

Notes on the genera *Neoophorus* HUBBS & TURNER, 1937 and *Allotoca* HUBBS & TURNER, 1937, with a description of a new species of *Allotoca* from Laguna de Zacapu, Michoacán, Mexico (Teleostei, Cyprinodontiformes: Goodeidae)

Manfred K. Meyer¹, Alfred C. Radda² und Omar D. Domínguez³

Abstract

After the definition on systematics and taxonomy of the genera *Allotoca* and *Neoophorus*, *Allotoca zacapuensis* sp.n. (loc. typ. Lagoon de Zacapu, Michoacán, Mexico) is described, illustrated and compared to all members of the genus *Allotoca*. The new species is closely related to the members of the *Allotoca diazi* species group, including *catarinae*, *diazi*, and *meekei*. *Allotoca zacapuensis* sp.n. differs from all members of the genus *Allotoca* in morphological characteristics and colouration.

Zusammenfassung

Nach der systematisch-taxonomischen Definition der Gattungen *Allotoca* und *Neoophorus* wird *Allotoca zacapuensis* sp.n. (loc. typ. Lagoon de Zacapu, Michoacán, Mexico) beschrieben, abgebildet sowie mit allen *Allotoca* Taxa verglichen. Die neue Art ist eng verwandt mit der *Allotoca diazi* Gruppe, nämlich *catarinae*, *diazi*, und *meekei*. *Allotoca zacapuensis* sp.n. unterscheidet sich von allen anderen *Allotoca* Arten in morphologischen Merkmalen und Farbmustern.

Resumen

Posterior a una revisión de la sistemática y taxonomía del género *Allotoca* y *Neoophorus*, *Allotoca zacapuensis* sp.n. (localidad tipo Lagoon de Zacapu, Michoacán, México) es descrita, ilustrada y comparada con todos los miembros del género *Allotoca*. La nueva especie está estrechamente relacionada con el grupo de especies de *Allotoca diazi*, incluidos *catarinae*, *diazi* y *meekei*. *Allotoca zacapuensis* sp.n. difiere de los otros miembros del género *Allotoca* en características morfológicas y coloración.

Introduction

The goodeid genus *Allotoca* HUBBS & TURNER (1937) with the type species, *dugesii* (BEAN, 1888), by monotype, probably from streams of Guanajuato, Mexico, included until now six valid species. All taxa of the genus are distributed in central western Mexico, from the Rio Ameca to the Rio Balsas basins.

¹ Schwalheimer Hauptstraße 22, D-61231 Bad Nauheim (Germany).

² Institut für Virologie, Universität Wien, Kinderspitalgasse 15, A-1095 Wien (Austria).

³ Laboratorio de Biología Acuática, Facultad de Biología, Fuente de las Rosas N° 65, Fracc. Fuentes de Morelia C.P. 58088 (Mexico).

SMITH & MILLER (1987) recognized for *Allotoca*, together with the type species, the following taxa: *catarinae* (DE BUEN, 1942) from Presa de Catarina, Uruapan, Michoacán, *diazi* (MEEK, 1902) from Lago de Pátzcuara, Michoacán, *goslinei* SMITH & MILLER, 1987 from Rio Potrero Grande, Jalisco, *maculata* SMITH & MILLER, 1980 from Laguna de Santa Magdalena, Jalisco, *meeki* (ALVAREZ, 1959) from Lago de Zirahuén, Michoacán.

The taxonomic status of *Neophorus regalis* ALVAREZ, 1959 from Los Reyes, Michoacán, was not discussed by SMITH & MILLER (1987), since the type species of *Neophorus*, namely *diazi*, was transferred to *Allotoca*. Although later ALVAREZ (1970) transferred *regalis* to the genus *Allophorus* HUBBS & TURNER, 1937 on the basis of trophotaeniae and ovar characteristics, we found no reason to include *regalis* longer to *Allophorus*, because no synapomorphy could be found. Herein we refer *regalis* to *Neophorus*, by monotype. PARENTI (1981) distinguished the subfamily Goodeinae from the other cyprinodontiformes by several characteristics, including the characteristics of a shortened anterior part of the male anal fin and a rudimentary first ray. Both characteristics are not present within *Neophorus*.

One autapomorphy declares the taxon *Neophorus* as an outstanding monophyletic group within the subfamily Goodeinae.

Allotoca is characterized by the derived nature of their sensory head canals.

The present paper describes one new freshwater species of the genus *Allotoca* (Goodeidae) from Central Mexico.

