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Description of a New Species of *Rheocles* (Atherinomorpha, Bedotiidae) from the Nosivolo Tributary, Mangoro River, Eastern Malagasy Republic

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ABSTRACT

A new species of bedotiid silverside, *Rheocles lateralis,* is described from a collection of fishes from the Nosivolo tributary of the Mangoro River, eastern Malagasy Republic. Its relationships are explored and determined to lie with *R. alaotrensis* (Pellegrin, 1914) and *R. pellegrini* (Nichols and LaMonte, 1931), being the sister species of the latter.

INTRODUCTION

Stiassny (1990) reviewed the composition and interrelationships of the endemic Madagascan silverside genus *Rheocles* Jordan and Hubbs, 1919. Based upon examination of museum material and a recent collection from the eastern highlands (Reinthal and Stiassny, 1991) four species, *Rheocles sikorae* (Sauvage, 1891), *R. alaotrensis* (Pellegrin, 1914), *R. pellegrini* (Nichols and LaMonte, 1931), and *R. wrightae* Stiassny, 1990, comprise the genus.

Rheocles has a restricted distribution, being found only in certain forested freshwater habitats in the central and eastern highlands of Madagascar (fig. 1). Virtually nothing is known of the basic biology or ecology of the genus but its close association with forested biotopes suggests that, like so many other rainforest-adapted series, *Rheocles* is extremely vulnerable to deforestation pressure (Reinthal and Stiassny, 1991). Stiassny (1990) raised the possibility that two of the species

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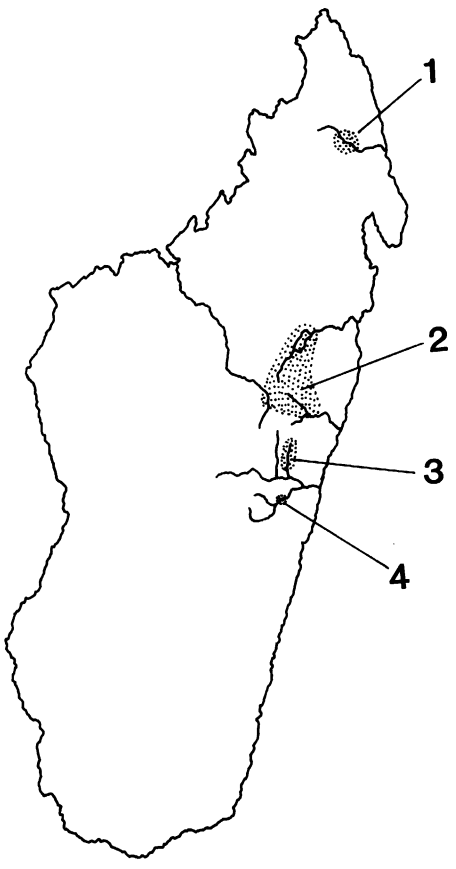

Fig. 1. Map of Madagascar. Stippling represents historical distributional ranges of: (1) *Rheocles pellegrini,* (2) *Rheocles alaotrensis,* (3) *Rheocles sikorae,* and *Rheocles wrightae,* and (4) *Rheocles lateralis,* n. sp. After Stiassny, 1990.

(*R. sikorae* and *R. wrightae*) may already have succumbed to the pressures of regional deforestation and habitat degradation, and are now extinct.

Recent collections (September 1990) of fishes from the Nosivolo tributary of the Mangoro River (Reinthal, in prep.) have yielded a new species of *Rheocles* from an isolated locality in the region of Ampasimaniona Village. Discovery of this new taxon highlights the urgent need for continued survey efforts to document the Madagascan ichthyofauna before further habitat degradation.

MATERIALS EXAMINED

The following is a list of materials examined. Specimens are noted according to type of material: c. & s. = cleared and stained, alc. = alcohol specimen.

Polymixiiformes: *Polymixia lowei* (AMNH 49674, c. & s.).

