

SHORT COMMUNICATION

Filling gaps in the ecological knowledge on Auchenipteridae catfishes (Ostariophysi: Siluriformes): first data for *Trachelyichthys exilis*

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The feeding habit of *Trachelyichthys exilis* is described for the first time, with additional comments on its growth type and size at sexual maturity. We analyzed 42 specimens from the Amaná Reserve (Amazonas state, Brazil) collected with a seine net amidst stands of floating herbaceous vegetation during the dry season of 2002. Stomach contents revealed a predominantly carnivorous habit (tending to piscivorous), an isometric growth type, and size at maturity around 5.5 cm standard length. Based on the biological characteristics of the consumed prey, we presume that *T. exilis* forage actively during the twilight/night around and among the root tangle of herbaceous vegetation, preying upon nocturnally active animals such as small fishes and aquatic invertebrates, and/or close to the water surface, where diurnally active prey usually rests. Our findings provide essential information to fill knowledge gaps on the natural history of auchenipterid catfishes, especially on trophic ecology.

KEYWORDS: feeding, maturity, growth pattern, ecology, Amazonia

Preenchendo lacunas no conhecimento ecológico de bagres Auchenipteridae (Ostariophysi: Siluriformes): primeiros dados para *Trachelyichthys exilis*

RESUMO

O hábito alimentar de *Trachelyichthys exilis* é descrito pela primeira vez, com comentários adicionais sobre seu tipo de crescimento e tamanho de maturação sexual. Nós analisamos 42 espécimes da Reserva Amaná (Amazonas, Brasil) coletados com rede de cerco em bancos flutuantes de herbáceas durante a estação seca de 2002. Conteúdos estomacais revelaram um hábito predominantemente carnívoro (tendendo a piscívoro), um tipo de crescimento isométrico e tamanho de maturação sexual em torno de 5,5 cm de comprimento padrão. Com base nas características biológicas das presas consumidas, presumimos que *T. exilis* forrageia ativamente durante o crepúsculo/noite ao redor e entre as raízes dos bancos flutuantes, onde captura presas noturnas como pequenos peixes e invertebrados aquáticos, e/ou próximo à superfície da água, onde geralmente repousam as presas diurnas. Nossos resultados fornecem informações essenciais para preencher lacunas de conhecimento sobre a história natural de bagres auchenipterídeos, especialmente sobre a ecologia trófica.

PALAVRAS-CHAVE: alimentação, maturação, padrão de crescimento, ecologia, Amazônia

The family Auchenipteridae, commonly known as driftwood catfishes, is currently composed of 127 species distributed along all major South American basins (Ferraris 2003; Calegari *et al.* 2019; Fricke *et al.* 2022). In general, auchenipterids are crepuscular/nocturnal fishes that swim just below the water surface, searching for insects and macroinvertebrates that fall from the adjacent vegetation (Ferraris 2003). However, different feeding habits (*e.g.*,

carnivorous, frugivorous) can also be found among these fishes. In this context, a recent study identified that information on feeding habits is lacking for many auchenipterid representatives, including the species of *Trachelyichthys* [see Raunkjæran shortfalls in Freitas *et al.* (2021)].

Trachelyichthys includes only two valid species, *Trachelyichthys decaradiatus* Mees, 1974, from Guyana (Rupununi River basin), and *T. exilis* Greenfield & Glodek,

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1977, from Peru (Nanay River, upper Amazon basin) (Fricke *et al.* 2022). Currently, all Amazonian populations are allocated to *Trachelyichthys exilis* (Calegari *et al.* 2019).

Trachelyichthys fish are usually found hiding in aquatic plant roots such as macrophyte banks or in submerged leaf litter (Hercos *et al.* 2009; van der Sleen and Albert 2018). Both *T. decaradatus* and *T. exilis* have been mentioned in fish inventories (DoNascimento *et al.* 2017; Pereira *et al.* 2020) and show potential for exploitation in the ornamental fish trade (Hercos *et al.* 2009). However, no additional information on their biology or ecology is currently available. In this context, we aimed to provide the first description of the feeding habits of *Trachelyichthys exilis*, as well as comments on its growth type and maturity size.

The Amanã Reserve is a protected area located between the Negro River and the Japurá and Solimões rivers (1°30'–3°05'S, 62°50'–65°00'W) in Amazonas state, Brazil (Queiroz 2005). *Trachelyichthys exilis* is listed as a potential ornamental fish for exploitation in the Amanã Reserve (Hercos *et al.* 2009). Samplings were carried out in the Amanã Lake and the Juá Grande stream during the dry season of 2002, between September and November, as part of a large inventory of the ichthyofauna of the reserve. We used a fine-meshed (5 mm between opposite knots) seine net (25 m long, 4 m high) to encircle portions of stands of floating and emergent herbaceous vegetation. We sampled 60 different floating meadows (eight of which resulted in the capture of *T. exilis*) within an area of approximately 170 km². Sampling was carried out from 7 am to 10 am, when individuals are resting after nocturnal activity (van der Sleen and Albert 2018).