Materials and methods

The new species of the genus *Allotoca* described in this paper is based on 6 adult males and females. The holotype and a series of paratypes have been deposited in the Naturhistorisches Museum Wien, University of Michoacana and the Museum Senckenberg Frankfurt/Main. Paralectotypes of *Neophorus* have been deposited in the Museum Senckenberg Frankfurt/Main and the University of Michoacana.

Comparative material examined: *Allotoca catarinae* from Presa de Catarina, Uruapan, Michoacán; *Allotoca diazi* and *Allotoca dugesii* from Rancho Molino, upper source of Lago Pátzcuaro, Michoacán; *Allotoca goslinei* from Rio Potrero Grande, Jalisco; *Allotoca maculata* from Granja Sahuaripa, Jalisco; *Allotoca meeki* from Opopeo, upper source of Lago Zirahuén, Michoacán; *Neophorus regalis* from Los Reyes, Michoacán.

Measurements and counts follow standard practice (MILLER, 1948). Measurements were made by vernier callipers reading to 0.1 mm. The number of specimens for all counts is greater than or equal to 4. The gill-raker count of the first arch includes any gill rakers in the angle of the gill arch. The last two rays in the dorsal fin are counted as a single ray. Vertebral count includes the hypural plate as one vertebra.

Nomenclature of the sensory canal system of the head follows the standard of GOSLINE (1949), that of the abdomopodium system of the male goodeid fishes follows TURNER et al. (1962)*.

* TURNER et al. (1962) used gonopodium for denotation of the modified goodeid male anal fin but the name is used for reference to the modified anal fin of pociliid fishes, therefore we use abdomopodium for goodeid fishes.

Abbreviations

AL = length of anal fin; A-NE = autapomorphy of *Neophorus*; APL = length of abdomopodium; BD = depth of body; CPL = length of caudal peduncle; CPD = depth of caudal peduncle; CPUM = fish collection of the University of Michoacana, Morelia; ED = diameter of eye; F = female; HL = length of head; Ht = holotype; IOW = interorbital width; J = juvenile; NMW = fish collection of the Naturhistorisches Museum Wien; PL = length of pectoral fin; Pt = paratype; SMF = fish collection of the Museum Senckenberg, Frankfurt/Main; SNL = length of snout; SL = standard length; S-AL = synapomorphy of *Allotoca*; TL = total length; VL = length of ventral fin.

Genus *Allotoca* HUBBS & TURNER, 1937

Diagnosis: *Allotoca* is characterized by the following derived characters: S-AL(1) supra-orbited canal system lack of sections: [3b - 6a] *diazi*, *catarinae*, *meeki* and *zacapuensis* sp.n., [4b - 6a] *goslinei*, [2b - 6a] *dugesii* and *maculata*. S-AL(2) break in the preopercular canal at the angle of the preopercular bone.

Species included are: *diazi*, *dugesii*, *catarinae*, *goslinei*, *maculata*, *meeki*, *zacapuensis* sp.n.

Type species: *A. dugesii* (BEAN, 1888)

Genus *Neophorus* HUBBS & TURNER, 1937

Neophorus is characterized as sharing only the fundamental derived characteristics of Goodeinae, which were worked out by PARENTI (1981), excluding two characteristics of the male modified anal fin, namely a rudimentary first anal fin ray and shortened anterior part. Both characteristics could not be found in *Neophorus*, but are present in the other taxa of Goodeinae. Therefore *Neophorus* is referred to the most primitive member of the subfamily.

Although the study of cytochrome b sequences of the genera *Allotoca* and *Neophorus* (unpublished data) show a close genetic relationship (announcement O. Domínguez Domínguez) we separate both taxa.

Diagnosis: Males lack a rudimentary nob of the anal fin, ray 1 of the lobe is developed like the female anal fin ray 1, rays 1 to 7 of the lobe are straight and not thickened basally, rays 3 to 7 are bifurcated. Additionally primitive characteristics are: the cephalic sensory pore system of the head is fully developed; the trophotaeniae is developed in a circular rosette.

One characteristic, namely the extension of the anterior part of the male anal fin, namely the abdomopodium is referred as derived: A-NE(1) abdomopodium rays 6 to 7 of adult males as long or longer than the longest anal fin rays.

Species included are: *regalis*.

