

**Population decline in a Brazilian cave catfish,
Trichomycterus itacarambiensis Trajano & Pinna, 1996
(Siluriformes): reduced flashflood as a probable cause.**

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Among the 24 subterranean troglomorphic Brazilian fishes known to date¹, *Trichomycterus itacarambiensis* (Siluriformes: Trichomycteridae) is unique in exhibiting polymorphism in eyes and pigmentation^{2,3}. It is also endemic to just one cave, the 5000 m long Olhos d'Água, in Itacarambi Co., Minas Gerais State, eastern Brazil. We assessed the population size of *T. itacarambiensis* during the dry season (April to October) of 1994 using mark-recapture techniques as described in⁴. The first 4000 m long cave stream reach, contiguous to the cave main entrance (the stream resurgence), was divided in 100 m sections, in which individuals were captured by hand-netting, marked and released. The total population size was estimated at 1500–2000 fish, a third of which were true albinos, the remaining presenting individual variation in degree of melanic pigmentation; this represents a relatively high density (0.15–0.20 m⁻²) for cavefish standards⁵.

When we revisited the cave in 2006, we noticed a decline in population density within the first 2000 m stream segment just upstream from the cave entrance. In order to investigate this apparent decline, we conducted visual censuses in the first 4000 m reach of the cave stream in July of 2007 and 2008. The remaining 1000 m reach was not resurveyed because of difficulties with access. The number of individuals observed was compared to that captured in July 1994 (Table 1). The latter were hand-netted after visual inspection of the habitat, with a collecting efficiency of 70–80% of fish seen.

We compared the total numbers of individuals and the numbers of albino and pigmented catfish observed, respectively, in 1994 (recaptures were excluded), 2007 and 2008 in the 4000 m long stream reach. In addition to a total count for the entire stream reach surveyed, we partitioned fish observations into four cave sectors corresponding to natural subdivisions of the cave in terms of habitat characteristics and population densities (as observed in 1994): Sector A: sections 1 to 18 (1800 m contiguous to the cave stream resurgence; shallow graveled riffles intercalated with soft-bottomed pools up to 1 m deep); Sector B: sections 19 to 23 (the next 500 m; deeper waters, partially running under large

rocky blocks); Sector C: sections 23 to 28 (the following 500 m; similar to the first sector); Sector D: sections 29 to 40 (1200 m close to the stream sinkhole into the cave; open riffles intercalated with shallow waters under blocks).

The sets of counts for the four cave sectors (subtotals in Table 1, pigmented + albinos) differed between 1994 and 2007 ($X^2 = 256.87$; $p < 0.0001$), and 1994 and 2008 ($X^2 = 132.70$; $p < 0.0001$). These differences are because of an accentuated decline in the fish population downstream (Sector A): ANOVA, $F = 5.118$, $p = 0.0154$; Bonferroni *post-hoc* test showing significant differences between 1994 and 2007 ($p = 0.041$) and 1994 and 2008 ($p = 0.0290$); no differences have been found for the other cave sectors. The real differences are probably greater than reported here, considering that we used, for statistical comparisons, the numbers of fish actually captured in 1994.

Table 1. Numbers of *Trichomycterus itacarambiensis* (Teleostei: Siluriformes) observed in the Olhos d'Água Cave, Itacarambi Co., Minas Gerais State, eastern Brazil. One section represents a 100 m linear segment of the stream, beginning with section 1 at the most downstream end of the cave; some sections were grouped because the marks used to delimitate them in the 1990s were lost before 2007.

Sector/Section	July 1994		July 2007		July 2008	
	Albino	Pigmented	Albino	Pigmented	Albino	Pigmented
Sector A (1800 m):						
Section 01-12	10	32	4	3	1	6
13-14	2	6	3	2	0	3
15-16	2	19	1	1	0	0
17-18	0	14	1	1	2	0
Subtotal:	14	71	9	7	3	9
Sector B (500 m):						
Section 19	0	0	1	0	0	1
20	1	1	1	2	0	0
21	2	0	0	1	0	1
22	1	1	1	1	1	3
23	1	6	1	1	1	6
Subtotal:	5	8	4	5	2	11
Sector C (500 m):						
Section 24	1	9	2	1	2	3
25	3	6	2	7	5	2
26	3	16	10	1	6	7
27	2	4	2	1	0	0
28	5	0	5	6	5	1
Subtotal:	14	35	21	16	18	13
Sector D (1200 m):						
Section 29	2	0	18	7	0	0
30-33	2	4	4	2	7	2
34-35	3	0	5	6	3	2
36	0	0	10	2	2	0
37-40	10	19	6	4	11	5
Subtotal:	17	23	43	21	23	9
TOTAL	50	137	77	49	46	42

Differences have also been found in the proportions of albino to pigmented individuals: albinos were significantly less frequent than pigmented fish in 1994 (ANOVA, $F = 4.53$; $p = 0.040$), but not in 2007 ($F = 1.65$; $p = 0.20$) and in 2008 ($F = 0.062$; $p = 0.803$).

Population declines in other threatened Brazilian cavefishes may be directly attributed to human disturbance on a regional scale, such as chemical pollution and tourism⁶ (the heptapterid catfish *Pimelodella kronei*), and over-harvesting of subterranean aquifers (the characiform *Stygichthys typhlops*)⁷. However, there is no evidence of local negative anthropogenic impact in the Olhos d'Água area – water leaving the cave was canalized for human use⁴, but not pumped, thus this use stopped when the water level was too low and almost all the water infiltrated in the soil. The cave is rarely visited and its recharge basin is protected with minimal environmental disturbance or evidence of chemical or organic pollution.

An explanation for this decline is the scarcity of flashfloods in the last decade; local inhabitants reported that there were no flashfloods for the four years prior to 2008 and evidence of floods we observed in 2006, 2007 and 2008 downstream inside the cave were at least a few years old. Flashfloods wash in organic matter and carry them from the upstream sinkhole throughout the 5000 m long cave, allowing nutrients to reach the downstream reach. Periodic nutrient input via flashfloods may be necessary to support the large catfish population observed in 1994 and in previous visits to the cave. This explanation is consistent with the fact that the population decline occurred in this part of the cave. Organic matter downstream of the cave would be scarcely replenished when the water velocity is low. The proportionally higher decrease in the number of pigmented individuals when compared to the albinos may indicate that the factors responsible for population decline affect more the former, possibly more sensitive to food limitation than the albinos.

For a small population, estimated in 1500–2000 individuals in 1994, the losses observed in the last decade are highly significant. Although we cannot rule out the possibility that such decline is part of a natural cycle, it may also be a consequence of environmental changes due to human activities, posing an extreme concern for the future of this unique species. This is especially true in view of the fact that there is no practical, politically and environmentally viable proposal of effective protection actions compatible with the macro-scale of the probable cause for the population decline of *T. itacarambiensis*.

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