

Morphology and distribution of the cave knifefish *Eigenmannia vicentespelaea* Triques, 1996 (Gymnotiformes: Sternopygidae) from Central Brazil, with an expanded diagnosis and comments on subterranean evolution

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We present herein data on morphology and distribution of the cave knifefish *Eigenmannia vicentespelaea* Triques, 1996, from the São Domingos karst area, Central Brazil, comparing it to the epigeal (surface) species, *Eigenmannia* sp., found in the same area (but not syntopic with *E. vicentespelaea*) and also with congeners from other localities. Collecting sites comprising epigeal and subterranean stream reaches in São Domingos were sampled during the dry seasons of 1999, 2000, and 2001 using several methods. Preserved specimens of *E. vicentespelaea* (n=25, including holotype and paratype) and of *Eigenmannia* sp. (n=15) were compared with focus on morphometric characters, body pigmentation and eye condition. A combination of characters separates *E. vicentespelaea* from *Eigenmannia* sp. and other congeners: the length from the tip of the snout to the posterior of the anal fin base, ocular diameter: head length and pre-anal distance: head length proportions, and body pigmentation. A wider morphometric variation in *E. vicentespelaea* is described than that reported in the original description (based on two specimens).

São apresentados dados sobre a morfologia e distribuição do peixe-elétrico cavernícola *Eigenmannia vicentespelaea* Triques, 1996, da área cárstica de São Domingos, Brasil Central, comparando-o com a espécie epígea da mesma área, *Eigenmannia* sp. e congêneres de outras localidades. Coletas de exemplares foram feitas em trechos epígeos e subterrâneos de rios durante as estações secas de 1999, 2000 e 2001, utilizando-se diferentes métodos de coleta. Espécimes preservados de *E. vicentespelaea* (n=25, incluindo holótipo e parátipo) e *Eigenmannia* sp. (n=15) foram comparados em relação a caracteres morfométricos, de pigmentação do corpo e da condição dos olhos. Uma combinação de caracteres separa *E. vicentespelaea* de *Eigenmannia* sp. e de outros congêneres: o comprimento da extremidade do focinho até a porção posterior da base da nadadeira anal, as proporções diâmetro ocular:comprimento da cabeça e distância pré-anal:comprimento da cabeça, e pigmentação do corpo. É descrita uma ampla variação dos caracteres morfométricos em *E. vicentespelaea*, comparando-se com a descrição original (baseada em dois espécimes).

Key words: Morphometric data, electric fishes, cave environment, São Domingos karst area.

Introduction

Electric fishes of the Order Gymnotiformes are an important component of the night-active ichthyofauna in South and Central America, corresponding to a monophyletic group based, among other characters, on the ability of producing and detecting weak electric fields (Alves-Gomes *et al.*, 1995; Albert & Campos-da-Paz, 1998; Albert, 2001). These fishes are distributed between 35°S, in Argentina, and 18°N, in Mexico (Eigenmann & Allen, 1942; Bullock *et al.*, 1979; Mago-Leccia, 1994), with some genera occurring almost exclusively in deep waters of the Amazon basin. The adaptations related to their predomi-

nantly nocturnal activity favor the colonization of totally dark habitats such as those in the subterranean realm (defined as the network of interconnected subsoil spaces, with variable sizes, filled with water or air and characterized by permanent darkness—*sensu* Juberthie, 2000).

According to Albert & Campos-da-Paz (1998) and Albert (2001; 2003), Sternopygidae Cope, 1871 is also a monophyletic group. The monophyly of its 23 recognized species – distributed in the genera †*Ellisella*, *Sternopygus*, *Archolaemus*, *Rhabdolichops*, *Eigenmannia*, and *Distocyclus* – is supported by 14 anatomical and physiological characters. However, Alves-Gomes *et al.* (1995), analyzing mitochondrial sequence data,

morphological and electrophysiological characters, suggested that Sternopygidae is not a natural group and proposed a new family, Eigenmanniidae, comprising the genera *Rhabdolichops* + (*Eigenmannia* + *Distocyclus*). Nevertheless, the monophyly of *Eigenmannia* Jordan & Evermann, 1896 was not demonstrated yet and its taxonomy remains confused (Mago-Leccia, 1978; Lundberg & Mago-Leccia, 1986; Albert, 2001).