Type species: *N. regalis* ALVAREZ, 1959

Allotoca zacapuensis sp.n. (Figs. 1 - 2)

Holotype: Male (NMW-94584), SL = 22.1 mm, Lagoon de Zacapu, Zacapu, Michoacán, Mexico; 14.2.2001, M.K. Meyer (Germany), A.C. Radda (Austria) & C.E. Rivas Benitez (Mexico) leg.

Paratypes: Female (NMW-94585), Lagoon de Zacapu, Zacapu, Michoacán, Mexico; 16.2.2001, A.C. Radda (Austria) & S. Mendoza Caideron (Mexico). 2 males, 2 females, 2 juveniles (SMF 28887); Lagoon de Zacapu, Michoacán, Mexico; 14.7.1990, D. Lambert (Great Britan). 9 specimens (CPUM 1079), Lagoon de Zacapu, La Angostura, Zacapu, Michoacán, Mexico; 19.3.1998, O. Domínguez Domínguez & E. Gonzalez (Mexico).

Etymology

The name of the new taxon derives from the basin Lagoon de Zacapu, which is the only known habitat and distribution.

Diagnosis

A small species of *Allotoca* (max. SL ca. 30 mm) is distinguished from all other species of the genus by the following characters: abdomopodium rays 2 to 7 thickened basally and curved anteriorly; males and females with a series of 10 to 14 dark brown pigmented v-shaped vertical bars along the body sides; adult males with a dark brown area surrounding about and in front of the genital region. *A. zacapuensis* sp.n. is also distinguished by the following unique combination of characters: both sexes of the new species with a dark brown abdominal pigmentation, vs, absent in males of *dugesii* and *maculata*, vs, absent in males and females of *goslinei*, vs, absent or weak in males of *catarinae*, *diasi* and *meeki*.

Description

Body moderate and slender, head long, 3.1 to 3.3 in standard length. Longitudinal scale series 32 to 34; predorsal scale series 24 to 26 (rarely 27); scale series around caudal peduncle 19 to 21. Number of vertebra 30 to 32. Gill rakers on the first arch 9 to 10.

Teeth of upper and lower jaws unicuspid and recurved, those of the outer row enlarged and well separated, middle region most prominent not numerous, inner teeth small and unicuspid.

Upper pharyngeal bones kidney-shaped. The central teeth of the pharyngeal bone plates enlarged, each side with a total of > 35 and < 45 teeth, 1/3 of the teeth enlarged, the teeth in the outer regions small and conical.

Lower pharyngeal bone (ceratobranchial 5) with a total of > 60 and < 100 curved unicuspid teeth, number of posterior rows 18 to 21, number of medial rows 5 to 6, those of posterior rows higher than those directly in front, except the 2 median teeth. The teeth of the middle region are enlarged. The two halves of the lower pharyngeal are triangular-shaped and are close together along the midline, where each side curves dorsolaterally, one towards the left and the other towards the right. The ends of the pharyngeal arms are very long and slender, the tips are spatulated and the longest arch of each side is needle-shaped. Ceratobranchial 4 with conical teeth, hypobranchial 4 absent.

Supraorbital canal system well developed and interrupted in section 3b to 6a, formula: 1 + 2a, 2b - 3a, 6 - 7; preopercular canal with 8 pores; preorbital canal represented with 5 pores; mandibular canal well developed with 4 pores (W-Z).



Fig. 1 - 2: (1) *Allotoca zacapuensis* sp.n. male, holotype (NMW-94584), caught in the wild, photograph taken after two weeks in a tank; (2) *Allotoca zacapuensis* sp.n., female, caught in the wild, photograph taken after two weeks in a tank.

The anterior part of the anal fin of adult males, namely abdomopodium, is modified to form a lobe, rays 1 to 7 reduced in length and thickened basally, rays 2 to 6 recurved, ray 3 bent at an angle, ray 7 straight, ray 8 of the anal fin reduced in length, thickened basally, bifurcated, curved and directed to the caudal fin.

Fins well developed; dorsal (19 to 20 rays, rarely 18) small and rounded in females, in males much larger and straight along the first 8 to 10 rays, origin in both sexes behind the insertion of anal fin; caudal 30 to 31 (14-15 branched) rays, anal of female rounded (rays 12 to 13), in males rays 1 to 6 shortened; pectoral (14 to 15) rays; ventral fin (6 rays) rounded, in females reaching to the anus and in males reaching to the abdomopodium.

