



Two new deep-water species of the genus *Thorogobius* (Teleostei: Gobiidae) from the upper continental slope of the Eastern Central Atlantic

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Abstract

Two new gobiid species, *Thorogobius alvheimi* **sp. nov.** and *Thorogobius laureatus* **sp. nov.** (Teleostei: Gobiiformes: Gobiidae), are described from the outer continental shelf and upper slope of the Eastern Central Atlantic off Angola, Ghana and São Tomé and Príncipe. The specimens were trawled from depths between 57 and 208 m. The new species are most similar to *Thorogobius angolensis*. *Thorogobius alvheimi* **sp. nov.** is distinguished from its congeners in the combination of following characters. Fins: first dorsal fin with the second and third spines distinctly elongated; pectoral fin ray count 20–21; pelvic disc complete and short with well-developed anterior membrane (frenum) and pointed lateral lobes. Scales: nape and predorsal area naked; no scales on opercle; scales in longitudinal series 27–31. Pattern of free neuromasts: supratemporal rows **tr** and **trp** developed, extending transversally between pores **H** and **K**; longitudinal row **g** short, not passing row **m** posteriorly and distinctly distant from row **h**; infraorbital row **6** long, ventrally extending to lower margin of preopercle, its ventral section **6i** originating anterior to its dorsal section **6s**; posterior lateral row **h** reaching anteriorly above posterior third of opercle. Coloration: body uniformly pale fawn and brown; margin of scale pockets dark brown pigmented, yielding a reticulated pattern; pale spots on nape and predorsal area; caudal fin uniformly dusky greyish. *Thorogobius laureatus* **sp. nov.** is distinguished from its congeners in the combination of following characters. Fins: first dorsal fin the second and third spines distinctly elongated; pectoral fin ray count 19–22; pelvic disc complete, short, with well-developed anterior membrane (frenum) with pointed lateral lobes. Scales: scales on sides of predorsal area and midline mostly naked; no scales on opercle; scales in longitudinal series 24–27. Pattern of free neuromasts (sensory papillae): supratemporal rows **tr** and **trp** developed, extending transversally between pores **H** and **K**; longitudinal row **g** long, passing row **m** posteriorly and relatively close to row **h**; infraorbital row **6** long, ventrally extending to lower margin of preopercle, its ventral (**6i**) and dorsal (**6s**) originating opposite to each other; posterior lateral rows: row **h** long, reaching anteriorly above middle of opercle. Coloration: body pale fawn and brownish; margin of scale pockets dark brown pigmented, yielding a reticulated pattern; five brown blotches on flanks in lateral midline from below first dorsal fin to caudal peduncle; caudal fin with six or seven distinct dark vertical bands.

Key words: *Thorogobius alvheimi* **sp. nov.**, *Thorogobius laureatus* **sp. nov.**, Gobiidae, Eastern Central Atlantic, Angola, Ghana, São Tomé and Príncipe, taxonomy

Introduction

The genus *Thorogobius* Miller, 1969 currently comprises four species: *T. ephippiatus* (Lowe, 1839) from the Mediterranean Sea and the temperate eastern Atlantic (Norwegian Sea to Canary Islands), *T. macrolepis* (Kolombatović, 1891) from the Mediterranean, *T. angolensis* (Norman, 1935) (Senegal to Angola) and *T. rofeni* Miller, 1988 (Equatorial Guinea to Angola).

By far most marine gobiid species inhabit inshore littoral waters. Only a few species are found below 150 m and are considered as secondary deep-water forms (Andriyashev 1953; Miller 1988; Goren & Baranes 1995; Ahnelt *et al.* 2000). While two species of the genus *Thorogobius*, *T. ephippiatus* and *T. macrolepis*, occur on upper

shelf (Miller 1986), the other two currently recognized species occur in distinctly deeper waters on the continental shelf and the upper continental slope: *T. angolensis* has been captured at depths between 50 and 135 m, and *T. rofeni* in depths between 260 and 650 m (Norman 1935; Sauberer & Ahnelt 2008).

In this study we describe two new deep-water species of *Thorogobius* from the Eastern Central Atlantic collected on the outer shelf and upper slope of West Africa: *Thorogobius alvheimi* sp. nov. and *Thorogobius laureatus* sp. nov.

Material and methods

All specimens of the new species were collected by the vessel R/V Dr. Fridtjof Nansen (DFN) with a large otter trawl in the FAO fishing area 34 (Eastern Central Atlantic) in island nation of São Tomé and Príncipe and off Ghana and in part of FAO fishing area 47 (Southeast Atlantic) off Angola (Fig. 1). Counts and measurements follow Miller, 1988 (*cheek depth* excluded). The additional measurement *upper jaw length* is defined as the length from the anteriormost point of the premaxilla to the posterior edge of the maxilla. Measurements were taken with the aid of electronic calipers and rounded to the nearest 0.1 mm. The terminology of the cephalic lateral-line canals follows Ahnelt (2001), and those of the canal pores follows Akihito (1986). Free neuromasts are listed by innervation categories for Gobiidae (Ahnelt & Bohacek 2004). The terminology of the free neuromasts of the lateral-line system follows Sanzo (1911). Characters of the holotype are indicated by asterisks in counts and by brackets in measurements. Fins and scales: the number of specimens studied with the specific counts is given in parentheses; values of the holotype are shown with an asterisk. As a result of the sampling method (dredging with a large otter trawl), the scales of most specimens are abraded and lost; those remaining are ctenoid. Nevertheless, the body regions covered by scales and the number of scales in lateral and transverse series could be determined in most specimens from the conspicuous scale pockets (Fig. 2). Sex was determined by the shape of the urogenital papilla, uniformly wide in females, narrowing at the tip in males. The types are deposited in the California Academy of Sciences, San Francisco (CAS), the Naturhistorisches Museum in Wien (NMW) and the Zoologische Staatssammlung München (ZSM). Comparative material is deposited at the Natural History Museum, London (BMNH), CAS, the Museu Municipal do Funchal (MMF), NMW and the Zoologisk Museum Statens Naturhistoriske Museum København (ZMUC).