Mugilomorpha; *Agonostomus monticola* (AMNH 31538, c. & s., AMNH 31550, alc.), *Mugil curema* (AMNH 39162, c. & s.).

Atherinomorpha: *Bedotia geayi* (AMNH 28132, c. & s.), *Bedotia* sp. (AMNH 88074, c. & s., alc.), *Rheocles sikorae* (AMNH 28127, c. & s.), *Rheocles alaotrensis* (AMNH 88001, c. & s., AMNH 88171, c. & s. alc.), *Rheocles wrightae* (AMNH 58908, c. & s.), *Rheocles pellegrini* (AMNH 9696, alc.), *Rheocles lateralis* (AMNH 59311, alc., AMNH 59312, c. & s., alc.), *Melanotaenia maccullochi* (AMNH 44401, c. & s.), *Teramulus keineri* (AMNH 88171, c. & s.), *Telmatherina ladigesi* (AMNH 35738, c. & s.), *Pseudomugil tenellus* (AMNH 36598, c. & s.), *Craterocephalus cuniceps* (AMNH 43184, alc.), *Atherinomorus stipes* (AMNH 53025, c. & s.), *Atherinops affinis* (AMNH 5522, c. & s.), *Menidia menidia* (AMNH 40592, c. & s.)

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ABBREVIATIONS

ep	epural
mesopt	mesopterygoid
mesopt-tp	mesopterygoid toothpatch
pal	palatine
pal-tp	palatine toothpatch
phyp	parhypural
PU2vt	preural ventral radial
un	uroneural

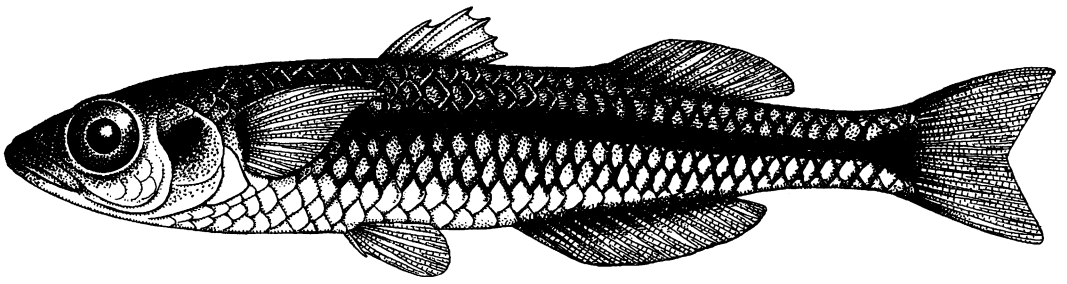

Fig. 2. Lateral view of the holotype of *Rheocles lateralis,* n. sp., 56.2 mm SL (AMNH 59311). Drawn by Patricia Wynn.

Rheocles lateralis, new species
Figure 2

HOLOTYPE: AMNH 59311, male 56.2 mm SL. Nosivolo River, below Ampasimaniona Village, 26 km east-northeast of Maralambo, Province of Tamatave, Madagascar (19°59'S, 48°15'E). Rotenone station in a large side pool below rapids. Sandy bottom with large boulders exposed. Collected on September 20, 1990, by P. N. Reinthal, M. L. J. Stiassny, and G. J. P. Naylor.

PARATYPES: AMNH 59312, 30 individuals (56.4–20.8 mm SL), same data as holotype.

DIFFERENTIAL DIAGNOSIS: *Rheocles lateralis* is readily distinguished from *R. sikorae* and *R. wrightae* by length of upper jaw and color pattern. In *R. lateralis* the upper jaw reaches the vertical line through the anterior margin of the orbit, whereas in both *R. sikorae* and *R. wrightae* it extends well beyond this line (Stiassny, 1990: fig. 18). No spotting on flanks; instead a well-marked lateral stripe extends from base of the caudal peduncle onto anterior third of the body. *Rheocles lateralis* differs from *R. pellegrini* in cheek and chest squamation and gill raker number. It is fully scaled on cheek and chest (scales lacking in *R. pellegrini*), and bears 10 gill rakers on lower limb of the first arch (7 in *R. pellegrini*). Distinguished from *R. alaotrensis* by slenderer body (BD 19.2–21.2% SL vs. 22.2–27.4% SL), longer caudal peduncle (CPL 86.4–96.7% HL vs. 58.2–68.3% HL), and separate fourth and fifth caudal hypural elements (fused in *R. alaotrensis*). *Rheocles lateralis* is unique among *Rheocles* species in bearing a series of broadly ossified interdorsal pterygiophores.

