Description of *Priapella lacandonae* sp. n. – a new poeciliid fish from the río Tulijá basin, Grijalva system, Chiapas, Mexico (Teleostei: Cyprinodontiformes: Poeciliidae)

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> Abstract

Priapella lacandonae, new species, is described from río Mizola, río Tulijá basin, río Grijalva system, Chiapas, Mexico. It is clearly distinguished by metrics, gonopodial and other morphological characteristics from all other species of the genus. A mitochondrial DNA-sequence based molecular phylogenetic analysis revealed similar results on the status of the new species as a separate taxon and its relation to the other closest related species.

> Kurzfassung

Priapella lacandonae sp. n. wird beschrieben aus dem río Mizola, río Tulijá basin, río-Grijalva-System, Chiapas, Mexico. Die Art unterscheidet sich deutlich durch ihre morphometrischen Merkmale, Besonderheiten des Gonopodiums und andere morphologische Charakteristika von den anderen Arten der Gattung. Eine auf mitochondrialer DNA-Sequenz basierende phylogenetische Analyse führte zu ähnlichen Ergebnissen zum Status der neuen Art als separates Taxon und ihrer Verhältnisse zu den am nächsten verwandten Arten.

> Key words

Systematics, Ichthyology, Fresh-water, Cyprinodontiformes, Poeciliidae, new species, Central America.

Introduction

Fish of the poeciliid genus *Priapella*, which includes *P. chamulae* Schartl, Meyer & Wilde, 2006, *P. compressa* Alvarez, 1948, *P. intermedia* Alvarez, 1952, *P. olmecae* Meyer & Perez, 1990 and the type species *P. bonita* (Meek, 1904) inhabit clear riverine and lacustrine freshwater biotopes in southeastern Mexico. *P. compressa*, *P. chamulae* and the new species are found in the upper reaches of the río Grijalva system, Chiapas, Mexico. In this area *P. compressa* and the new species are not syntopic as far as known. The present paper describes the new species of *Priapella* from the headwaters of the río Tulijá basin, Chiapas, Mexico.

Parenti (1981), Parenti & Rauchenberger (1989) established the supertribus Poeciliini and included *Priapella* and all remaining genera of Poeciliinae except *Tomeurus*. The tribe Poeciliini sensu Rosen & Bailey (1963) was adopted by the authors. According to Rosen (1979) and Schartl, Meyer & Wilde (2006) *Xiphophorus* is the most closely related genus to *Priapella*. Meyer *et al*. (1994) generally confirmed by DNA-sequence based phylogenetic methods earlier studies that used morphological and metric analyses. On the contrary, Rodriguez (1997) strongly advocated for an exclusion of *Priapella* from Poeciliinae. Gheodotti (2000) finally established for the genus *Priapella* an own tribe, Priapellini, and points out the close relationship to Alfarini and Gambusiini. Finally Hrbek *et al*. (2007) ordered *Priapella* together with *Scolichthys*, *Carlhubbsia*, *Xiphophorus*,

Heterandria (however, see HRBEK *et al*. 2007 for the status of *H. formosa*), *Gambusia* and *Belonesox* in a group, which then represents a supertribus or tribus Gambusiini. Within this group *Priapella* must be recognized as the main primitive Gambusiini member that occurred already approximately 44 million years ago in Middle Central America (HRBEK *et al*. 2007).

Materials and methods

All material of *Priapella* used for the morphological comparison stemmed from the private fish collection of MANFRED MEYER, Bad Nauheim, and BMNH: *Priapella chamulae*, upper río Tacotalpa, Tabasco, Mexico; *Priapella compressa*, río Otolum, southern tributary of río Michol (Tulijá system), Palenque ruinas and río Paxilha, southern tributary of río Tulijá, Aqua Azul, Chiapas, Mexico; *Priapella intermedia*, río de la Lana, Papaloapan basin, Oaxaca, and northern tributary of río Junapan, 5 km north of Donaji, río Coatzacoalcos basin, Oaxaca, Mexico; *Priapella olmecae*, Rio de la Palma, Veracruz, Mexico; *Priapella bonita*, Refugio, Veracruz, Mexico and *Priapella n. sp*., río Mizola, Chiapas, Mexico.

Fish used for the molecular phylogenetic analyses were *Priapella compressa* from Palenque ruinas and Aqua Azul (Chiapas), *Priapella olmecae* from Laguna Escondida (Veracruz), *Priapella intermedia* from río de la Lana (Oaxaca), Jesus Caranza (Veracruz) and río Sarabia (Oaxaca), *Priapella chamulae* from Tapijulapa (Tabasco), *Priapella n.sp*. from río Mizola (Chiapas). *Xiphophorus maculatus* from río Jamapa (strain Jp163a) was used as outgroup.