Comparative material. *Thorogobius angolensis*: 56 specimens; BMNH 1935.5.11, syntypes, 13 males, standard length (SL)+caudal fin length (CL) 44.3+d (damaged)–75.6+d mm and 13 females, 50.8+17.3–68.4+d mm SL+CL, off St. Paul de Loanda [Luanda], Angola (no data on coordinates and depth), R.R.S. Discovery Cruise stn. 274, 4 Aug. 1927; CAS 222449, 3 females, 68.3–84.5 mm SL, off Lobito, Angola (12°17'S, 13°34'E), 57–53 m, R/V Dr. Fridtjof Nansen (DFN) stn. 3611, 2 April 2005; CAS 224965, 1 male, 76.9 mm SL, 1 female, 75.8 mm SL, sw. of Porto Amboim, Angola (10°54.91'S, 13°43.71'E), 55–54 m, DFN stn. 61, 6 Mar. 2007; CAS 225190, 2 males, 58.8+d–64.1+16.3 mm SL+CL, 12 females, 52.1+17.9–83.3+d mm SL+CL, n. of Luanda, Angola (8°34.7'S, 13°15.3'E), 54–53 m, DFN stn. 107, 11 Mar. 2007; CAS 239250, 2 males, 63.1+19.8–67.4+21.7 mm SL+CL, off Senegal (15°19.1'N, 16°55.5'W), 53–50 m; DFN stn. 98, 28 May 2012; CAS 243859, 8 males, 37.5–94.6 mm SL, 6 females, 43.2–64.0 mm SL, off Guinea-Bissau (11°56.5'N, 17°12.3'W), 75–74 m, DFN stn. 56, 20 May 2012.

Thorogobius ephippiatus: 41 specimens; Data from P.J. Miller's original description of the genus *Thorogobius* (Miller 1969).

Thorogobius macrolepis: 17 specimens; NMW 94928, 1 female, 94.1+12.6 mm SL+CL, Croatia, Gulf of Kvarner (no data on coordinates and depth), 1995, leg. M. Kovačić; 9 males, 35.9+9.4–51.8+15.9 mm SL+CL, 7 females, 45.6+11.1–50.4+13.6 mm SL+CL; Croatia, Gulf of Kvarner (no data on coordinates and depth), 1995, leg. M. Kovačić.

Thorogobius rofeni: 7 specimens; ZMUC P781640, holotype, 1 female, 81.9+d mm SL+CL, Gulf of Guinea, Equatorial Guinea (2°09'N, 9°27'E), no data on depth; CAS 222316, 2 males, 74.9+d–77.1+20.4 mm SL+CL, 4 females, 58.0+17.2–71.7+19.9 mm SL+CL, off Cunene R. mouth, Angola (17°13'S, 11°22'E), 294–288 m, DFN stn. 3585, 27 Mar. 2005.