DESCRIPTION: Morphological measurements and meristic counts are given in table 1. Largest known specimen of *Rheocles lateralis* is a sexually mature male (56.4 mm SL) with enlarged testes.

Rheocles lateralis are slender, fusiform fishes not deep-bodied anteriorly and with little belly curvature. Head and dorsum are more or less straight and the short-based second dorsal fin originates well behind a vertical through the origin of the anal fin.

Head with an acute and narrow snout. Dorsal head profile smoothly rounded, not interrupted by premaxillary pedicels. Lower jaw slightly prognathous and angled at 20–25° to the horizontal when the mouth is closed. Premaxilla and maxilla reach a vertical through the anterior margin of orbit.

Teeth: Both upper and lower jaws bear 2 to 3 rows of small, strongly recurved unicuspid teeth. In the lower jaw the anterior 4 to 5 outer row teeth are often slightly enlarged and procumbent. Outer row teeth in both jaws are larger than those of inner rows. Vomer, palatine, and mesopterygoid bones edentate (fig. 3A) as in *R. pellegrini* (Stiassny, 1990). These bones are denticulate in *R. sikorae, R. wrightae,* and *R. alaotrensis* (e.g., fig. 3B).

Gill Rakers: 2 or 3 stout hypobranchial rakers and 7 or 8 elongate ceratobranchial rakers are present on the lower limb of the first branchial arch. All rakers are strongly denticulate.

Scales: Body covered with large regularly imbricate cycloid scales. Predorsal scale count ranges from 13 to 15 along the dorsal midline. 35 or 36 scales along midlateral axis. 3 to 5 scales separate first and second dorsal fins. Dorsal, anal, and caudal scale sheaths, and axillary pelvic scales lacking. As in *R. alaotrensis* and *R. pellegrini,* the region from rounded interpelvic scale to genital papilla is

TABLE 1

***Rheocles lateralis*, new species**

(Figures in parentheses indicate values for the holotype; remaining columns are the range for paratypical series. l = length, w = width.)

	Holotype	Paratypes N	min	max	mean
Standard length	(56.2)	30	20.8	56.4	38.6
PreD1 (%SL)	(47.1)	15	41.9	48.9	46.4
PreD2 (%SL)	(65.5)	15	59.4	66.1	63.6
Preanal (%SL)	(59.4)	15	57.3	61.9	59.7
Prepelv. (%SL)	(38.5)	15	36.9	41.5	39.6
Abase (%SL)	(22.6)	15	21.2	24.3	22.6
D2 base (%SL)	(17.2)	15	16.2	17.4	16.9
Body depth (%SL)	(19.6)	15	19.2	21.2	20.1
Head l (%SL)	(25.0)	15	24.3	26.7	25.7
Snout l (%HL)	(34.9)	15	28.7	36.1	34.2
Eye depth (%HL)	(35.7)	15	33.8	36.9	35.5
Lower jaw l (%HL)	(56.6)	15	52.3	61.0	56.7
Upper jaw l (%HL)	(44.8)	15	44.3	47.8	46.3
Caud. peduncle l (%HL)	(91.1)	15	86.4	96.7	91.1
Caud. peduncle w (%HL)	(41.3)	15	39.2	42.6	40.7
P1-P2 (%SL)	(14.5)	15	13.5	15.3	14.4
P2-D2 (%SL)	(33.1)	15	32.0	34.9	33.7
D1-A (%SL)	(22.6)	15	21.8	23.8	22.9
D2-A (%SL)	(20.1)	15	19.3	21.3	20.4

	Holotype	N	Range	Distribution	
Longitudinal scales	(36)	22	35–36	35 (12)	36 (10)
Gill rakers (lower arch)	(10)	22	10		
D2 rays	(10)	22	10		
Anal rays	(14)	22	14		
Vertebrae	(37)	22	37–38	20 + 17 (11)	
				20 + 18 (11)	

scaleless. Interpelvic region of *R. sikorae* and *R. wrightae* fully scaled (Stiassny, 1990).