The only known troglobitic gymnotiform is *E. vicentespelaea* Triques, 1996, from the São Domingos karst area, upper Tocantins River basin, in Central Brazil (troglobites are defined as species restricted to subterranean habitats, usually showing specializations related to the evolution in isolation in this environment – troglomorphisms *sensu* Christiansen, 1962). This species was included in the *E. virescens* species-group (*sensu* Albert, 2001), which comprises four species (*E. virescens*, *E. trilineata*, *E. vicentespelaea*, and an undescribed species) sharing the following character states: two or three longitudinal lines on either side of the body; lateral *valvula cerebellum* large; and anterior intermuscular highly branched.

Triques (1996) based the description of *E. vicentespelaea* on two specimens collected in 1978 in São Vicente I Cave. The species diagnosis was based in the proportion of the ocular diameter in relation to the head length. This character has also been used to separate the epigeic (surface) species, *E. macrops*, *E. humboldtii* and *E. virescens*, from Venezuela (Mago-Leccia, 1978), and also *Sternarchorhynchus* species from Brazil (Campos-da-Paz, 1997).

During a study on the epigeic and subterranean ichthyofauna from São Domingos karst area, including the ecology and behavior of *Eigenmannia* spp. (Bichuette, 2003; Bichuette & Trajano, 2003), specimens of the cave *E. vicentespelaea* and an epigeic species were collected, allowing a comparative study of their external morphology. The identification of the epigeic species equivocal became because some character states (overlapping of OD:HL and SNL:HL proportions – R. Campos-da-Paz, pers. comm.) indicated that it would belong to the *E. macrops* species-group (*sensu* Albert, 2001), representing a new geographical record for this group (upper Tocantins River basin). However, the inclusion of the epigeic species in the *E. macrops* species-group is doubtful since other character states, such as three longitudinal lines along the body, characteristic of the *E. virescens* species-group, are present in this species. For this reason, this epigeic species from Domingos karst area is herein referred as *Eigenmannia* sp.

Preliminary observations on the large intrapopulation variability regarding eyes and body pigmentation in *E. vicentespelaea*, combined with the morphological similarity between the two *Eigenmannia* species from São Domingos karst area, raised some doubts about the diagnosis of *E. vicentespelaea*.

We present herein morphometric and distributional data on *E. vicentespelaea*, comparing it to the epigeic species *Eigenmannia* sp. from the same area and congeners from other regions. An expanded diagnosis is proposed for the former, and the evolution in the subterranean environment is discussed.



Fig. 1. Sinkhole of São Vicente Cave System, São Domingos karst area, Goiás State, Central Brazil – type locality of *Eigenmannia vicentespelaea* Triques, 1996. Photo: E. M. Bichuette.

Study area. During the present study, specimens of *E. vicentespelaea* were found in the São Vicente I and São Vicente II caves, and specimens of *Eigenmannia* sp. in the Rio da Lapa and subterranean stream reaches of the São Mateus and Angélica caves. These localities are within the limits of the Terra Ronca State Park (13°30' - 13°50' S, 46°0' - 46°30' W), in São Domingos County, eastern State of Goiás, Central Brazil. The area lies in the Cerrado (the savannah-like Brazilian vegetation) phytogeographic domain (Ab'Saber, 1977), presenting a tropical semi-humid climate with 4-5 dry mo/yr (Nimer, 1979). São Domingos is a carbonate karst area characterized by the presence of continuous limestone outcrops belonging to the Bambuí Group and is crossed by several parallel streams running westward to join the Paranã River, a tributary of the upper Tocantins River, Amazon basin. After an epigeic reach, each major stream enters into a cave through a sinkhole (Fig. 1), crossing hundreds to thousands of meters through subterranean conduits, and emerging to the surface through resurgence.