Measurements were made by vernier calipers, reading to 0.1 mm. Measurements and counts follow standard practice (MILLER, 1948). The length of the distal tip of gonopodium ray 4a and 3 was measured on a horizontal line from the distal tip of ray 4p to the distal tip of the gonopodial hook. The depth of gonopodium was measured on a vertical line from ray 3 to ray 5p exactly where the serrae 4p starts to nestle against ray 4a. The number of specimens for all counts is greater or equal to 5. The total gill-raker count of the first gill arch includes all gill rakers in the angle of the gill arch. The last two rays in the dorsal fin were counted as a single ray. Vertebral counts include the hypural plate as one vertebra. The nomenclature of the sensory canal system of the head follows the standard of GOSLINE (1949) and parts of the gonopodial system follow ROSEN & GORDON (1953), ROSEN & KALLMAN (1959) and ROSEN & BAILEY (1963).

Genomic DNA was isolated from pooled organs of individual fish as described by SCHARTL *et al*. (1995) or from dorsal fin clips according to ALTSCHMIED *et al*. (1997). Sequences from the mitochondrial *cytochrome b* gene were amplified by PCR. For *cytochrome b* the primer pair L14725 (5'GA YTTGAARAACCAYCGTTG3' and H15982 (5'CCT AGCTTTGGGAGYTAGG3') described by HRBEK *et al*. (2007) was used. The PCR was done under the following conditions: denaturation 95 °C for 30 sec, annealing 48 °C for 40 sec, extension 72 °C for 45 sec. 31 cycles were run from less than 100 ng genomic DNA. In each case a single PCR product was obtained and sequenced directly by GATC Biotech (Konstanz, Germany). Nucleotide sequences were analyzed using the program BioEdit Sequence Alignment Editor (copyright http://www.mbio.ncsu.edu/BioEdit/bioedit.html). Multiple sequence alignments were generated using the same program. Phylogenetic analyses were done with MEGA 3.1 (TAMURA *et al*., 2007). For calculating the distance matrix the transition/transversion rate was set to 2.0. Minimum evolution and Neighbor-joining (NJ) trees were constructed. Robustness of the trees was tested by bootstrap analyses using 2000 and 10 000 replicas. All DNA sequences generated in this study are deposited in GenBank under accession numbers JF 892547–49.

Abbreviations

APL	distance anus to pectoral fin;
BD	depth of body;
BMNH	fish collection of the Natural History Museum, London, England;
CPL	length of caudal peduncle;
CPD	depth of caudal peduncle;
DDG	depth of gonopodium tip;
ED	diameter of eye;
F	female;
GL	length of gonopodium;
HL	length of head;
HT	holotype;
IOW	interorbital width;
LDG	length of gonopodium tip;
M	male;
MTD F	fish collection of the Museum fuer Tierkunde, Dresden, Germany;
PDL	predorsal length;
PL	length of pectoral fin;
PT	paratype;
SMF	fish collection of the Forschungsinstitut und Museum Senckenberg, Frankfurt/Main, Germany;
SNL	length of snout;
SL	standard length;
TL	total length;
VL	length of ventral fin.

Fig. 1. *Priapella lacandonae*; Mexico: río Mizola 20 km S Palenque, holotype, MTD F 32298, male, 32.6 mm SL.

Fig. 2. *Priapella lacandonae*; Mexico: río Mizola 20 km S Palenque, paratype, MTD F 32299, female, 49.1 mm SL.

Priapella lacandonae, new species

Figs. 1–5

Holotype. Male (MTD F 32299), 32.6 mm SL; río Mizola, above Cascada Misol-Ha, about 20 km S Palenque along the road 186, río Tulijá basin, Chiapas, Mexico, K. Schneider *leg*., March 9th, 2004.

Paratypes. 5 males, 4 females (MTD F 32299–32307), 2 males, 2 juveniles, 1 female, 2 males, 1 female (SMF 33545); same data as holotype. 4 females, 6 males, (SMF 33546), Rio Mizola, below Cascada Misol-Ha (see above) 17° 23.466′ N, 092° 00.070′ W Chiapas, Mexico, S. Schories, M. Schartl *leg*., May 8th, 2007.

