Nannacara quadrispinae sp. n. – a new dwarf cichlid fish (Teleostei: Perciformes: Cichlidae) from the drainage of the Orinoco Delta in Venezuela

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Abstract. *Nannacara quadrispinae* sp. n. is described from the western drainage of the Orinoco delta in the state of Monagas in eastern Venezuela. The new species is closely related to *Nannacara anomala* and the other members of the *N.–anomala*–species complex which share the reduced number of 14 instead of 16 caudal fin rays. The new species is characterized by a normally 4-spined anal fin.

Resumen. Se describe una nueva especie de cíclido, *Nannacara quadrispinae*, de la cuenca del Río Orinoco en el estado Monagas al este de Venezuela. Se distingue de todas las demás especies del género *Nannacara* en particolar por 4 espinas en la aleta anal. Se trata de una specie del grupo de especies *Nannacara anomala*. Estas especies son reconocibles basados en 14 radios en la aleta caudal.

Kurzfassung. *Nannacara quadrispinae* sp. n. wird aus westlichen Zuflüssen des Orinokodeltas beschrieben, die im östlichen Venezuela im Bundesstaat Monegas liegen. Die neue Art ist nahe mit *Nannacara anomala* verwandt und gehört in den *N.-anomala*-Artenkomplex, dessen Mitglieder die reduzierte Zahl von nur 14 statt 16 Flossenstrahlen in der Schwanzflosse besitzen. Ein diagnostisches Merkmal der neuen Art bildet der Besitz von gewöhnlich vier Afterflossenstacheln.

Key words. Systematics, ichthyology, freshwater, ecology, reproductive behaviour, Cichlidae, new species, Venezuela.

Introduction

The South-American cichlid genus *Nannacara* Regan, 1905 currently consists of five nominal species (KULLANDER, 2003), which are distributed in the drainages of the río Negro in Brazil, the upper Essequibo River in Guyana and along the Atlantic coast in a region between Belem (Brazil) in the south and Mabaruma (Guyana) in the north. All are very small fishes (maximum reported size 56,4 mm SL).
SCHULTZ (1949) first reported three specimens of a *Nannacara* species which were collected in Venezuela. KULLANDER & NIJSSEN (1989) discussed the possibility that these three specimens from the Orinoco delta are distinct from the formally described species as they have four anal fin spines. This diagnostic feature of the *Nannacara* from Venezuela was confirmed by Staeck & Schindler, who in 1992 collected more than 30 specimens of that species, some of which even had five anal fin spines. KULLANDER & PRADA-PEDREROS (1993) regarded this dwarf cichlid as an undescribed species and called it *Nannacara* sp. (Venezuela), a name later adopted by LINKE & STAECK (1997), STAECK & SCHINDLER (2000) and STAECK (2003). The purpose of the present paper is to present a diagnosis and formal description of *Nannacara* spec. (Venezuela) as *Nannacara quadrispinae*.

Material and Methods

The holotype and one paratype (28.4 mm SL) were fixed in 75 % ethanol, the remaining paratypes and other specimens were fixed in formalin and later transferred into 75 % ethanol. The holotype and 18 paratypes are deposited in the fish collection of the Museum für Tierkunde Dresden (MTD F). Additional specimens (non types) of *N. quadrispinae* are in the fish collection of NRM (Naturhistoriska Riksmuseet, Stockholm) as a temporary loan.