After closing the net, the plants were removed, and the fish retained were euthanized with a lethal dose of Eugenol. Collected specimens were immediately preserved in 10% formalin, later transferred to 70% ethanol, and stored in the zoological collection of Instituto Nacional de Pesquisas da Amazônia (INPA-ICT 053095). In the laboratory, the specimens were measured [standard length; SL (in cm); 0.1 cm precision] and weighed [total mass; TM (in g); 0.1 g precision]. These values were used to estimate the length-weight relationship (LWR), following the model $TM = a * SL^b$ (Froese 2006), where a is the coefficient of proportionality and b is the coefficient of allometry (interpreted as the growth pattern). To identify sex-specific growth patterns, the function was initially adjusted to all individuals, comparing the residuals for males and females with a t-test (5% significance level). The LWR parameters were obtained from a non-linear regression in the R program (R Core Team 2021). The study was conducted under authorization of INPA's Ethics Committee for the Use of Animals in Scientific Studies (CEUA/INPA # 033/2012).

The abdominal cavity of each specimen was opened to determine the sex, gonadal maturation stage, and stomach

contents. The classification of gonad maturation stages followed the macroscopic categories defined by Núñez and Duponchelle (2009) for females (immature, maturing, mature, spawned, and resting) and males (immature, maturing, mature, and spent). The stomachs were dissected to examine the food items under a stereomicroscope and prey items were identified to the lowest possible taxonomic level and weighed (0.001 g precision). For each item, we calculated the frequency of occurrence (FO%) as the percentage of food-containing stomachs in which a given food item occurred (Hyslop 1980), and the mass percentage (M%), as the weight contribution of a given item to the total weight of all ingested items (Hynes 1950). Both parameters were combined into the alimentary index (Ai%) adapted from Kawakami and Vazzoler (1980). The Ai% estimates the importance of each food item in the diet and was calculated as $Ai\% = (FO\% * M\%) / (\sum FO\% * M\%) * 100$. Prey items were grouped into three food categories (fish, invertebrates, and plant remains) and FO%, M%, and Ai% were calculated for each category.

A total of 42 individuals were analyzed, of which 25 were females (5.6 ± 1.1 cm SL, range 3.9 to 8.5 cm) and 17 were males (5.5 ± 1.1 cm SL, range 3.6 to 7.5 cm). There was no significant difference in the morphometric residuals between the sexes. Hence, LWR was represented by the single equation $TM = 0.025 * SL^{3.04}$ ($R^2 = 0.961$), evidencing an isometric growth type. Among females, ten specimens were classified as immature (40% of all females), six in maturing stage (24%), six mature (24%), and three resting (12%). No female in spawned stage was observed. For males, ten individuals were immature (59% of all males), two maturing (12%), four mature (24%), and one spent (6%). The immature stage was recorded for females and males up to 3.9 and 3.6 cm SL, respectively, while mature specimens were recorded at 5.5 and 5.3 cm SL for females and males, respectively.

We identified 31 food items in stomachs of 23 individuals that contained food (Table 1). Fourteen contained one, seven contained two, and one contained three food items. The most relevant food category was fish (65.2 Ai%), followed by invertebrates (20.4 Ai%), and plant remains (14.4 Ai%). The most important food items were juveniles of the pelagic engraulid fish *Anchoviella jamesi* (Jordan & Seale, 1926) (38.6 Ai%), followed by plant remains (35.1 Ai%) and juveniles of curimatid fishes (12.6 Ai%). Curimatids were not identified to lower taxonomic levels due to their advanced state of digestion. Other prey items were a juvenile of a doradid fish (*Amblydoras* sp.), a juvenile of a weakly electric eel (*Hypopygus* sp.), and invertebrates (e.g., ants, shrimps, and immature dragonflies) (Figure 1).

Our results evidenced a predominantly carnivorous habit (tending to piscivorous) for *T. exilis*, an isometric growth type, and size at maturity around 5.5 cm SL as novel biological and ecological data for the species and the genus. The maturation

Table 1. Prey items (n = 31) retrieved from stomach contents of 23 individuals of *Trachelyichthys exilis* sampled in Amanã Reserve (Amazonas state, Brazil). n.i. = not identified; FO% = frequency of occurrence; M% = mass percentage; AI% = Alimentary index. The parameters were calculated per food item and per food category (bold).