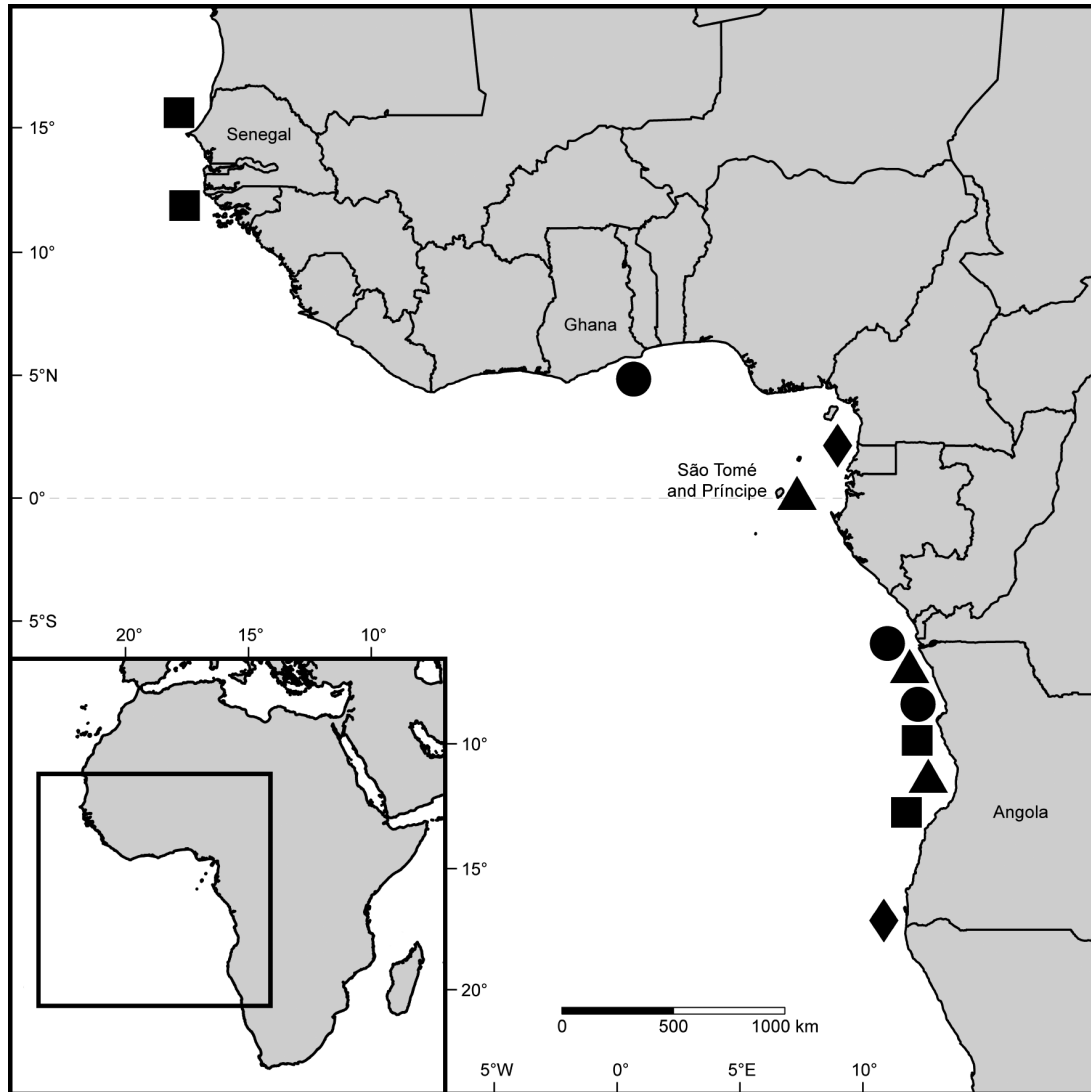


FIGURE 1. Map of West Africa, showing sampling sites of *Thorogobius angolensis* (squares), *Thorogobius alvheimi* **sp. nov.** (circles), *Thorogobius laureatus* **sp. nov.** (triangles) and *Thorogobius rofeni* (diamonds).

Taxonomy

Genus *Thorogobius*. Defined by (1) anterior and posterior oculoscapular and preopercular head canals present; (2) seven transverse suborbital rows of free neuromasts, with seventh as single papilla at pore **F**; rows **5** and **6** divided by longitudinal row **b** in dorsal and ventral sections; (3) anterior dorsal rows **o** meeting in midline; (4) longitudinal supratemporal neuromast row **x1** extending anterior to pore **G** of the postorbital section of the anterior oculoscapular canal; (5) anterior nostril tubular without dermal process from rim; (6) uppermost rays of pectoral fin contained within membrane; (7) complete pelvic disc.

Key to species of *Thorogobius*

- | | | |
|----|---|--|
| 1a | Nape and predorsal area completely or only laterally scaled | 2 |
| 1b | Nape and predorsal area naked | 3 |
| 2a | Nape and predorsal area completely scaled and two dark patches at the bases of both dorsal fins; eastern Atlantic from Senegal to Angola. | <i>Thorogobius angolensis</i> |
| 2b | Predorsal area scaled at sides, otherwise naked and no dark patches at the bases of both dorsal fins; eastern Atlantic from São Tomé and Príncipe to Angola | <i>Thorogobius laureatus</i> nov. sp. |

- 3a Scales in transversal series ≥ 11 and brown blotches present all over the body *Thorogobius ephippiatus*
 3b Scales in transversal series ≤ 10 and no brown blotches all over the body 4
 4a Pectoral fin rays ≥ 19 , no pale brown spots and blotches on the body and head; spots, if present, pale fawn and only on nape and predorsal area; eastern Atlantic from Ghana, Equatorial Guinea (Gulf of Guinea) and Angola 5
 4b Pectoral fin rays ≤ 18 , pale brown spots and blotches all over the body and head; endemic to the Mediterranean Sea
 *Thorogobius macrolepis*
 5a Scales in longitudinal series ≥ 30 and no blotches or spots on body and head; distinct dark vertical stripes on caudal fin; Equatorial Guinea (Gulf of Guinea) and southern Angola; head neuromast rows **tr** and **trp** absent *Thorogobius rofeni*
 5b Scales in longitudinal series ≤ 29 and pale fawn spots irregularly scattered over nape and predorsal area; no vertical stripes on caudal fin; eastern Atlantic from Ghana and Angola; head neuromast rows **tr** and **trp** present
 *Thorogobius alvheimi* **nov. sp.**

***Thorogobius alvheimi* sp. nov.**

(Figures 1–3, 7; Tables 1–3)

Holotype. CAS 222482, female, standard length+caudal fin length 72.1+19.8 mm; Angola, off Luanda (8°24'S, 12°56'E) at depths of 166–162 m, R/V Dr. Fridtjof Nansen (DFN) stn. 3713, 15 April 2005.