Eigenmannia vicentespelaea coexists with epigeic fishes in the São Vicente I Cave (a siluriform, *Pseudocetopsis plumbeus*) and São Vicente II Cave (a siluriform, *Spatuloricaria* sp. and four gymnotiforms, *Sternopygus* sp., *Sternarchorhynchus mesensis*, *Archolaemus blax*, and *Porotergus* sp.). The epigeic *Eigenmannia* species coexists, in the Rio da Lapa, with characiforms (*Brycon* undescribed species, *Characidium* sp., and *Creagrutus britski*) and siluriforms (*Pseudocetopsis plumbeus*, *Aspidoras poecilus*, *Parotocinclus* undescribed species, *Hypostomus* sp., *Ancistrus* sp., *Phenacorhamdia tenebrosa*, and *Imparfinis hollandi*) (Bichuette & Trajano, 2003).

Materials and Methods

For the comparative study of the external morphology and morphometry of *Eigenmannia* species, different localities comprising both epigeic and subterranean streams were sampled during the dry seasons of 1999, 2000, and 2001 using different collecting methods (e.g., hand-nets during snorkeling, electrofishing, and nets installed in the marginal vegetation of the epigeic streams). The collected specimens were preserved

in formalin and transferred to 70% alcohol for studies in the laboratory, where they were measured straight-line under a stereomicroscope with a dial caliper, 0.1 mm precision, on the left side. Measurements followed Mago-Leccia (1978), Triques (1996), and Campos-da-Paz (1997, 2000): LEA, length from the tip of the snout to the posterior of the anal fin base; HL, head length; SNL, snout length; OD, ocular diameter; PF, length of the pectoral fin; PPD, pre-pectoral distance; DSA, snout-anus distance; PAD, pre-anal distance. The following proportions were calculated (expressed in %): OD:HL, SNL:HL, PF:HL, HL:LEA, DSA:LEA and PAD:LEA. The degree of body pigmentation in preserved animals was categorized into two classes: evident pigmentation (P) with some coloration pattern (evident longitudinal stripes), and reduced pigmentation with faint longitudinal stripes –(RE). Three individuals of each species were cleared and stained (C&S) following the Taylor & Van Dyke (1985) method. All specimens were deposited in the ichthyological collection of the Museu de Zoologia da Universidade de São Paulo (MZUSP), Brazil.

In total, 25 specimens of *E. vicentespelaea* from the São Vicente cave system and 15 specimens of *Eigenmannia* sp. from the epigeal reach of Rio da Lapa (11) as well as subterranean reaches of the São Mateus (2) and Angélica (2) streams were examined. The measurements of the holotype and paratype of *E. vicentespelaea* (Triques, 1996) were also included in the graphical and statistical analyses. In addition, morphometric data on other *Eigenmannia* species were obtained from literature (Mago-Leccia, 1978, 1994): *E. humboldtii* (Steindachner, 1878) (n=18), *E. virescens* (Valenciennes, 1842) (n=14), *E. macrops* (Boulenger, 1897) (n=12), and *E. nigra* Mago-Leccia, 1994 (n=7).

In order to test possible differences among the data set relative to the body size and the proportions between OD:HL and PAD:HL, non-parametric tests (Mann-Whitney and Wilcoxon) and ANOVA analysis (with *a posteriori* Dunn's test) were applied. The Spearman correlation test was applied in the comparison between LEA and OD values (Zar, 1996). Before each test, data were tested for homogeneity of variance (homoscedasticity) and normality. All analysis were made using Sigma Stat software (version 2.0), with $\alpha=0.05$.