Males and females with no well pronounced sex-specific coloration. Ground colour of body of adult females and males greyish brown; blue, pink and green colour reflections along midline and venter; body side with one series of 10 to 14 vertical bars, which are broad and most prominent on the rear body half, longitudinal region sometimes with dark blotches most abundant in the middle; the scales of upper body sides with a dark coloured reticulum. Abdominal region with a dark brown coloured area. Dorsal fin light orange, anal fin and caudal fins light yellow or orange, paired fins hyaline.

Comparison and relationships

On the basis of synapomorphies, *Allotoca zacapuensis* sp.n. are unequivocally attached to the genus *Allotoca*. The derived characters of *Allotoca* are given in the generic diagnosis.

Synapomorphy between *Allotoca zacapuensis* sp.n., *Allotoca catarinae*, *Allotoca diazi* and *Allotoca meeki*: S-AL(3) section 3b - 6a of the supraorbital canal system deleted.

In contrast to *Allotoca catarinae*, *Allotoca diazi* and *Allotoca meeki*, *Allotoca zacapuensis* sp.n. shows a lower number of gill rakers on the first arch (*catarinae*, *diazi* and *meeki* 10 to 13), lower number of preopercular pores (*catarinae*, *diazi* and *meeki* 10 to 11).

In comparison to *Allotoca goslinei* the new species is distinguished by a higher number of dorsal fin rays (*goslinei* 16), smaller number of longitudinal scale series (*goslinei* 34 to 38), lower number of gill rakers on the first arch (*goslinei* 11 to 14), section 3b to 6a of supraorbital canal system not present (4b to 6a absent in *goslinei*).

In contrast to *Allotoca maculata* and *Allotoca dugesii* the new taxon shows more dorsal fin rays (*dugesii* 14 to 17, *maculata* 12 to 15), lower number of gill rakers on the first arch (*dugesii* 10 to 13, *maculata* 11 to 12), section 3b to 6a of supraorbital canal system (2b to 6a absent in *dugesii* and *maculata*). In contrast to *Allotoca maculata* the new species shows a higher number of longitudinal scale series (*maculata* 29 to 31). In contrast to *Allotoca dugesii* the new species shows a lower number of preopercular pores (*dugesii* 10 to 11).

In comparison to all known *Allotoca* taxa the new species is distinguished by the most derived state of the abdomopodium: recurved and basally thickened rays 2 to 7. The colouration of the body also distinguishes *Allotoca zacapuensis* sp.n. from all members of the genus.

Tab. 1 : Measurements (mm) of holotype and paratypes of *Allotoca zacapuensis* sp.n.

	TL	SL	HL	SNL	BD	IOW	APL	ED	CPL	CPD	PL	VL	AL
Ht (M)	27.7	22.1	7.1	1.5	5.6	2.1	2.6	2.4	3.9	2.4	4.8	3.2	
Pt (M)	32.2	27.1	8.5	1.8	7.6	2.7	3.1	2.6	5.8	3.2		3.4	3.9
Pt (M)	28.4	23.0	7.4	1.6	6.4	2.3	2.7	2.4	4.2	2.7	4.9		3.2
Pt (M)	35.1	28.5	9.0	1.9	7.8	2.9	3.2	2.7	6.1	3.3	5.6	3.6	4.1
Pt (F)	39.5	31.7	9.8	2.1	9.5	3.2		2.9	6.6	3.6	6.0	3.5	
Pt (F)	32.7	27.2	8.6	1.8	8.4	2.7		2.6	5.9	3.3	5.4	3.1	
Pt (J)	1.4												
Pt (J)	1.6												

Habitat and associates

Allotoca zacapuensis sp.n. is restricted to Lagoon de Zacapu and its outlet in the north-east of the lagoon, namely Rio Angulo, Zacapu, Michoacán, Mexico.

The turbid still water is 50 to 100 cm deep at the point of collection. The ground is predominantly of mud. The new species can be found sporadically along the shore, generally hides under aquatic vegetation. In this region *Allotoca zacapuensis* sp.n. can be found along with 5 taxa of Goodeinae, namely *Hubbsina*, *Goodea*, *Skiffia*, *Xenotoca*, *Zoogoneticus* and the poeciliid *Poeciliopsis infans*.

Allotoca zacapuensis sp.n. was collected in February 2001. At the type locality water temperatures varied from 17 °C to 20 °C, pH 7.0, GH dH < 13, KH dH < 11, conductivity < 100 µS.