Fins: First dorsal fin bears 5 or 6 weak spines. Short-based second dorsal fin bears a weak spine followed by 10 soft rays. Anal fin has a weak spine and 14 soft rays. Second soft dorsal and anal fin rounded in outline. Pectoral fins high set and relatively short, longest upper rays rarely extending beyond a vertical from the pelvic fin insertion. Caudal fin with forked lobes.

Osteology and Other Anatomical Features: Vertebral counts are 20 precaudal + 17 or 18 caudal centra. Dorsal ramus of urohyal is simple and unexpanded (fig. 4), lacking modifications of the *R. sikorae* / *R. wrightae* species pair (Stiassny, 1990). In caudal fin skeleton (fig. 5) fourth and fifth hypural elements are separate, rather than fused into a single element as in *R. alaotrensis* (Stiassny, 1990; fig. 11D). *Rheocles lateralis* is unique among bedotiids in its series of broad platelike interdorsal pterygiophores (fig. 6A). In other bedotiids and melanotaeniids they are bladelike (e.g., figs. 6B, C; Allen, 1980: fig. 22). Similar bladelike interdorsal bones are present in mugilid fin skeleton (e.g., *Agonostomus,* fig. 6D). *Rheocles lateralis* retains a well-developed ethmomaxillary ligament which is absent in *R. wrightae* and *R. sikorae* (Stiassny, 1990).

COLORATION: In preserved specimens color is pale creamy white. Dorsum of head, dorsolateral aspect of snout, upper and lower jaw, and infraorbital region of cheek are darkly pigmented. Dark wedge-shaped blotch on operculum, and crescentic patch of dark pigment at base of pectoral fin. Well-marked

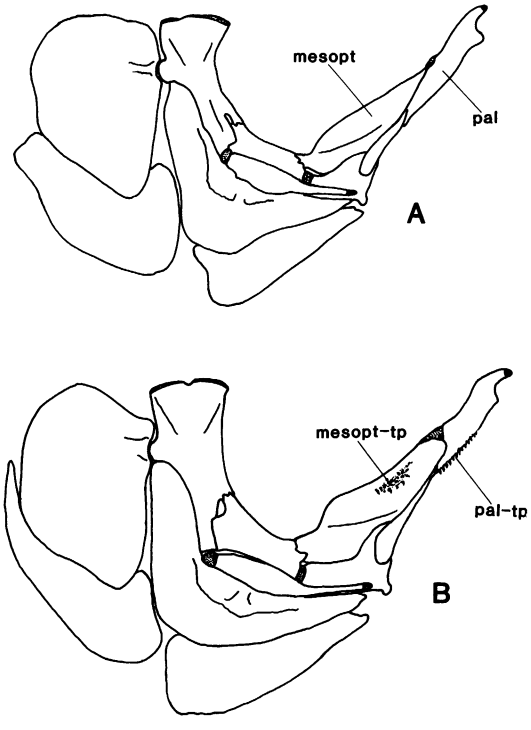

Fig. 3. Suspensorial elements of (A) *Rheocles lateralis,* n. sp. (AMNH 59312), (B) *Rheocles alaotrensis* (AMNH 88001).

midlateral stripe extends from anterior third of body to base of caudal peduncle, where it thickens and terminates in a broad wedge at fin base. Base of anal fin has thin border of black pigment. Dorsal, anal, and caudal fins are dusky gray proximally and hyaline distally. Pectoral and pelvic fins hyaline. Each body scale is usually ringed around exposed edge with fine black border.