Diagnosis. *Priapella lacandonae* is a large sized species of *Priapella* (max. SL 48 mm), which is distinguished from all other species of the genus by the following characters: membranous hook of the gonopodium ray 3 weakly developed and distally faintly bent, vs. slightly bent *in P. bonita, P. compressa*, *P. intermedia*, *P. olmecae* and strongly bent in *P. chamulae*; subdistal plate-like membranous process on gonopodium ray 3 faintly developed, vs. well developed in *P. chamulae* and not very prominent in *P. compressa* and *P. intermedia*; distal spines of gonopodium ray 3 long and densely crowded, vs. not densely crowded in *P. compressa* and *P. intermedia,* and short and not densely crowed in *P. olmecae;* tip of gonopodium ray 4p reaching the tip of the membranous hook, vs. not reaching the tip of the hook in *P. bonita*, *P. compressa*, *P. intermedia*, *P. chamulae* and *P. olmecae*.

P. lacandonae is also distinguished by the following unique combination of characters: length of gonopodium short; frequency distribution of SL/GL radius 3.30–3.60, vs. 2.60–2.75 in *P. olmecae*, 3.00–3.20 in *P. compressa*, 2.60 in *P. bonita* and 3.50–3.60 in *P. intermedia*; 11 to 12 gill rakers, vs. 15–16 in *P. bonita*, 12 to 13 in *P. compressa*, 12 to 14 in *P. compressa*; 8 to 9 dorsal fin rays, vs. 8 in *P. bonita*, 10 in *P. compressa*.

Table 1. Measurements (in mm) of holotype and paratypes of *Priapella lacandonae* sp. n.

	TL	SL	HL	SNL	BD	IOW	GL	ED	APL	CPL	CPD	PL	VL	PDL
01.HT(M)	41.80	32.60	9.00	2.50	10.80	3.80	9.90	3.00		9.10				
02.PT(F)	61.20	49.10	11.30	3.70	16.40	6.30		3.80	14.60	13.30				
03.PT(M)	40.30	31.50	8.70	2.40	10.40	3.70	9.50	2.90		8.90	7.20			
04.PT(M)	41.20	32.00	8.80	2.50	9.50	3.80	9.60	3.00		9.00	9.80			
05.PT(F)	38.60	30.50	8.40	2.30	9.10	3.60		2.80	10.00	8.90	7.00			
06.PT(F)	34.60	28.10	7.70	2.10		3.30		2.60	8.90	8.20	7.10			
07.PT(M)	39.00	30.60	8.50	2.30	9.20	3.30	9.10	2.80			6.90			
08.PT(M)	40.60	31.60	8.80	2.40	10.20	3.70	9.40	3.00				6.40	3.50	19.30
09.PT(M)	34.90	27.70	7.60	1.90	7.90	3.10	8.20	2.60		7.70	6.80	9.60	5.70	29.80
10.PT(M)	36.80	29.70	8.10	2.20	8.30	3.20	8.50	2.80		8.70	6.90			
11.PT(M)	37.60	29.90	8.20	2.20	8.50	3.20	8.60	2.80		8.80				
12.PT(M)	34.80	27.60	7.50	1.90	8.30	3.10	8.20	2.60		7.50				
13.PT(M)	35.70	28.10	7.90	2.00	8.40	3.30	8.30	2.70			6.70			
14.PT(M)	42.90	33.70	9.20	2.60	11.20	4.00	9.70	3.30						
15.PT(F)		36.10	9.90	2.80		4.30		3.50	11.20					
16.PT(F)	38.60	30.60	8.40	2.30	9.30	3.20		2.80	10.10	8.80				

Description. Body deep, head long and sharply pointed, 25.5–27.5 % of SL. Longitudinal scale series 26–(rarely) 28; predorsal scale series 13–14; scale series around caudal peduncle 16. Number of vertebrae 29 to 30. Gill rakers on first arch 11 to 12+1.

Teeth of upper and lower jaws unicuspid and recurved; those of outer row enlarged and spear-like shaped, not numerous and widely spaced; spear-like shaped inner teeth numerous. Upper pharyngeal bones kidney-shaped. Teeth of the medial region somewhat enlarged, each side with a series of 5–6 rows, teeth small and conical. Lower pharyngeal bone (ceratobranchial 5) with a total of 120–140 large unicuspid teeth, 6–8 on posterior rows, 6–7 on middle rows. Teeth of medial region very large. Both halves of lower pharyngeal antler-shaped, closely together on a small part along midline. Arms of pharyngeal long and split at the ends. Ceratobranchial 4 without teeth, hypobranchial 4 absent.

Supraorbital canal system well developed, sections 1+2a, 2b–4a, 4b–6a, 6b–7 usually represented as grooves and pits; preopercular canal with 7 or 8 pores (8–13, U, V); preorbital canal with 4 pores (sometimes represented as groove); mandibular canal with 4 pores (W-Z).