Paratypes. (8 specimens). **Angola:** CAS 222338, 1 male 51.8+d mm SL+CL, 1 female 52.3+d mm SL+CL, sw. of Congo R. mouth (6°27'S, 11°55'E), 109–108 m, DFN stn. 3783, 22 April 2005; CAS 244059, 1 male 102.4+d mm SL+CL, same data as for holotype; CAS 225193, 1 female 52.2+d mm SL+CL, off Luanda (8°53.5'S, 13°02.21'E) 190–187 m, DFN stn. 102, 11 March 2007; NMW 99079, 1 female 62.6+20.2 mm SL+CL, same data as for CAS 222338. **Ghana:** CAS 243855, 1 female 64.1+17.4 mm SL+CL, off Accra (5°16.44'N, 0°10.65'W), 91–88 m, DFN stn. 13, 2 May 2010; CAS 243856, 1 male 51.3+15.3 mm SL+CL, off Keta (5°49.26'N, 1°07.57'E), 84–74 m, DFN stn.4, 1 May 2010; CAS 243857, 1 female 58.6 + d mm SL+CL, se. off Keta, (5°53.89'N, 1°16.37'E), 208–201 m, DFN stn. 2, 2 May 2010.

Non-type specimens. (4 specimens). Excluded from type material because of damage and/or juvenile stage. CAS 244060, 4 specimens of undetermined sex (37.9–46.5 mm SL), same data as for holotype.

Diagnosis. *Thorogobius alvheimi* sp. nov. is distinguished from its congeners in the combination of following characters: Fins: first dorsal fin with six spiny rays, second and third distinctly elongated; pectoral fin ray count 20–21; pelvic disc complete and short with well-developed anterior membrane (frenum), with pointed lateral lobes. Scales: nape and predorsal area naked; no scales on the opercle; scales in longitudinal series 27–31. Pattern of free neuromasts: supratemporal rows **tr** and **trp** developed, extending transversally between pores **H** and **K**; longitudinal row **g** short, not passing row **m** posteriorly and distinctly distant from row **h**; infraorbital row **6** long, ventrally extending to lower margin of preopercle, its ventral section **6i** originating anterior to its dorsal section **6s**; posterior lateral row **h** reaching anteriorly above posterior third of opercle. Body proportions: body depth (16.6–20.4% at anal-fin origin in SL), head width (42.9–53.8% in head length); upper jaw long (42.6–45.7% in head length); minimum height of caudal peduncle (34.8–50.2% in caudal peduncle length); eyes large (22.4–31.3% in head length); caudal fin short (27.1–32.3% in SL). Coloration: body uniformly pale fawn and brown; margin of scale pockets dark brown pigmented, yielding a reticulated pattern; pale spots on nape and predorsal area; caudal fin uniformly dusky greyish.

Description. Profile of head steep; dorsal outline of body straight. Tubular anterior nostril short without process from rim; branchiostegal membrane attached to side of isthmus.

Fins. D1 with 6 spiny rays (6*: 9); D2 with 1 spiny and 11 articulated rays (1+11*: 9); anal fin with 1 spiny and 10 articulated rays (1+10*: 9); pectoral fin with 20–21 articulated rays (20*: 7, 21: 2); dorsalmost rays of pectoral fin within fin membrane; pelvic disc with 1 spiny and 5 articulated rays on each side (1+5*: 9); caudal fin with 16–17 segmented rays (16*: 1, 17: 8), 14 of them branched (14*: 9). Second to fourth spiny rays of D1 longest; second spiny ray of D1 extremely elongated, when depressed reaching to end of D2 base; depressed third dorsal spiny ray reaching approximately to first quarter of D2 base. Pelvic disc complete (oval-shaped) with well-developed anterior membrane (frenum) that extends about 75% of first (spinous) ray; lobes distinct, narrow and pointed.

Squamation. Scales in lateral series 27–31 (27: 2, 28: 1, 29*: 3, 30: 1, 31: 1); scales in transversal series 8–11 (8:2; 9: 1; 10*: 1, 11: 1). Entire trunk, breast and base of pectoral fin covered by large scales. Predorsal area, nape, cheek and opercle naked (Fig. 3).



FIGURE 2. *Thorogobius alvheimi* sp. nov. Holotype, CAS 222482, female, 72.1 mm SL; Angola. 15 April 2005. **A** dorsal view, **B** lateral view. Scale bar = 1 cm.

TABLE 1. Numbers of free neuromast papillae in cephalic lateral-line system of *Thorogobius alvheimi* sp. nov., *Thorogobius laureatus* sp. nov. and *Thorogobius angolensis* grouped by innervation categories (Ahnelt & Bohacek, 2004). Values are range and, in parentheses, mean and standard deviation. d = damaged.