In life *R. lateralis* is a drab greenish gray fish lacking the brightly colored finnage of *R. alaotrensis,* the only other species for which live color data are available (Stiassny, 1990).

DISTRIBUTION: *Rheocles lateralis* is known from a single locality on the Nosivolo River, a large southern tributary of the Mangoro River (fig. 1). Collections made above and below this station failed to locate additional specimens, suggesting a highly restricted distributional range for the species.

ETYMOLOGY: The specific epithet, from the Latin *latus,* in reference to the well-marked midlateral stripe extending from the base of the caudal peduncle into the anterior third of the body.

Fig. 4. Urohyal bone of *Rheocles lateralis,* n. sp. (AMNH 59312).

RELATIONSHIPS: The immediate relationships of *R. lateralis* lie with *R. alaotrensis* and the little known northern species, *R. pellegrini* (fig. 7). Evidence for this alignment is found in the shared possession of a derived feature of body squamation: *R. lateralis* in common with *R. alaotrensis* (Stiassny, 1990: fig. 20A) and *R. pellegrini,* is scaleless from the rounded interpelvic scale to the genital papilla and anus. *Rheocles sikorae* (Stiassny, 1990; fig. 20B) and *R. wrightae* are fully scaled in this region, as are related bedotiids and atherinids. Based on patterns of distribution among basal paracanthopterygians, polymixioids, mugiloids, and atherinoids, Stiassny (1990) argued that a loss of scales on the venter represents a derived condition within *Rheocles,* and as such is interpreted here as evidence for the close relationship of the three species.

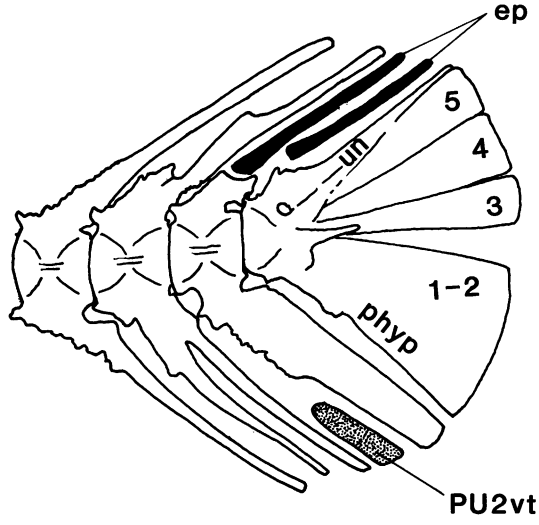

Fig. 5. Caudal fin skeleton and associated vertebrae of *Rheocles lateralis,* n. sp. (AMNH 59312).