Gonopodium short and compact, 3.3 to 3.6 times in SL; ray 3 broadly expanded, terminating in a small and faintly bent membranous hook, distal spine-like bony segment of ray 3 long, angular and directed towards subdistal spine-like series, 8 to 9 slightly angulate spine-like series long and slender, plate-like process of membranous tissue ventral to spine-like series not well developed, base of ray 3 somewhat thickened and subdivided in 4 to 5 segments; ray 4a longest and generally totally bent over the gonopodium hook of ray 3, subdistal segments of ray 4a broader than long; ray 4p straight and distally slightly bent, proximal serrae with 8 to 9 thorns; ray 5 shorter than rays 3 and 4. Rays 6 and 7 thickened distally, tips broadly expanded and curved dorsally.

Gonopodial suspensorium with three well developed gonapophyses, gonapophyses I, II and III long and slender, each with an uncinus (interpreted by ROSEN & BAILEY (1963) as parapophyses); parapophyses present on gonapophysis I, II and III; shaft tips of gonapophysis I and II angular and curved ventrally, gonapophysis III curved anteriorly. Ligastyle very long and slender. Gonactinost 1 without inferior wing-like appendage, gonactinostal complex 2 to 4 in front with a superior lateral wing, gonactinosts 5 to 9 without bony plates or outgrowths.

Dorsal fin with 8–9 rays (first 3 rays simple, all others branched), origin of dorsal fin posterior to the insertion of anal fin; caudal fin with 27 to 28 rays (15 branched); anal fin 10 rays (first 2 to 3 rays simple, all others branched); pectoral fin with 13 to 14 rays (first 2 and last 2 rays simple, all others branched); ventral fin with 6 rays (first and last ray simple, all others branched), in females not reaching to the anal fin base and in males reaching to the base of the gonopodium, first ray thin and bent distally. Adult males with a weakly developed keel, starting on the edge of caudal peduncle and ending near base of gonopodium; keel with small scales.

Males and females without sex specific coloration (Fig. 3). Body color of adult females and males greyish; iris iridescent blue. Border of dorsal fin and upper and lower ramus of caudal fin with light whitish color, all other fins hyaline.

Etymology. The new taxon is named in appreciation of the native population of Lacandons, who live

Fig. 3. *Priapella lacandonae*; Mexico: Cascada Misol-Ha, aquarium specimen, male.

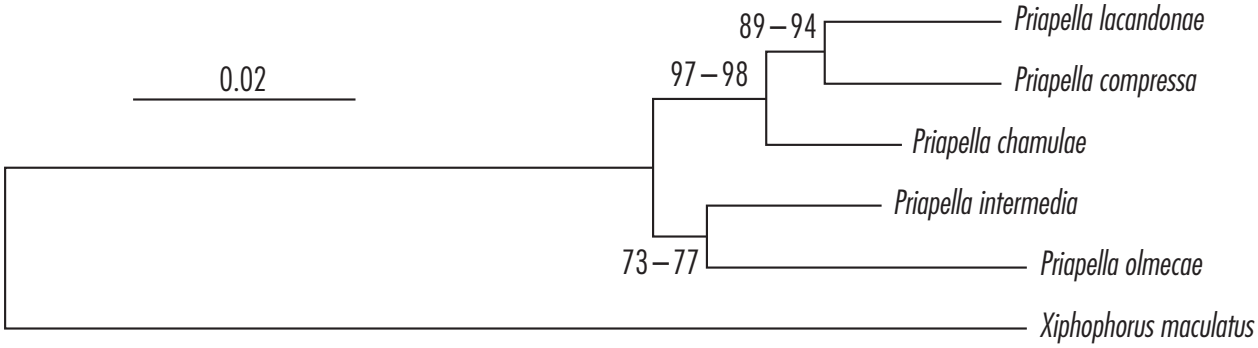

Fig. 4. Phylogram of *Priapella lacandonae* and related *Priapella* species based on mitochondrial DNA sequences. 50 % majority rule consensus tree rooted on *Xiphophorus maculat*us as outgroup. Minimal and maximal bootstrap values obtained using different types of analysis (see Material and Methods) are indicated above the branches.

mainly in northeastern Chiapas, Mexico and Petén, Guatemala.