Comparative material is in MTD F or in the personal collections of the authors (CIS).
Types of *N. quadrispinae* are listed under species description. Counts of anal fin spines in additional 30 unregistered specimens of *N. quadrispinae* temporarily in NRM are considered in the description.
Comparisons were made with the following specimens:
N. anomala Regan, 1905: MTD F 27871–27878, 8 specimens 14.0-26.3 mm SL, Demerara River drainage, Timberhead Lodge, Guyana. *N. anomala*: CIS. 3 specimens 23.0–27.2 mm SL, Long Creek, Linden Highway, Demerara River drainage, Guyana. *N. anomala*: MTD F 27879–27882, 4 specimens 40.8–46.7 mm SL, western drainage of Rivière de Cayenne, French Guiana. *N. anomala*: MTD F 27883–27885, 3 specimens 40.3 to 47.2 mm SL, small creek, eastern drainage of Rivière de Cayenne, French Guiana. *N.* cf. *anomala* (Mabaruma): CIS. 5 specimens 21.0–43.5 mm SL, Mabaruma, Guyana.
N. aureocephalus Allgayer, 1983: MTD F 27886, 1 specimen 52.6 mm SL, Mana dranaige, French Guiana. *N. aureocephalus*: CIS. 3 specimens 40.5–60.8 mm SL, commercial import of aquarium fish from French Guiana. *N.* cf. *aureocephalus* (Soumourou): MTD F 27887–27889, 3 specimens 41.9–50.0 mm SL, Crique Soumourou, French Guiana.
Data from REGAN (1912), KULLANDER & PRADA-PEDREROS (1993) and from the redescription of *N. anomala* based on material from Surinam by KULLANDER & NIJSSEN (1989) are also used.
Measurements and counts were taken as described by KULLANDER (1980, 1986) and KULLANDER & NIJSSEN (1989: fig. 3). As the sample size of *N. quadrispinae* is small and only a few fully grown specimens are included, in this paper a robust mean is used for the description of measurements instead of the simple arithmetic mean. Therefore, the formula: robust mean $= \sum x_{\mathbf{y}} * w_{\mathbf{x}} / \sum w_{\mathbf{x}}$ is used (LITTLE & RUBIN, 1987), where $w_{\mathbf{x}}$ is the weight of inclusion in the sample for unit x, and $x_{\mathbf{y}}$ is the value of x in character y. It is assumed for the design weight that the larger specimens carry more important information for the calculation of the real mean value than smaller ones. The largest specimen (highest value of standard length) gets the weight of 1 and the smallest of 0.1 respectively. All the other specimens get a weight between 0.1 and 1 which represents the relation of their standard length (SL) to the SL of the biggest and smallest specimens.
Scale rows are numbered as described in KULLANDER (1990). E1 row scales (= Squ. long. in KULLANDER & NIJSSEN, 1989) represent the scales in the horizontal series directly above the row including the lower lateral line. Numbers in brackets after counts indicate the number of specimens examined.
Abbreviations: CIS = personal collection of the authors, NRM = Naturhistoriska Riksmuseet, Stockholm, MTD F = Staatliche Naturhistorische Sammlungen Dresden, Museum für Tierkunde, Fischsammlung; SL = standard length; TL = total length.

Nannacara quadrispinae sp. n. (Figs. 1-5)

Holotype: MTD F 27890, male, 33.5 mm SL, Venezuela, Estado Monagas, río Amana, a tributary of río Guanipa, *leg*. April 1992 by Schindler & Staeck.
Paratypes: MTD F 27891, female, 28.4 mm SL, collecting data like holotype. MTD F 27892–27908, 17 specimens, 12.2–26.9 mm SL, Venezuela, Estado Monagas, río Mapirito, a tributary of río Guanipa, *leg*. April 1992 by Schindler & Staeck.

Diagnosis. A member of the *Nannacara-anomala*-species group as diagnosed by KULLANDER & PRADA-PEDREROS (1993). This group is characterized by the reduced number of only 14 caudal fin rays (versus 16 in the other *Nannacara* and all the other cichlids), a reduced number of frontal lateralis foramina and the continuous lower labial fold. The new species *Nannacara quadrispinae* differs both from all the members of the *N.-anomala*-group and the remaining *Nannacara* by 4 or even 5 anal fin spines (in 94 % of the examined specimens; only 6 % of them have 3 spines) versus only 3 in all the other *Nannacara* species.