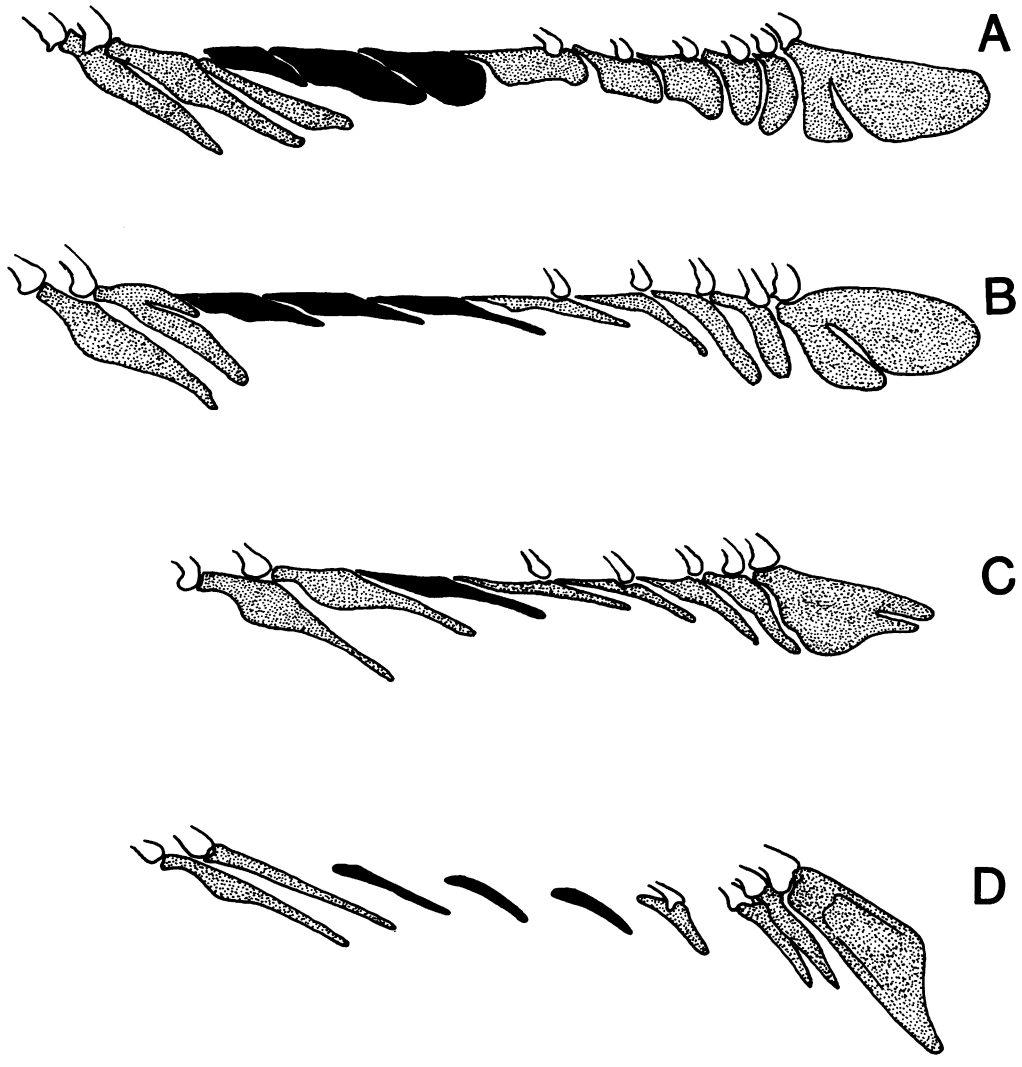

Fig. 6. Skeletal support elements of the dorsal fins of: (**A**) *Rheocles lateralis,* n. sp. (AMNH 59312), (**B**) *Rheocles alaotrensis* (AMNH 88001), (**C**) *Bedotia* sp. (AMNH 88074), and (**D**) *Agonostomus monticola* (AMNH 31538). Ray bearing pterygiophores stippled; rayless interdorsal pterygiophores black.

Rheocles lateralis, R. alaotrensis, and *R. pellegrini* share further similarities in meristic features, e.g., a shorter second dorsal fin (10–11 vs. 14–16 rays in *R. sikorae* and *R. wrightae*). However, a low second dorsal fin ray count also characterizes other bedotiid taxa, mugiloids, and basal paracanthopterygian clades (Stiassny, 1990), and is probably best interpreted as plesiomorphic for atherinomorphs.

Relative to the *R. sikorae* / *R. wrightae* pair, the *R. lateralis* / *R. alaotrensis* / *R. pellegrini* group has a low longitudinal (midlateral) scale count (30–36 vs. 36–40). Attempts to determine the polarity of meristic characters, particularly in the absence of clear disjuncts, are problematical. In related bedotiids, a longitudinal scale count of 33–35 is common, whereas in melanotaeniids counts range from about 28 to 60 (Allen, 1980). An elevated count is present in polymixioids, mugiloids, and most atherinid taxa. In the face of such variation we are hesitant to place too much emphasis on this minor meristic

difference in a phylogenetic analysis of intrageneric relationships.