The Lagoon de Zacapu is situated between the latitude north 19°49'40" and 19°49'26" and between the longitude west 101°46'54" and 101°47'25". 50% of the lake is surrounded by the city of Zacapu. It is part of the Lerma-Santiago drainage of the middle Lerma. Formerly, this lake was a large "cienega" with 33.500 ha in size, but was drained to provide land for cultivation, and is now a small body of water with 33,5 ha in size. The lake has more than 20 springs and the largest one is La Angostura spring with more than 2000 l/sec and a depth of 12,0 m. The lagoon itself has a mean depth of 1,2 m and a maximum depth of ca. 3,0 m.

The vegetation consists of pine forests in the drier area and some *Taxodium* and *Salix* around the lagoon. The more abundant water plants are the species: *Potamogeton pectinatus*, *Potamogeton illinoensis*, *Ceratophyllum demersum*, *Myriophyllum* spp., *Typha latifolia*, *Sagittaria* sp., *Scirpus* sp., *Besula erecta*, *Rorippa nasturtium*, *Hydromystrina laevigata* and *Eichhornia crassipes*.

The distribution patterns of the vegetation have importance for distribution and survival as well as for alimentation and reproduction of the Zacapu fish fauna. The fauna comprises 7 species of goodeids, namely *Allophorus robustus*, *Allotoca zacapuensis* sp.n., *Goodea atripinnis*, *Hubbsina* sp., *Skiffia lermae*, *Xenotoca variata* and *Zoogoneticus quitzeoensis* and one species of poeciliid, *Poeciliopsis infans*; two cyprinids, *Notropis calientis* and one atherinoid, *Chirostoma humboldtianum*, and the exotics, *Cyprinus carpio*, *Micropterus salmoides*, *Algansea lacustris* and *Ctenophardingodon idella*.

The people living on the lake make use of some flora and fauna: some species of fish like *G. atripinnis*, *A. robustus*, *C. humboldtianum*, *A. lacustris* and *C. carpio* are used as food, and some plants are used for handicrafts. No waste water from the city is pumped into the lake, waste water is channelled to the Rio Angulo.

Acknowledgements

The authors gratefully acknowledge the collaboration and assistance of the following persons: Mr. H. Zetzsche, Senckenberg Museum, Frankfurt; Mrs. I. Radda, Wien; Mrs. K. Meyer, Bad Nauheim; Mr. Kees de Jong, Hoorn; Mr. Derek Lambert, Lincs.; Mr. Salvador Mendoza Caideron, Uruapan; Mr. Carlos Enrique Rivas Benitez, Uruapan.

References

- ALVAREZ, J. 1959: Contribución al conocimiento del género *Neophorus* (Pisces, Goodeidae). – *Ciencia* 19, pp. 13-22.
- ALVAREZ, J. 1970: Peces mexicanos (Claves). – Ser. Inv. Pesq., Inst. Nac. Inv. Biol. Pesq. México, pp. 166.
- BEAN, T.H. 1888: Description of five new species of fishes sent by Prof. A. Duges from the province of Guanajuato, Mexico. – *Proc. U.S. Nat. Mus.* (for 1887) 10, pp. 370-375.
- HUBBS, C.L. & C.L. TURNER 1939: Studies of the fishes of the order Cyprinodontes. XVI. A revision of the Goodeidae. – *Misc. Publ. Mus. Zool. Univ. Michigan*, (42), pp. 1-80.
- GOSLINE, W.A. 1949: The sensory canals of the head in some cyprinodont fishes, with particular reference to the genus *Fundulus*. – *Occas. Papers Mus. Zool. Uni. Michigan*, 519, pp. 1-17.
- MILLER, R.R. 1948: The cyprinodont fishes of the Death Valley system of eastern California and southwestern Nevada. – *Misc. Publ. Mus. Zool. Univ. Michigan*, 68, pp. 1-155.
- PARENTI, L.R. 1981: A phylogenetic and biogeographic analysis of Cyprinodontiform fishes. – *Bull. Am. Mus. nat. Hist.* 168, art. 4, pp. 335-557.
- SMITH, M.L. & R.R. MILLER 1980: *Allotoca maculata*, a new species of goodeid fish from Western México, with comments on *Allotoca dugesi*. – *Copeia*, (3), pp. 408-417.
- SMITH, M.L. & R.R. MILLER 1987: *Allotoca goslinei*, a new species of goodeid fish from Jalisco, Mexico. – *Copeia* (3), pp. 610-616.
- TURNER, C.L., MENDOZA, G. & R. REITER 1962: Development and comparative morphology of the gonopodium of goodeid fishes. – *Proc. Iowa Acad. Sci* 69, pp. 571-586.