Prey type/ Order	Family	Taxon	FO%	M%	AI%
Fish			30.4	74.6	65.2
Clupeiformes	Engraulidae	<i>Anchoviella jamesi</i>	13.0	42.2	38.6
Characiformes	Curimatidae	n.i.	8.7	20.7	12.6
Siluriformes	Doradidae	<i>Amblydoras</i> sp.	4.3	3.4	1.0
Gymnotiformes	Hypopomidae	<i>Hypopygus</i> sp.	4.3	8.4	2.6
Invertebrates			47.8	14.9	20.4
Ephemeroptera (larvae)			17.4	0.1	0.2
Hymenoptera			13.0	3.4	3.1
Odonata (larvae)			4.3	0.2	0.1
Insect remains (terrestrial)			17.4	3.7	4.5
Crustacea	Palaemonidae	n.i.	4.3	7.5	2.3
Plant remains			47.8	10.5	14.4
Plant remains			47.8	10.5	35.1

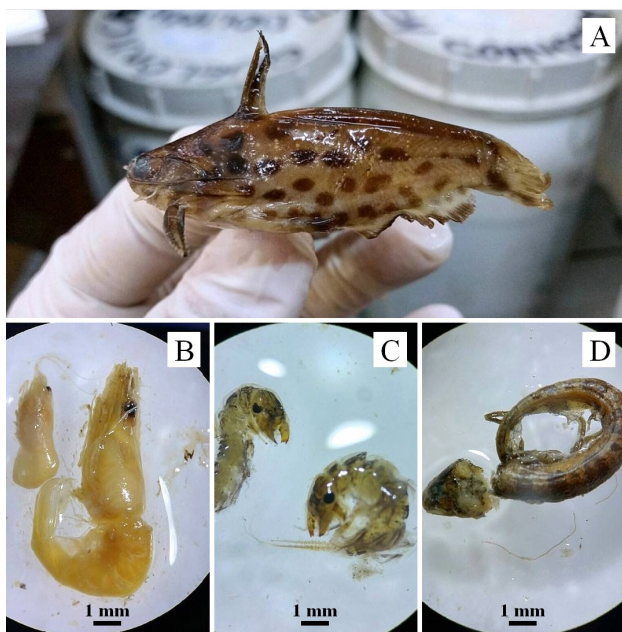


Figure 1. A – Female of *Trachelyichthys exilis* (6.7 cm SL) and prey items retrieved from stomach contents of *T. exilis* from Amanã Reserve (Amazonas state, Brazil); B – Palaemonidae shrimps; C – invertebrates (Ephemeroptera nymphs); D – weakly electric eel *Hypopygus* sp. This figure is in color in the electronic version.

size should be considered with caution, as more long-term data are necessary for reliable inferences about the species' life cycle.

Despite the relatively high proportion of empty stomachs, we assume that our sample is representative of the feeding

habits of *T. exilis* in its natural foraging habitat in Amanã Reserve, considering that we sampled a high number of sites. High percentages of empty stomachs occurred in other studies on carnivorous fishes (Barbarino-Duque and Winemiller 2003), including auchenipterids (Pouilly *et al.* 2004; Sá-Oliveira *et al.* 2014; Freitas *et al.* 2020). Although the prey items were not measured, it is noteworthy that all fishes were swallowed whole, despite their relatively large dimensions (see Figure 1) compared to the predator's size. The consumed items and the nocturnal/crepuscular habit of *T. exilis* (van der Sleen and Albert 2018) indicate that it actively forages around and among the roots or near the substrate of herbaceous vegetation stands for nocturnally active prey (e.g., *Amblydoras* sp., *Hypopygus* sp., shrimps, some immature aquatic insects), and/or close to the water surface, where diurnally active prey rest (e.g., *Anchoviella jamesi*, and curimatid species). Such behavior was also observed in other auchenipterid genera such as *Ferrarissoaresia* (Cabeceira *et al.* 2015) and *Ageneiosus* (Freitas *et al.* 2020). The ingestion of plant matter may occur accidentally along with the ingestion of animal prey within vegetation stands.

Primary data on feeding and reproduction is essential for studies on functional ecology, as, in their absence, these parameters are estimated from the most closely related taxa, potentially leading to a distorted interpretation of specific biological characteristics (Hortal *et al.* 2015). Primary data are also valuable for macroecological and evolutionary research. A current study is in progress on the phylogenetic context of the diet in auchenipterid species, and the data presented herein for *Trachelyichthys exilis* will allow the inclusion of the genus in the analyses (Freitas *et al.* unpubl. data). Future efforts should focus on the feeding habits in natural conditions of other auchenipterid genera with scarce or no available information (e.g., *Liosomadoras*, *Pseudepapterus*, *Pseudotatia*, *Spinipterus*, *Trachelyopterichthys*).

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