Within the *R. lateralis / R. alaotrensis / R. pellegrini* group, *R. lateralis* appears to be most closely related to *R. pellegrini*. Evidence for this phylogenetic alignment is found in the palatal and buccal dentition of the two taxa: in *R. lateralis* and *R. pellegrini* the vomer, palatines, and mesopterygoid bones are edentate (e.g., fig. 3A). In *R. alaotrensis* (fig. 3B), *R. sikorae, R. wrightae,* and all other bedotiids and melanotaeniids, tooth patches are present on each of these bones. Denticulate palates are found in polymixioids and *Agonostomus*. Although among atherinids there is a trend of reduction in palatal dentition, mesopterygoid and often also palatine tooth patches are retained in most taxa. In view of this distributional data, the conclusion that a loss of palatal teeth is a derived condition within *Rheocles* seems justified.

In *R. lateralis* and *R. pellegrini* the outer row teeth, particularly on the lower jaw, are somewhat enlarged relative to the inner row. In other *Rheocles,* bedotiids, melanotaeniids, and most atherinids, there is little differentiation between the outer row teeth and numerous inner row teeth.

Rheocles lateralis (fig. 2) and *R. pellegrini* (Stiassny, 1990: fig. 26) are also similar in that the second dorsal fin originates well behind a vertical through the origin of the anal fin. In *R. alaotrensis, R. sikorae,* and *R. wrightae* the second dorsal fin originates at or just a little behind a vertical through the origin of the anal fin (see Stiassny, 1990: figs. 19, 23, 24). However, in other atherinoids the second dorsal fin is usually posteriorly displaced, originating well behind a vertical through the origin of the anal fin as is also the case in most mugilid genera. On the basis of this distributional data it would appear that a posteriorly displaced second dorsal fin represents the plesiomorphic atherinomorph condition (see also Chernoff, 1986). The anterior displacement of the fin in *R. alaotrensis* is perhaps best interpreted as having been derived independently from that of the *R. sikorae / R. wrightae* pair (fig. 7).

In view of the overall low diversity previously found in the Madagascan freshwater ichthyofauna (Arnoult, 1959), discovery of an undescribed taxon in the Nosivolo River indicates that less is known about this evolutionarily important fauna than was previously thought. Based on comparisons with other eastern rainforest rivers (Reinthal and Stiassny, 1991), the Mangoro/Nosivolo river system contains a large number of native and endemic species. Taken in the context of existing threats to watersheds (Reinthal and Stiassny, 1991) and the high priority given to Madagascan conservation, surveys of the island's ichthyofauna are urgently needed.

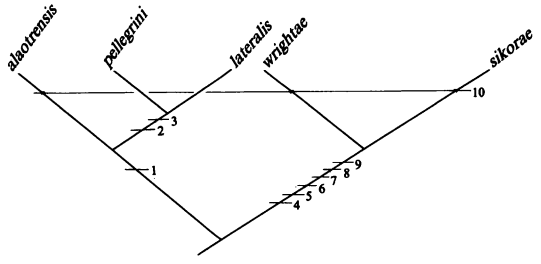

Fig. 7. Cladogram depicting the interrelationships of *Rheocles* (Consistency Index = 0.909). Characters supporting the scheme are as follows: **1.** Region from rounded interpelvic scale to anus naked (see p. 5). **2.** Vomer, mesopterygoid and palatine bones edentate (see p. 7). **3.** Outer row teeth in upper and lower jaws enlarged relative to teeth of inner rows (see p. 7). **4.** Series of irregular black spots along lateral aspect of the body (see Stiassny, 1990: 21). **5.** First dorsal fin darkly pigmented (see Stiassny, 1990: 21). **6.** Genital papilla darkly pigmented (see Stiassny, 1990: 21). **7.** Anterior ramus of the urohyal bone broad and dorsally expanded (see Stiassny, 1990: 22). **8.** Ethnomaxillary ligament absent (see Stiassny, 1990: 22). **9.** Long-based second dorsal fin with an elevated soft ray count (see Stiassny, 1990: 22). **10.** Second dorsal fin originates at, or a little behind, the vertical through the origin of the dorsal fin (see p. 7).

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