Comparison and relationships. Rodriguez (1997) gives the following derived characters for the genus *Priapella*: gonopodium ray 3 with the most distal segment modified into a forward-curved bony hook, a long membranous segment posterior to the ray joining with the last segments of ray 4a, the membranous segment becoming flat at the junction and gonopodium ray 4a with 10–13 distal segments extending far behind the tip of ray 4p. All these characters are present in *P. lacandonae*. On the basis of these synapomorphies, *P. lacandonae* is unequivocally attached to the genus *Priapella*.

By morphological criteria *P. lacandonae* is most closely related to *P. chamulae* and *P. compressa*. There are several synapomorphies that unite *P. lacandonae* with *P. compressa* and *P. chamulae,* namely: numerous, long and pointed subdistal spines of gonopodium ray 3; subdistal segments of gonopodium ray 4a opposite serrae shorter than high. However, *P. lacandonae* is recognized as a separate species, because it does not share the following synapomorphy between *P. compressa* and *P. intermedia*: distal tip of gonopodium long (LDG/DDG radius 0,85–0,95). In addition there is one autapomorphy of *P. lacandonae*: ray 4a totally bent over the hook of gonopodium ray 3. *P. lacandonae* is further distinguished from *P. intermedia* and *P. compressa* by fewer subdistal spines of gonopodium ray 3 (3–5 vs. 6–7, 5–7), from *P. intermedia* by the much longer first isolated spine of gonopodium ray 3, and a much longer distal spine-like bony segment of ray 3, from *P. olmecae* by longer spines of gonopodium ray 3; and from *P. compressa* by fewer dorsal fin rays (8–9 vs. 10).

A molecular phylogenetic analysis was performed using mitochondrial *cytochrome b* sequences. The resulting data set consists of approx. 1130 bases for each species. The genetic distances calculated (Table 2) revealed that the genetic distance between the species of the genus *Priapella* are in the same range as for instance over the whole genus *Xiphophorus* (Meyer & Schartl, 2003). In particular the genetic

Table 2. Pairwise distance matrix between *Priapella* species and *X. maculatus* using the Kimura 2-parameter as correction method.

	P. lacandonae	*P. intermedia*	*P. olmecae*	*P. compressa*	*P. chamulae*	*X. maculatus*
P. lacandonae	–	5.56	6.14	3.20	3.48	17.02
P. intermedia		–	4.40	5.15	3.74	16.37
P. olmecae			–	6.50	5.63	17.57
P. compressa				–	3.09	17.38
P. chamulae					–	16.83
X .maculatus						–

Fig. 5. Habitat: rio Mizola, above Cascada Misol-Ha, type locality of *P. lacandonae*.

distance values between *P. lacandonae* and the most closely related species, *P. compressa* and *P. chamulae* are even higher than corresponding values for the well recognized species of Southern swordtails. The genetic distance between one individual of *P. lacandonae* collected above the waterfall and one below the waterfall was zero.

The molecular data were analyzed with minimum evolution and neighbour-joining methods which yielded almost identical phylogenetic results. The topology of the resulting trees was always the same. Two major branches were resolved, which unite *P. intermedia* and *P. olmecae* in one group and *P. compressa*, *P. chamulae* and *P. lacandonae* in the other. The new species is clearly separated from *P. chamulae*; similar to the split between *P. intermedia* and *P. olmecae*. It is also separated from *P. compressa* on a branch, the length of which is absolutely in the range of those for the other previously recognized species. Of note, all nodes within the genus *Priapella* are supported by high bootstrap values, which underlines the robustness of the molecular phylogenetic tree.

Distribution. *Priapella lacandonae* is only known from the type locality.

Habitat notes. The collection site is a small stream (río Mizola), approx. 7 to 8 m wide, above Cascada Misol-Ha, that flows into to the río Tulijá basin, río Grijalva system. At the type locality (280 m elevation, 17° 23′ 15.9″ N, 91° 59′ 17.4″ W) on March, 9th, 2004 at noon the water had a temperature of 25 °C, a conductivity of 520 µS, pH 8.3, and a total hardness of 16. The water was clear and fast flowing with no aquatic vegetation. The substratum consisted mainly of rocks, gravel, sand and leaves. The stream is shadowed by the vegetation. Accompanying poeciliid fishes were *Pseudoxiphophorus bimaculatus*, *Poecilia mexicana*, cichlids and a Characid, *Astyanax mexicanus*. The habitat below the waterfall is similar, except that there are large rocks in the river that structure the environment and create basins of different flow velocity. On May 8th, 2007, at noon the water had 27 °C (air 32 °C), a conductivity of 72 µS, pH 8 and a total hardness of 8. Accompaning poeciliid fishes were *Xiphophorus hellerii*, *Poecilia mexicana* and a Characid, *Astyanax mexicanus*.

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