	<i>T. alvheimi</i> sp. nov. (n = 9)		<i>T. laureatus</i> sp. nov. (n = 11)		<i>T. angolensis</i> (n = 56)
Neuromast- row	Holotype left, right	Range (mean±SD)	Holotype left, right	Range (mean±SD)	Range (mean±SD)
<i>T. supraorbitalis</i>					
s1	7, 7	5–10 (7.2±1.2)	4, 4	3–7 (5.1±1.2)	4–10 (6.3±1.2)
s2	10, 9	6–13 (9.4±1.5)	8, 9	6–12 (8.8±1.7)	6–14 (10.1±1.6)
n	15, d	8–16 (11.4±2.7)	10, 10	8–18 (12.0±3.4)	7–18 (13.1±2.6)
o	12, 12	6–12 (8.9±1.9)	6, 7	5–11 (7.3±2.0)	4–9 (6.1±1.3)
<i>T. infraorbitalis</i>					
s3	8, 8	4–9 (6.3±1.7)	4, 4	3–4 (3.4±0.5)	3–7 (4.3±1.0)
r1	14, 13	8–14 (12.0±1.9)	14, 15	11–19 (14.0±2.1)	7–15 (10.5±1.8)
r2	14, 13	11–20 (13.7±3.2)	13, 16	9–23 (13.6±3.5)	6–17 (11.3±2.1)
c ²	20, 20	16–24 (19.5±2.3)	20, 20	13–37 (19.7±6.8)	14–31 (21.4±4.0)
c ¹	d	5–8 (6.1±1.0)	d	5–10 (6.6±1.8)	2–16 (9.6±2.4)
c ₂	d	8–11 (9.8±1.0)	d	7–16 (10.9±3.0)	9–19 (12.6±1.9)
c ₁	5, 5	3–6 (4.6±0.7)	6, 6	3–9 (5.4±1.4)	3–11 (6.7±1.5)
1	20, 20	13–21 (16.9±2.4)	23, d	12–25 (17.5±3.8)	14–29 (22.1±3.2)
2	19, 19	12–20 (15.5±2.6)	20, 20	13–24 (17.0±3.1)	15–25 (19.8±2.4)
3	21, 21	12–22 (17.6±2.9)	21, d	15–27 (19.4±3.4)	16–28 (21.9±2.7)
4	22, d	16–25 (19.4±3.2)	23, d	16–29 (21.9±4.0)	19–30 (23.8±2.8)
5s	9, 8	6–11 (8.4±1.4)	11, d	8–15 (11.1±2.2)	8–17 (12.5±1.9)

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	<i>T. alvheimi</i> sp. nov. (n = 9)		<i>T. laureatus</i> sp. nov. (n = 11)		<i>T. angolensis</i> (n = 56)
Neuromast- row	Holotype left, right	Range (mean±SD)	Holotype left, right	Range (mean±SD)	Range (mean±SD)
5i	15, d	9–17 (12.9±2.5)	d, 16	10–18 (14.7±2.5)	10–18 (13.8±1.8)
6s	18, d	9–19 (14.5±3.9)	14, 15	8–22 (14.3±4.8)	10–27 (17.0±3.1)
6i	27, 28	18–32 (23.8±4.4)	d, 21	17–25 (22.5±2.7)	17–29 (22.7±2.6)
7	1, 1	1 (1.0±0.0)	1, 1	1 (1.0±0.0)	1–7 (1.5±1.2)
<i>T. hyomandibularis</i>					
b	24, 24	17–25 (21.6±2.8)	23, 22	20–27 (23.6±2.4)	15–31 (24.0±3.0)
d	38, 43	22–43 (34.1±6.3)	39, 35	24–48 (35.8±6.6)	27–49 (39.0±5.1)
z	11, d	8–12 (9.8±1.6)	12, 13	9–15 (11.5±2.3)	8–16 (11.7±1.8)
ot	d, 42	28–42 (36.2±4.6)	34, 37	29–38 (33.9±3.5)	30–54 (41.3±5.8)
oi	d	10–13 (11.5±2.1)	d	7–11 (8.8±2.0)	8–15 (11.5±1.7)
os	14, 15	12–18 (14.3±2.1)	15, d	13–18 (15.5±2.1)	10–27 (20.0±3.9)
e1	46, 45	32–46 (40.0±4.7)	41, d	32–46 (36.9±4.4)	34–62 (46.2±5.8)
e2	37, 39	29–40 (36.3±4.0)	44, 44	34–44 (40.4±3.9)	32–51 (42.5±4.0)
i1	11, 10	10–12 (11.1±0.7)	12, 12	9–12 (11.0±0.8)	19–27 (21.7±1.6)
i2	d, 11	10–12 (10.5±0.6)	10, 10	9–11 (9.9±0.4)	12–26 (20.1±2.4)
f	26, 26	17–29 (22.7±3.6)	22, 22	17–31 (21.9±4.0)	15–29 (22.2±3.5)
<i>R. supratemporalis</i>					
g	21, 21	12–22 (17.7±3.5)	d, 25	16–30 (21.9±4.0)	9–26 (13.6±3.1)
m	12, 12	5–13 (9.2±2.7)	d, 13	7–13 (10.4±2.0)	5–12 (6.4±1.6)
x1	20, 22	15–22 (18.1±2.8)	18, d	16–24 (19.8±2.1)	13–30 (21.9±3.4)
x2	10, 9	4–13 (8.3±2.6)	d, 8	7–10 (8.8±0.9)	4–13 (8.7±2.2)
tr	6, d	3–8 (4.9±1.6)	3, 4	3–6 (4.4±1.1)	1–6 (3.7±1.0)
trp	8, 8	1–8 (5.0±2.0)	2, 4	2–6 (4.0±0.9)	2–8 (4.7±1.5)
q	7, 6	4–10 (6.0±1.6)	6, 6	3–8 (5.5±1.1)	3–11 (6.0±1.4)
u	3, 3	3 (3.0±0.0)	3, 3	3 (3.0±0.0)	3 (3.0±0.0)
<i>R. lateralis posterioris</i>					
h	35, 31	18–35 (26.1±4.7)	26, 31	20–31 (26.2±3.0)	12–28 (16.2±4.3)
y	4, d	1–5 (2.5±1.1)	1, d	1 (1.0±0.0)	2–7 (4.2±1.1)
as1	16, 16	16–22 (18.0±2.5)	d	14 (14.0±0.0)	9–17 (13.2±2.7)
as2	d	d	11, d	11 (11.0±0.0)	8–20 (12.9±2.6)
as3	d	d	d	d	13–29 (20.5±4.5)
la1	d	6–9 (7.6±1.1)	d	8 (8.0±0.0)	6–12 (8.7±1.8)
la2	d	8 (8.0±0.0)	d, 8	6–8 (7.0±1.4)	4–16 (9.1±3.2)

Dentition. Premaxillary teeth arranged in an outer row of distinctly larger canine teeth and 5–6 rows of small conical teeth; on dentary some teeth of anteriormost row enlarged and caniniform, followed by series of 5–6 intermediate rows of small conical teeth and innermost row of enlarged teeth.