Fig. 1: *Nannacara quadrispinae* sp. n., holotype, 33.5 mm SL, MTD F 27890 (Foto.: F. Höhler)

Fig. 2: *Nannacara quadrispinae* sp. n., topotype, dominant male, approx. 4 cm TL.

Fig. 3 (left): *Nannacara quadrispinae* sp. n., topotype, dominant female, approx. 3.5 cm TL.
Fig. 4 (right): *Nannacara quadrispinae* sp. n., topotype, subdominant female.

Table 1: Morphometry of *Nannacara quadrispinae*. Measurements of holotype and 7 paratypes in percents of SL (except SL in mm); min = lowest value, max = highest value, mean = robust mean, sd = standard error of robust mean.

measurement	min	max	mean	sd
SL (mm)	21.2	33.5		
Head length	31.34	36.32	33.2	0.58
Snout length	5.28	6.4	5.8	0.15
Body depth	35.2	40.52	38.3	0.51
Orbital diameter	10.45	12.27	11.1	0.18
Head width	19.01	21.46	19.8	0.35
Interorbital width	7.89	9.85	8.9	0.29
Preorbital depth	1.89	2.99	2.44	0.13
Caudal peduncle depth	15.85	17.45	16.7	0.16
Caudal peduncle length	4.25	7.29	5.74	0.21
Length of pectoral fin	29.58	37.74	33.7	0.84
Length of pelvic fin	28.33	36.43	33.3	0.89
Length of anal-fin base	24.65	27.51	25.48	0.33
Length of dorsal-fin base	61.25	68.77	66.2	0.63
Length of last D spine	12.32	15.82	14.1	0.44

Etymology. The species epithet *quadrispinae* is a noun in apposition. It is derived from the Latin prefix *quadri-* (= four in compounds) and the noun *spina* (= spine). It refers to the high number of anal fin spines which is a distinguishing and diagnostic feature of this species.

Description. Based on the holotype, with notes on the paratypes. See figs. 1–3 for general shape and colour patterns.
Body elongate, laterally compressed, dorsal and ventral contours more or less equally arched. Caudal peduncle short, dorsal edge slightly shorter than ventral. Predorsal and prepelvic contour slightly curved. Head moderately elongate, rounded. Mouth terminal, lower jaw slightly longer than upper one. Maxilla extending to anterior margin of orbit. Lips thick, folds continuous. Soft dorsal and anal fin pointed in males, more elongated than in females. Dorsal- and anal fin bases not scaled, but adjacent body scales reaching slightly over the bases of posterior spinous and anterior soft dorsal and anal fin area. Pelvic fins reaching beyond anal fin origin in males, in females to anal fin origin. Measurements in per cent of SL (given is the robust mean value and error of mean of 8 measured specimens of 21.2–33.5 mm SL, arithmetic mean 26.0 mm): Head length 33.2±0.58; snout length 5.8±0.15; body depth 38.3±0.51; orbital diameter 11.1±0.18; head width 19.8±0.35; interorbital width 8.9±0.29; preorbital depth 2.44±0.13; caudal peduncle depth 16.7±0.16; caudal peduncle length 5.74±0.21; pectoral fin length 33.7±0.84; pelvic fin length 33.3±0.89; anal fin base length 25.48±0.33; dorsal fin base length 66.2±0.63; last dorsal spine length 14.1±0.44. Dorsal fin XVI/7 (1), XVI/8 (1), XVII/7 (10), XVII/8 (1), XVII/9 (1). Anal fin III/8 (2), III/9 (1), IV/7 (8), IV/8 (31), V/8 (2). Pectoral fin 11 (2), 12 (12). Pelvic fin I/5 (14). Caudal fin 14 (14). Scales in E1 row 21 (1), 22 (13). Lateral line total counts: upper 12 (2), 14 (5), 15 (2), 16 (5); lower 4 (1), 5 (8), 6 (5). External first ceratobranchial gill rakers 5 (2), 6 (6).

