cave (Figure 1) was located about 10 km south of Micos, San

TABLE I.

Properties of Micos cave water.

Filtrate			Residue		
pH		8.00	Ca	mg/l	1.40
Ca	mg/l	88.77	Mg	»	0.36
Mg	»	3.40	SO_4	»	3.88
Na	»	9.00	H_2S	»	1.02
K	»	2.50	SiO_2	»	1.30
Cl	»	8.34	Fe	γ/l	1.82
SO_4	»	9.47	Mn	»	74.00
Fe	γ/l	35.00	P	»	34.00
Mn	»	< 20.00			
P	»	0.75			
°d Ca		12.40			
°d Mg		0.78			
GH		13.20			
d KH		12.80			

Luis Potosi, a small town near Ciudad Valles. The entrance was at the base of a small mountain range (San Dieguito). The entrance had a strong descent, but the inner parts were rather level. During the April visit, which was in the dry season, water was mainly concentrated in 3 unconnected pools which were stagnant. Their maximum depths were : pool 1, 0.50 m ; pool 2, 1.50 m ; and pool 3, unknown. The water in all pools was clear and was the warmest in pool 3. The chemical values are shown in table I.

The cave was mapped as follows. The length and changes in elevation of the floor were taken with a metal tape measure. Width and height of the cave were sometimes measured, but were usually estimated after visual inspection. Direction in the cave was taken with a compass.

During the rainy season a lot, perhaps all water enters the cave from a creek which is dry in the dry season. The cave becomes a subterranean stream, and at this time there are probably no separate pools. This is shown by parts of shrubs and trees which are jammed in the ceiling and by rubble concentrated at several points in the cave.

Although *A. jordani*, *A. hubbsi*, and *A. antrobius* are not different species, but only a series of hypogean populations of the epigean *Astyanax mexicanus* their old names have been used in this paper. The new *Anoptichthys* population is called the Micosfish.

Results.

a) THE MICOSFISH.

Micosfish were found living in all 3 pools, though most of them were in pool 3. The specimens caught and observed were mostly adults or at least half grown. The rudimental eyes of these fish were less reduced than those of *A. hubbsi* and *A. antrobius*, though the variability was higher. The variability was approximately half as large as that of the F2-generation when *A. hubbsi* or *A. antrobius* are crossed with the epigean form (Wilkens 1970 a). The eye sizes corresponded to the small-eyed part of the distribution curve of this cross. A large part of the eyes was covered by skin, as is typical for eyes of this size (Breder and Gresser 1941, Wilkens 1970 a, c).

The variability in melanin pigmentation was low. Its intensity surpassed that of *A. hubbsi* and *A. antrobius* considerably, and will, contrary to eye size, increase after the cave individuals are kept in daylight for some weeks. Then the fish are nearly as dark as individuals of the epigean population.

b) OTHER ANIMALS CAUGHT.

Besides the Micosfish, which was the most numerous, several individuals of epigean *Astyanax mexicanus* and *Poecilia sphenops* were captured in the cave. The epigean *Astyanax* could easily be identified by its large non-reduced eyes. This normal eye size has been confirmed by keeping fish in the laboratory and by observing their offspring. These possess complete and non-reduced eyes, whose variability corresponds to that of an epigean population of *Astyanax* from the Rio Tampaon (Wilkens, 1970 a). Also, the melanin pigment in these two epigean populations did not show any differences. Both are *Astyanax mexicanus* and belong to the same general population without any apparent differences (Géry, personal communication).

Individuals of both populations have very few anal rays (iii, 18-19 (i)), are rather deep, and have the dorsal fin well in front of midbody. The depth of the peduncle is less than half the length of the head, the maxillary is short with 1 or 2 teeth, and the lateral mandibulary teeth are noticeably smaller than the frontal teeth.

The *Astyanax* from the cave were 2 to 8 cm long (total length). The smaller ones showed symptons of malnutrition. Their bodies were slender and small with large heads, and their ventral sides were sunk in. In the laboratory under good care they recovered and reproduced. No visible symptoms of malnutrition were observed in the adult individuals.

The second fish species captured in the cave was the live bearing tooth carp *Poecilia sphenops*. All specimens displayed the characteristic symptoms of malnutrition mentioned above.

Besides the fish, a tadpole was caught, and bats were encountered throughout the cave. The main bat roost was located in the largest chamber, near pool 3, and it contained approximately 2000 *Pteronotus*. A small unidentified member of the *Phyllostomus* bat group was captured near pool 1, and other bat species were probably present. As there were only 0.25 cm between ceiling and water surface of pool 2 the bats of the main roost presumably do not leave the cave by the entrance described. There seem to be other openings in the largest chamber.

TABLE II.

Contents of stomach and intestine from the Micosfish and the epigean Astyanax *from Micos cave.*

(TL. = Total - length in cm).