Gill-rakers (holotype). Eight gill-rakers on ceratobranchial bone; one on epibranchial and one on pharyngobranchial.

Vertebrae. Total number 28; 11 precaudal and 17 caudal, including urostyle.

Body proportions. Presented in table 2.

TABLE 2. Body proportions of *Thorogobius alvheimi* sp. nov. and *Thorogobius laureatus* sp. nov. Values are range and, in parentheses, mean and standard deviation.

Measurement	<i>T. alvheimi</i> sp. nov. (n = 9)		<i>T. laureatus</i> sp. nov. (n = 11)	
	Holotype	Range (mean±SD)	Holotype	Range (mean±SD)
% of standard length				
head length	32.1	28.9–33.1 (31.5±1.3)	31.5	29.8–33.5 (31.4±1.3)
head width	14.6	13.9–15.7 (14.8±0.7)	16.3	15.1–18.7 (16.3±1.3)
distance between snout and first dorsal-fin origin	36.8	35.7–40.3 (37.5±1.6)	37.9	36.4–38.6 (37.5±0.7)
distance between snout and second dorsal-fin origin	57.1	54.9–59.8 (57.4±1.6)	57.3	55.7–58.5 (57.1±1.0)
distance between snout and center of anus	58.4	53.8–60.0 (57.1±2.0)	58.2	54.1–61.8 (57.3±2.3)
distance between snout and anal-fin origin	66.0	61.6–66.3 (63.8±1.8)	64.5	61.5–66.3 (64.0±1.6)
distance between snout and pelvic-fin origin	34.0	31.2–34.1 (32.3±1.1)	33.9	31.2–36.0 (32.9±1.4)
caudal peduncle length	22.1	20.8–27.5 (23.8±2.2)	23.8	20.9–25.2 (23.2±1.6)
first dorsal-fin base length	12.6	10.7–13.7 (11.9±1.0)	10.9	10.9–14.2 (12.4±1.1)
second dorsal-fin base length	25.1	22.2–26.0 (24.1±1.4)	26.3	23.6–27.3 (25.5±1.1)
distance between first and second dorsal-fin	6.1	6.1–9.9 (8.8±1.4)	7.8	7.2–9.4 (8.2±0.8)
anal-fin base length	16.1	14.5–17.2 (15.9±0.9)	19.0	16.4–20.1 (18.3±1.3)
caudal-fin length	27.5	27.1–32.3 (29.2±2.4)	35.5	27.9–35.5 (31.9±2.5)
pectoral-fin length	18.9	18.9–27.8 (24.7±2.9)	26.1	22.4–26.4 (24.4±1.5)
pelvic-fin base length	24.1	22.5–26.1 (24.0±1.3)	25.7	21.8–27.1 (25.2±1.4)
body height at pelvic-fin origin	17.5	16.6–19.9 (18.3±1.1)	20.7	16.8–25.6 (20.2±2.5)
body height at anal-fin origin	16.7	16.6–20.4 (17.9±1.4)	20.7	18.9–23.8 (20.7±1.5)
body width at anal-fin origin	9.3	9.3–12.0 (10.5±0.9)	12.1	11.2–14.4 (12.4±0.8)
minimum height of the caudal peduncle	9.1	9.1–11.0 (10.1±0.7)	13.7	10.9–13.7 (12.4±0.8)
distance between pelvic-fin origin and anus	27.0	23.0–29.2 (26.0±2.0)	26.0	23.6–30.7 (25.8±2.1)
% of caudal peduncle length				
minimum height of the caudal peduncle	41.4	34.8–50.2 (42.9±4.9)	57.4	45.1–59.8 (53.6±5.0)
% of head length				
snout length	21.9	19.0–26.7 (23.3±2.8)	26.8	22.3–30.0 (24.8±2.5)
horizontal eye diameter	28.6	22.4–31.3 (27.8±3.1)	28.8	23.9–30.9 (28.5±2.1)
postorbital distance	51.3	47.0–51.9 (49.8±1.7)	49.8	48.1–53.6 (49.9±1.6)
head width	45.4	42.9–53.8 (47.0±3.5)	51.8	48.5–56.0 (51.8±2.4)
upper jaw length	43.2	42.6–45.7 (44.6±1.6)	54.4	41.8–58.0 (52.6±4.7)
% of eye diameter				
interorbital distance	12.7	9.9–18.0 (12.3±2.6)	12.0	9.6–18.4 (12.8±2.5)
% distance between pelvic-fin origin and anus				
pelvic-fin base length	89.2	87.2–104.2 (92.8±5.3)	98.8	81.3–108.8 (97.5±8.7)