Results

Eigenmannia sp. was so far recorded in the epigeal reach of Rio da Lapa, from the Terra Ronca Cave entrance (sinkhole of the stream – 13°44'00"S 46°21'30"W) to about 100 m upstream, and in subterranean stream reaches of the Angélica (13°31'24"S 46°23'20"W) and São Mateus III (13°46'05.5"S 46°22'00"W) caves. The latter were always observed near the cave stream resurgences (where a subterranean stream reaches the surface). Apparently, the cave species, *E. vicentespelaea*, recorded only in caves of the São Vicente cave system (13°35'30"S 46°21'00"W, at the stream sinkhole in the São Vicente I Cave), has no contact with *Eigenmannia* sp., since the latter has not been found in epigeal reaches of the São Vicente stream.

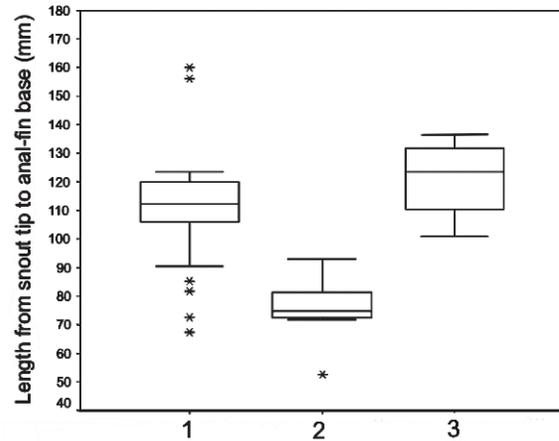


Fig. 2. Length (LEA) medians (horizontal bars), standard deviations and confidence intervals for *Eigenmannia vicentespelaea* (n = 25) and *Eigenmannia* sp. (n = 15) from São Domingos karst area, Central Brazil. *outliers; 1, *E. vicentespelaea*; 2, *Eigenmannia* sp. collected in epigeal river; 3, *Eigenmannia* sp. collected in subterranean stream reaches.

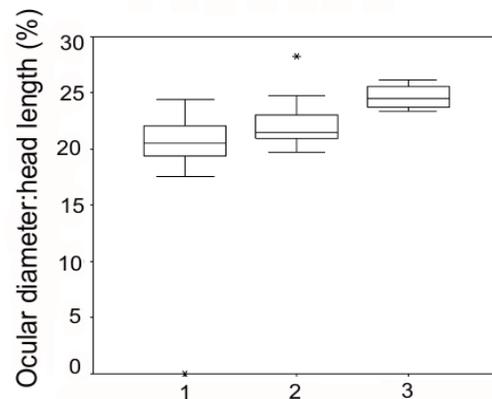


Fig. 3. Ocular diameter:head length proportions, standard deviations and confidence intervals for *Eigenmannia vicentespelaea* (n = 25) and *Eigenmannia* sp. (n = 15) from São Domingos karst area, Central Brazil. *outliers; 1, *E. vicentespelaea*; 2, *Eigenmannia* sp. collected in epigeal river; 3, *Eigenmannia* sp. collected in subterranean stream reaches; horizontal bars, medians.

Morphometric data relative to the two studied species of *Eigenmannia* are shown in Table 1 (data from holotype and paratype not included) and a summary of differences between *Eigenmannia* species is presented in Table 2. Individuals smaller than 70 mm LEA (*E. vicentespelaea*) and 50 mm (*Eigenmannia* sp.) were not found. The LEA medians and the proportions between OD and HL and between OD and LEA, in both *E. vicentespelaea* and *Eigenmannia* sp., are shown in Figs. 2 and 3, respectively. The regression between OD and LEA in *E. vicentespelaea* is shown in Figure 4.

On average, *E. vicentespelaea* specimens showed body length measurements significantly larger than the examined

Table 1. Morphometric data for the cave knifefish, *E. vicentespelaea* (n = 23) and epigeal knifefish, *Eigenmannia* sp. (n=15), from São Domingos karst area, Goiás State, Central Brazil. Measurements expressed in mm and proportions in percentage. Sd, standard deviation; P, pigmented individual; RE, reduced pigmentation.