Micosfish			Cave epigean *Astyanax*		
	TL	Contents	N°	TL	Contents
1	5.0	chitin	1	4.0	chitin
2	7.0	»	2	6.0	»
3	5.5	»	3	8.0	»
4	6.5	»	4	6.5	»
5	7.0	»	5	5.5	»
6	3.0	»	6	4.5	»
7	5.5	»	7	6.5	»
8	7.0	»	8	3.8	»
9	5.0	»	9	3.8	»
10	10.0	» et fish	10	5.0	indet.
11	6.5	» »	11	6.0	»
12	9.5	» »			
13	5.8	» »			
14	6.0	fish			
15	8.5	»			
16	6.5	»			
17	7.0	indet.			
18	8.5	»			

c) FOOD STUDIES.

The stomachs and intestines of the epigean *Astyanax* and the Micosfish were filled with brown substance (Table 2). Microscopic examination proved this to be mostly fragments of chitin originating from the exoskelleton of insects, and considerable amounts of scales from wings of nocturnal lepidopterae. In parts of the cave this substance, guano of insectivorous bats, covered the floor. Additionally, the stomachs of some large specimens of the Micosfish contained partly digested fish bodies. These could no longer be identified.

Discussion.

A. jordani, the cavernicolous population of *Anoptichthys* first described, is definitely a hybrid and not a cave fish in statu nascendi (Wilkens in press c). However, there is reason to believe that the Micosfish is a phylogenetically young cave form, though it may be crossed with the cave epigean form, as is shown by laboratory breeding studies. This assumption is supported by several facts. First, the variability in size of eye rudiments is lower than in the hybrid population of *A. jordani* but surpasses that of the true cave fish *A. hubbsi* and *A. antrobius*. This is true of phylogenetically young troglobionts. Secondly, in spite of reduced eye size, the melanin pigment seems to be almost unafflicted by regressive mutations, contrary to the other *Anoptichthys* (Wilkens, 1970 b). Its variability is much lower than in *A. jordani* or the F2-generation cross between epi- and hypogean forms *Anoptichthys* x *Astyanax* (Wilkens, 1970 b). Furthermore, the eye size of the epigean *Astyanax* found in the cave lies outside the distribution curve of eye size for the Micos cave form. Laboratory offspring show no more variability than that of the epigean form from the Rio Tampaon, which has been previously studied (Wilkens, 1970 a). These facts insure that these fish are not extremes of a normally distributed curve of eye sizes of a hybrid population. They are, apparently, individuals of an epigean population of *Astyanax* which wash into the cave from the epigean creek during the rainy season. This assumption is supported by the presence of other epigean animals in the three pools.

However, the possibility of a more previous hybridization between a more reduced cave fish and some epigean ancestor cannot completely be excluded. If this occurred, the originally more extensive variability in eye size could have been reduced, secondarily, to the size we observe today. This possible hybridization is rather improbable, however, because the melanin pigmentation does not differ considerably from that of the epigean ancestor. In a hybridization all degrees of pigmentation between pigmented and non-pigmented parental forms should be found, as is shown by *A. jordani*.

Studies in the laboratory demonstrate that the epigean *Astyanax* is preadapted for cave life (Schemmel, 1968 ; Wilkens in press b).

If kept in darkness or if blinded, it is able to orient, to propagate, and to feed. Therefore it is assumed that the symptoms of malnutrition, observed in almost all of the epigean fish from the cave are not caused by their inability to live in darkness. Probably, during the time of separation from the epigean ancestor, the Micosfish developed adaptations to cave life that today enable them to overcome the latter in competition in darkness (Mitchell, personal communication). The result is that epigean fish, which happen to enter the cave today usually starve and may be eaten by the cave form, as is demonstrated by fish bodies found in the stomachs of the latter.

The same is probably true for the live bearing tooth carp *Poecilia sphenops*. This fish is also preadapted for cave life (Parzefall, 1969 ; Zeiske, 1968). Consequently an eye-reduced cave population may be derived from it, and one has been discovered in a cave near Teapa, Tabasco, Mexico (Gordon and Rosen, 1962). Like the epigean *Astyanax* all individuals of *Poecilia* in the Micos cave exhibit symptons of malnutrition, and, probably, like the epigean *Astyanax* form, succumb in competition with the Micosfish.

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Universität Hamburg, Zoologisches Institut und Zoologisches Museum, 2 Hamburg 13, Papen-Damm 3. Wildlife Research Center, Bldg. 16, Federal Center, Denver, Colorado 80225.

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Personal communications : Roberts W. Mitchell, Texas Tech. University, Lubbock, Texas 79409, USA.

Personal communications : Dr. J. Géry, 24 Saint-Geniès (Dordogne), France.