Colouration in life. Dominant adult males with metallic green ground colour. Head more yellowish, chest and belly greyish white, nape and dorsal region dark grey to brown. Scales on the body sides mostly with a dark dot at their base. Dorsal fin grey, with thin red margin and light blue submarginal stripe. Distal part of dorsal fin bluish, spinous portion with many minute brown dots. Caudal fin translucent grey. Pelvic fins greyish, with thin white anterior

Fig. 5: *Nannacara quadrispinae* sp. n., female guarding older fry.

edges. Anal fin blue, with black margin. Iris dusky golden or orange. Sometimes with dark brown horizontal band from distal margin of orbit to the middle of the caudal fin base.
Ground colour of adult females beige, greyish or light brown; with orange stripe below the dark horizontal band. All fins greyish to translucent. Spinous portion of dorsal fin without tiny brown dots, but often with two dark spots in its basal portion. Brooding females are very dark and develop an intensive pattern of black horizontal and vertical bars. They show along the back a second horizontal band on and slightly below the upper lateral line and six dark vertical bars over the body sides. The first is on the caudal peduncle, the second between the ends of the soft dorsal and anal fin, the third above the origin of the soft anal fin, the fourth above the spinous anal fin, and the fifth and the sixth between the origin of the anal fin and the pelvic fins. The lower region of the head is also black.

Colouration in alcohol. Based on male holotype and a female paratype (28.8 mm SL).
Male: Ground colour greyish brown; with black horizontal band from distal margin of orbit to caudal peduncle. Along the back a second horizontal band on and slightly below the upper lateral line. A dark vertical band on the base of the caudal fin. Dorsal, anal and caudal fin greyish brown. Anal fin with black margin. Spinous portion of the dorsal fin covered with numerous tiny black dots. Lappets of dorsal fin hyaline.
Female: Colouration of sides and fins much like male, but with indications of the six vertical dark bars in the dorsal region and without the patterns of minute dark dots in the dorsal fin. Instead with two black spots on the basal portion of dorsal fin between the sixth and eleventh spine.

Geographical distribution. So far known only from western tributaries to the lower río Orinoco in an area between approximately 8°40’ and 10°10’N and approximately 62°20’ and 63°10’W in the Estado Monagas in north eastern Venezuela. Collections of *Nannacara quadrispinae* were made by the authors at several localities in the drainages of río Amana, río Mapirito, río Guanipa, río Tigre, río Morichal Largo, Morichal Morrocoy and río Uracoa. An additional collecting site is the río San Juan near Caripito (SCHULTZ, 1949).

Ecological notes. There is some indication that *Nannacara quadrispinae* prefers clear water habitats and typical black water habitats containing clear, tea-coloured water, or a mixture of these two water types. Water data of several collecting sites are: pH 4,9-6,2; both total and temporary hardness below l °dH, electrical conductivity 10-50 µS/cm, water temperature in April 29-31 °Celsius, in August 24-26 °Celsius. This dwarf cichlid lives along the banks in zones of extremely shallow water, i.e., in a water depth between approximately 10 and 40 cm. There *Nannacara quadrispinae* was collected either in a thick layer of dead leaves covering the bottom of the bank side or among aquatic and submerged terrestrial vegetation (*Cabomba aquatica, Chara* sp., *Nymphea* sp., *Echinodorus* ssp., *Eichhornia azurea, E. crassipes*). There is a distinct correlation between the available shelter and the abundance of the species. The highest population density occurs where a thick layer of dead leaves provides plenty of cover and protection. At such collecting sites more than one adult fish was frequently caught per 1 m of shoreline. As there are no stones in such biotopes, the only suitable substrate available for egg deposition is forest litter. Associated cichlid species are *Satanoperca mapiritensis, "Aequidens" pulcher, Mesonauta egregius* and *Apistogramma guttata*. Other fish frequently collected together with *Nannacara quadrispinae* are *Polycentrus schomburgki* Müller & Troschel, 1848, *Pyrrhulina* sp., and *Rivulus* sp.