	<i>E. vicentespelaea</i>			<i>Eigenmannia</i> sp.		
	Range	Mean	Sd	Range	Mean	Sd
LEA	67.6-164.5	111.8	24.73	52.6-136.4	84.5	26.48
HL	8.9-18.5	13.3	2.19	8.4-16.9	12.2	2.59
SNL	2.6-6.0	4.1	0.83	2.0-5.7	3.6	0.93
OD	0-1.9	1.3	0.39	1.2-2.5	1.7	0.32
PF	6.3-14.4	10.3	1.87	6.1-12.2	8.7	1.96
PPD	9.3-20.7	14.6	2.60	8.9-17.4	12.8	2.56
DSA	4.7-9.7	7.9	1.14	5.3-9.9	6.9	1.40
PAD	12.7-23.7	19.0	2.79	7.6-25.7	16.2	5.04
HL:LEA	10.6-15.0	12.1	0.97	12.0-16.7	14.9	1.98
SNL:HL	27.7-36.1	31.0	2.03	23.8-36.4	29.4	3.15
OD:HL	0-24.4	19.8	4.71	19.7-28.3	23.0	2.38
PF:HL	65.2-92.9	76.2	6.49	65.8-86.8	73.0	5.64
DSA:LEA	5.9-9.6	7.3	0.93	6.4-11.8	8.5	1.45
PAD:LEA	14.3-24.4	17.3	2.14	10.6-26.4	19.0	3.78
PAD:HL	128-171	143.6	12.02	77-157	128.4	17.57
Pigments (%)	91.3% RE 8.7% P			13.3% RE 86.7% P		

specimens of *Eigenmannia* sp. (T = 160.0, p = 0.029) (Fig. 2). Only *Eigenmannia* sp. specimens captured in the subterranean reaches of the São Mateus III and Angélica streams overlapped in size with those of *E. vicentespelaea*. Compared to other *Eigenmannia* species, *E. vicentespelaea* showed body lengths significantly smaller than *E. humboldtii* (T=24.0; p=0.000) and *E. nigra* (W=325.0; p=0.000) (Table 2).

The OD:HL proportions varied between 17.6 and 24.4 % in most examined specimens of *E. vicentespelaea* (with one case of individual with no externally visible eyes - Fig. 5), and between 19.7 and 28.3 % in *Eigenmannia* sp. OD:HL proportions in *E. vicentespelaea* are significantly smaller than the observed for *Eigenmannia* sp. (T = -418.0; p = 0.002). In addition, the eye size variation herein recorded for *E.*

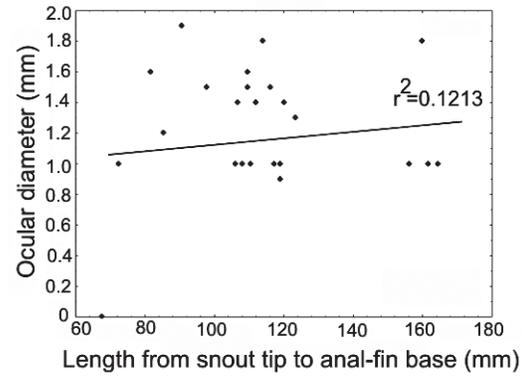


Fig. 4. Regression between OD and LEA in *Eigenmannia vicentespelaea* (n = 25).

vicentespelaea is much wider than the proposed as diagnostic for this species, between 8.2 and 8.8 % (Triques, 1996).