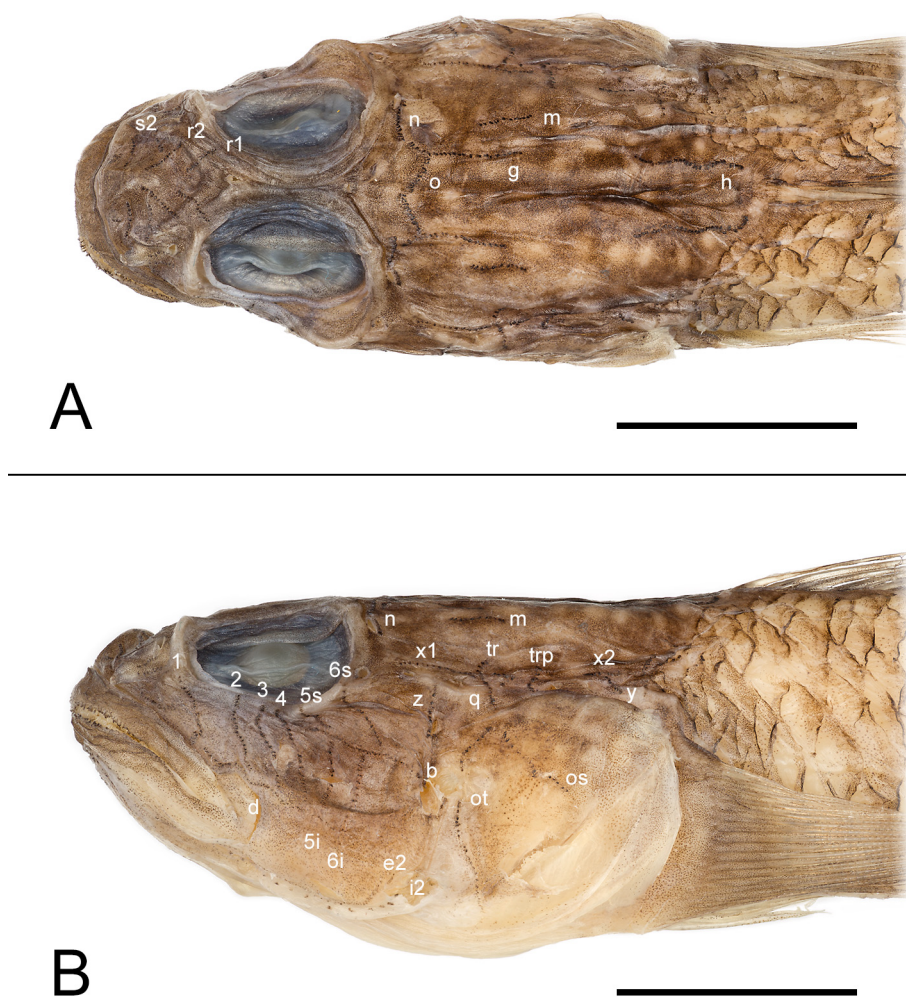


FIGURE 3. *Thorogobius alvheimi* sp. nov. Holotype. Detailed view of cephalic neuromast rows and spots on nape and predorsal area. Neuromast rows: s1, n, o, r1, r2, 1, 2, 3, 4, 5s, 5i, 6s, 6i, b, d, z, ot, oi, os, e2, i2, g, m, x1, x2, tr, trp, q, h, y. **A** dorsal view, **B** lateral view. Scale bar = 1 cm.

Head lateral line system (Fig. 3). Anterior and posterior oculoscapular canals complete with pores (from anterior to posterior) **B**, **C** (unpaired), **D** (unpaired), **E**, **F**, **G**, **H** and **K**, and **L**, respectively. Preopercular canal with pores (from dorsal to ventral) **M**, **N** and **O**; these pores larger than pores of other head canals. Rows and number of neuromasts (sensory papillae) given in table 1. Generally a high number of papillae present in most of the neuromast rows.

Coloration (preserved in ethanol). Body pale fawn and brown; head, including nape and predorsal area, darker than trunk; lips not distinctly darker than head; nape and predorsal area with pale spots in a reticulate pattern over dark ground laterally extending onto dorsal part of opercle; neuromasts (sensory papillae) dark brown; margin of scale pockets dark brown, yielding a reticulated pattern. Trunk uniformly pale fawn to brownish; no dark patches at the bases of dorsal fins; caudal, pectoral and pelvic fins uniformly dusky greyish (Figs. 2, 3).

Etymology. This species is named in honor of Oddgeir Alvheim of the Institute of Marine Research, Bergen, Norway, for his many photographic contributions to the FAO Species Identification Guides and for his assistance and advice to the second author during three surveys aboard the R/V Dr. Fridtjof Nansen.

Distribution and habitat. So far *Thorogobius alvheimi* sp. nov. is known only from the type localities off Angola and Ghana. It was dredged on the outer edge of the continental shelf from 208–74m depth and occurs on soft bottom.

Remarks. *Thorogobius alvheimi* **sp. nov.** differs distinctly from other species of the genus in the following specific characters (also see table 3 for an additional character matrix).

TABLE 3. Character matrix of *Thorogobius*. *T.an.* = *Thorogobius angolensis*, *T.al.* = *Thorogobius alvheimi* **sp. nov.**, *T.ep.* = *Thorogobius ephippiatus*, *T.la.* = *Thorogobius laureatus* **sp. nov.**, *T.ma.* = *Thorogobius macrolepis*, *T.ro.* = *Thorogobius rofeni*. ? = values not known.