Reproductive behaviour. Observations under aquarium conditions showed that *Nannacara quadrispinae* is a polygynous substrate spawner and that the male defends a territory containing several potential spawning sites. Each of them may serve as the focus of a smaller territory occupied by a female. Like most other open brooders these dwarf cichlids place their eggs on a horizontal surface. The preferred spawning site is drift wood or a stout plant leaf. At 27 °Celsius hatching occurs about three days postspawning, and the fry attempt swimming six days thereafter. After spawning the female drives the male energetically from the close proximity of the spawning site. Parental care is exclusively maternal in this species, although the male may indirectly assist by defending the territory against predators.

Discussion

With the addition of the new taxon from Venezuela there are four nominal species in the *N.-anomala*-species complex (KULLANDER& PRADA-PEDREROS, 1993; STAECK & SCHINDLER, 2000), which is diagnosed by the reduced number of only 14 caudal fin rays, viz. *N. anomala* Regan, *N. taenia* Regan, *N. aureocephalus* Allgayer and *N. quadrispinae* sp. nov. This, however, draws a misleading picture of the species richness in this group, for there seems to be a much greater diversity in this species complex. We know several forms which seem to be distinct from the four nominal species referred to above, but which have not yet been described since only inadequate material is available (KULLANDER & NIJSSEN, 1989; STAECK & SCHINDLER, 2000; STAECK, 2003). Because of the lack of sufficient material, currently most of these forms can only be distinguished from the nomical *Nannacara* species on the basis of their colouration. But we assume that a critical study of adequate material from the entire range of the *Nannacara-anomala*-species complex will provide additional separating character states that will justify the recognition of some of this form as distinct species.

All the members of *Nannacara-anomala*-species complex are very similar to each other in general appearance. *N. quadrispinae*, however, is distinguished from all the congeners by the unusual number of 4 (or even 5) anal fin spines (in 41 of 44 examined specimens of *N. quadrispinae*). All the other nominal species have only 3 anal fin spines.

The only exception is a possibly distinct species from Mabaruma (Guyana) which occasionally has also 4 anal fin spines (2 of 5 examined specimens). This population differs from *N. quadrispinae* by a more elongate body (34.0±1.09) and by two orange longitudinal stripes (above and below dark lateral stripe) in females versus only one narrower orange stripe in

females of *N. quadrispinae* (see STAECK & SCHINDLER, 2000). EIGENMANN (1912) mentions 2 specimens from Aruka (from the same drainage as the Mabaruma specimens), which, however, both have only 3 anal fin spines.
An additional statistically significant diagnostic feature of *N. quadrispinae* (pair wise comparison with Whitney-Mann-Test each p<.001) is the higher number of dorsal fin spines (mode XVII in *N. quadrispinae* versus mode XVI in *N. anomala, N. aureocephalus* and *N. taenia*). Further, *Nannacara quadrispinae* seems to have a more robust body than the other three species of this group. In comparison with *N. anomala,* the geographically neighbouring species, this can be quantified by a higher body (body depth in *N. quadrispinae* 38.3±0.51 versus 35.9±0.71 in *N. anomala* from Demerara [n=5], and 35.3±0.25 in *N. anomala* from Surinam [n=36, adopted from KULLANDER & PRADA-PEDREROS, 1993], 36.6±0.31 from French Guiana [n=7]) and a wider interorbital distance (interorbital width 8.9±0.29 in *N. quadrispinae* versus 7.8±0.21 in *N. anomala* from Demerara, 7.6±0.06 in *N. anomala* from Surinam and 8.4±0.21 from French Guiana). However, as KULLANDER & NIJSSEN (1989) observed a certain variability of these measurements even between different populations of *N. anomala* from Surinam, more studies on the basis of a greater number of fully grown specimens are required to verify the reliability of such differences as diagnostic character states.

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