In relation to the PAD:HL proportions, Mann-Whitney and ANOVA analysis showed that *E. vicentespelaea* presents values significantly higher than *Eigenmannia* sp. (T=46.0; p=0.001), *E. humboldtii* (Q=6.243; p<0.05), *E. virescens* (Q=3.326; p<0.05) and *E. macrops* (Q=3.962; p<0.05) (Table 2). At the size range recorded for *E. vicentespelaea*, there was no significant correlation between OD and LEA (r = 0.0752; p = 0.725) (Fig. 4).

Regarding coloration, specimens of *E. vicentespelaea* with reduced pigmentation - RE (91.3% of the sample) presented a translucent aspect when alive (Fig. 6). Only 8.7% of the examined *E. vicentespelaea* specimens showed body pigmentation similar to that of *Eigenmannia* sp. When preserved in alcohol, specimens of *E. vicentespelaea* showed a pale aspect, with no visible longitudinal stripes (Figs. 5a-b).

Based on the characters presently analyzed, we propose a combination of characters separating *E. vicentespelaea* from its congeners: LEA, OD:HL and PAD:HL proportions and body pigmentation.

Table 2. Compared data of *Eigenmannia* species from South and Central America. * Data from Mago-Leccia (1978, 1994) and Albert (2001, 2003).

	<i>E. vicentespelaea</i>	<i>Eigenmannia</i> sp.	<i>E. humboldtii</i> *	<i>E. virescens</i> *	<i>E. macrops</i> *	<i>E. nigra</i> *
LEA range	67.6-164.5mm	52.6-136.4 mm	125.5-255.0 mm	79.4-194.2 mm	73.9-136.5 mm	172.1-334.0 mm
HL range	8.9-18.5 mm	8.4-16.9 mm	17.2-33.8 mm	10.7-25.0 mm	11.1-19.9 mm	25.0-44.7 mm
OD range	0-1.9 mm	1.2-2.5 mm	3.0-5.3 mm	2.3-4.9 mm	2.8-4.3 mm	4.8-8.5 mm
OD:HL range	0-24.4 %	19.7-28.3 %	15.0-22.0 %	14.0-22.0 %	21.0%-31.0%	17.3-19.2 %
PAD:HL range	128-171 %	77-157 %	94-113 %	107-158 %	74-134 %	158.4-194.1 %
Body pigmentation	Translucent aspect	Three longitudinal stripes, overlapping of OD:HL and SNL:HL proportions	Black spots along the body and head	Two to three longitudinal stripes on either side of the body	Overlapping of OD:HL and SNL:HL proportions	Black coloration
Geographic distribution	Central Brazil: Tocantins River basin (São Vicente cave system)	Central Brazil: Tocantins River basin (rio da Lapa, subterranean stream reaches of Angélica and São Mateus III caves)	Northern South America: Brazil, Colombia and Venezuela	>From Orinoco to La Plata River basins	Brazil and Guyana	Northern South America: Brazil, Colombia, Guyana and Venezuela

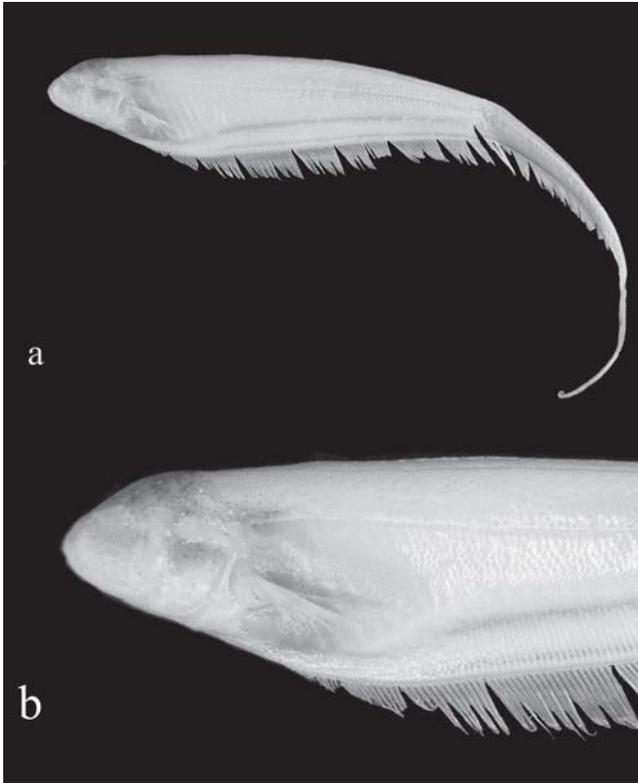


Fig. 5. Preserved specimen of *Eigenmannia vicentespelaea* with no visible eyes and pale aspect (LEA: 67.6 mm). **a.** Entire individual. Scale bar, 10 mm; **b.** Detail of head with no visible eyes. Scale bar, 5 mm. Photos: M. E. Bichuette.

Expanded diagnosis. *Eigenmannia vicentespelaea* differs from the epigeal *Eigenmannia* sp. from São Domingos karst area and other epigeal congeners, by the following combination of characters: significantly reduced eyes, with ocular diameter usually between 17.6 and 24.4% of head length, rarely with no externally visible eyes (OD:HL 19.7 to 28.3% in *Eigenmannia* sp.); body pigmentation reduced, with a translucent aspect when alive; average body lengths significantly larger than that recorded for *Eigenmannia* sp. and smaller than that recorded for *E. humboldtii* and *E. nigra*. PAD:HL proportions significantly larger than in *E. humboldtii*, *E. virescens* and *E. macrops*.



Fig 6. Living specimen of *Eigenmannia vicentespelaea* with relatively well developed eyes and translucent aspect. Note the three longitudinal stripes (LEA: 121.9 mm). Photo: José Sabino.

Discussion

In view of the confused taxonomy and the disputed monophyly of the genus *Eigenmannia*, and the uncertain identification of the presently studied epigeal species, a hypothesis of sister-group relationship between *Eigenmannia* sp. and *E. vicentespelaea* lacks phylogenetic support. On the other hand, these are the only members of the Clade F of Eigenmanninae (*sensu* Albert & Campos da Paz, 1998) found in the study area (Bichuette & Trajano, 2003). Thus, the most parsimonious geographic hypothesis (to be tested in a phylogenetic framework), which would involve no local extinctions of other species closer to any of the two above mentioned, is that of a sister-group relationship between them.

Several authors advocate a correlation between the time of isolation in the subterranean habitat and the degree of reduction of eyes and pigmentation (classical troglomorphy), with populations isolated for shorter times showing less reduced and/or variable eyes and pigmentation than those homogeneously anophthalmic and unpigmented (Wilkins, 1982, 1986; Trajano, 1995). According to this hypothesis, *E. vicentespelaea* may represent a boundary case, as result of quite a short time in isolation, in view of the high degree of variability observed, mainly in relation to the eyes size.

It is not possible to know whether the troglitic species is completely or only partially isolated from epigeal species, because the latter was found in the same large river basin as *E. vicentespelaea* (the Paranã river basin, a tributary of the Upper Tocantins), but not in the same microbasins. In addition, there are records of quite large (see below) and well-fed specimens of *Eigenmannia* sp. in subterranean reaches from the Angélica and São Mateus streams, indicating that this typically epigeal species is able to survive for a long time in the hypogean environment. Thus, in theory these fishes could join the exclusively subterranean *E. vicentespelaea* if they would find their way to the São Vicente stream basin. Therefore, *E. vicentespelaea* may be either the result of allopatric or parapatric differentiation.

The larger body sizes recorded for the specimens of *Eigenmannia* sp. captured in subterranean stream reaches may be related to a lower pressure of predation in this environment (corroborated by the record of potential predators in the epigeal Rio da Lapa – *Brycon* sp. – see Bichuette & Trajano, 2003). This may be associated to a low interspecific competition in caves because it seems that food represented by prey living on the large amount of vegetal debris carried during floods into the studied caves is not limiting for these fishes in hypogean habitats (Bichuette, 2003). Therefore, cave specimens of *Eigenmannia* sp. have the opportunity to take food in rather abundance and live longer without being preyed upon, thus reaching larger sizes than the epigeal ones.

The description of *E. vicentespelaea* was based on two specimens (Triques, 1996), preserved in alcohol since 1978, and its diagnosis was based solely on the OD:HL proportion. As expected, much wider variation in diagnostic characters and morphometric data was found when additional specimens

were examined. Nevertheless, eyes size allied to pigmentation and body sizes may still be used to distinguish the two species of *Eigenmannia* from São Domingos karst area.

Examined material. *Eigenmannia vicentespelaeca*: MZUSP 42605, holotype, 120 mm LEA; São Vicente II Cave: São Domingos County, Goiás State, Central Brazil. MZUSP 47984, paratype, 1 ex., 160 mm LEA; São Vicente II Cave: São Domingos County, Goiás State, Central Brazil. MZUSP 83461, 4 ex., 108.1-164.5 mm LEA; São Vicente I Cave: São Domingos County, Goiás State, Central Brazil. MZUSP 83462, 2 ex., 117.2 and 121.9 mm LEA; São Vicente II Cave: São Domingos County, Goiás State, Central Brazil. MZUSP 83463, 1 ex. (C&S), 118.9 mm LEA; São Vicente II Cave: São Domingos County, Goiás State, Central Brazil. MZUSP 83464, 1 ex., 161.6 mm LEA; São Vicente II Cave: São Domingos County, Goiás State, Central Brazil. MZUSP 83465, 2 ex., 106.2 and 109.2 mm LEA; São Vicente II Cave: São Domingos County, Goiás State, Central Brazil. MZUSP 83466, 1 ex., 119.0 mm LEA; São Vicente II Cave: São Domingos County, Goiás State, Central Brazil. MZUSP 83467, 3 ex., 109.7-123.3 mm LEA; São Vicente II Cave: São Domingos County, Goiás State, Central Brazil. MZUSP 83468, 3 ex., 81.6-116.2 mm LEA; São Vicente II Cave: São Domingos County, Goiás State, Central Brazil. MZUSP 83469, 1 ex., 112.1 mm LEA; São Vicente II Cave: São Domingos County, Goiás State, Central Brazil. MZUSP 83470, 3 ex., 72.5-97.7 mm LEA; São Vicente II Cave: São Domingos County, Goiás State, Central Brazil. MZUSP 83471, 1 ex. (C&S), 106.7 mm LEA; São Vicente II Cave: São Domingos County, Goiás State, Central Brazil.

Eigenmannia sp.: MZUSP 83472, 3 ex., 52.6 and 71.8 mm LEA (one not measured); rio da Lapa: São Domingos County, Goiás State, Central Brazil. MZUSP 83473, 2 ex., 54.7 and 62.9 mm LEA; rio da Lapa: São Domingos County, Goiás State, Central Brazil. MZUSP 83474, 2 ex., 74.1 and 75.8 mm LEA; rio da Lapa: São Domingos County, Goiás State, Central Brazil. MZUSP 83475, 2 ex., 70.3 and 81.1 mm LEA; rio da Lapa: São Domingos County, Goiás State, Central Brazil. MZUSP 83476, 1 ex. (C&S), 81.1 mm LEA; rio da Lapa: São Domingos County, Goiás State, Central Brazil. MZUSP 83477, 1 ex., 73.6 mm LEA; rio da Lapa: São Domingos County, Goiás State, Central Brazil. MZUSP 83478, 2 ex., 119.8 and 136.4 mm LEA; Angélica Cave: São Domingos County, Goiás State, Central Brazil. MZUSP 83479, 2 ex., 100.8 and 127.5 mm LEA; São Mateus III Cave: São Domingos County, Goiás State, Central Brazil.

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