Character	T.an.	T.al.	T.ep.	T.la.	T.ma.	T.ro.
Brown blotches in lateral midline	+	–	–	+	–	–
Two dark patches at the bases of D1 and D2	+	–	–	–	–	–
Blotches spread all over the body and head	–	–	+	–	+	–
Blotches on nape and predorsal area only	–	+	–	–	–	–
Squamation on nape and predorsal area: none	–	+	+	–	+	+
Squamation on nape and predorsal area: lateral strips	–	–	–	+	–	–
Squamation on nape and predorsal area: complete	+	–	–	–	–	–
Scales in transversal series ≤ 9 (mode)	–	–	–	–	+	–
Scales in transversal series ≤ 11 (mode)	+	+	–	+	–	+
Scales in transversal series ≥ 11 (mode)	–	–	+	–	–	–
Scales in lateral series ≥ 33	–	–	+	–	–	–
Scales in lateral series 28–32	+	+	–	–	+	+
Scales in lateral series ≤ 27	–	–	–	+	–	–
Scales in lateral series on caudal fin 1–2	–	+	–	+	–	–
Scales in lateral series on caudal fin 2–3	+	–	+	–	+	+
Pectoral fin rays ≤ 20 (mode)	–	–	+	–	+	+
Pectoral fin rays ≥ 20 (mode)	+	+	–	+	–	–
Neuromast rows tr and trp present	+	+	–	+	–	–
Neuromast row r2 long, reaching upper lip	–	+	–	–	–	–
Neuromast row 6i originating anteriorly to row 6s	–	+	–	–	–	–
Neuromast row 6i originating opposite to row 6s	+	–	+	+	+	+
Distance between rows g and h of the length of g	–	–	–	+	–	–
Distance between rows g and h at least twice length of g	+	+	+	–	+	+
Neuromast row f ≤ 17 (mode)	–	–	+	–	+	+
Neuromast row f ≥ 18 (mode)	+	+	–	+	–	–
Neuromast rows i1+i2 ≤ 23	–	+	–	+	+	+
Neuromast rows i1+i2 ≥ 30	+	–	+	–	–	–
Upper jaw length in head length $\geq 50\%$	–	–	?	+	–	–
Upper jaw length in head length $\leq 45\%$	+	+	?	–	+	–
Upper jaw length in head length $\leq 36\%$	–	–	?	–	–	+
Caudal peduncle depth in length $\geq 50\%$	+	–	–	+	–	–
Caudal peduncle depth in length $\leq 43\%$	–	+	+	–	+	+
Caudal fin length in SL $\leq 30\%$	–	+	+	–	+	+
Caudal fin length in SL $\geq 30\%$	+	–	–	+	–	–

Thorogobius alvheimi **sp. nov.** and *Thorogobius angolensis* differ in: (1) squamation of nape and predorsal area and dorsal part of opercle (naked vs. completely scaled) (Fig. 7); (2) number of neuromasts in head neuromast rows (less numerous and shorter vs. numerous and longer), e.g. row **i1** (10–12 vs. 19–25); coloration (preserved) of (3) trunk (uniformly pale fawn to brownish with no distinct markings vs. pale fawn to brownish with two brown

blotches on flanks in lateral midline below rear of D1 and center of D2, respectively); of (4) nape and predorsal area (with pale spots in a reticulate pattern over dark ground extending onto dorsal part of opercle vs. no spots on nape, predorsal area or opercle); of (5) pectoral fin (no dark vertical band on dorsal half of pectoral fin base vs. dark band on base of pectoral fin); (6) caudal fin uniformly dusky greyish vs. 4–5 vertical dark bands.

Thorogobius alvheimi **sp. nov.** and *Thorogobius ephippiatus* differ in: (1) scales in lateral midline (27–31 vs. 33–42); (2) lobe of pectoral fin (scaled vs. naked); (3) neuromast rows **tr** and **trp** (present vs. absent); coloration (preserved) of (4) head, nape and predorsal area (pale spots in a reticulate pattern on nape and predorsal area only vs. brown spots on head, nape and predorsal area); of (5) trunk (uniformly pale fawn to brownish with no distinct markings vs. covered with dark brown blotches); (6) habitat preference (offshore between 74 and 208 m on soft bottoms vs. inshore in 6–60 m on sandy areas of rocky shores, also cave dwelling); (7) distribution (off Angola and Ghana vs. Norwegian Sea to Canary Islands).

Thorogobius alvheimi **sp. nov.** and *Thorogobius laureatus* **sp. nov.** differ in: (1) squamation of nape and predorsal area (naked vs. sides of nape and predorsal area scaled) (Figs. 3, 5, 7); (2) pattern of the head neuromast lateral line system (distance between rows **g** and **h** as least as long as row **g** vs. distance between both rows half-length of row **g** or less; row **6i** originates anterior to **6s** vs. rows **6i** and **6s** opposite to each other); coloration (preserved) of (3) nape and predorsal area (with pale spots in a reticulate pattern over dark ground laterally extending on dorsal part of opercle vs. no spots on nape and predorsal area) (Figs. 3, 5); of (4) pectoral fin (no dark vertical band on dorsal half of pectoral fin base vs. dark band on base of pectoral fin) (Figs. 2, 4, 6); of (5) caudal fin (uniformly dusky greyish vs. with 6–7 distinct dark vertical bands) (Figs. 2, 6).

Thorogobius alvheimi **sp. nov.** and *Thorogobius macrolepis* differ in: (1) number of pectoral fin rays (20–21 vs. 17–18); (2) number of neuromasts in head neuromast rows, e.g. **r2** (11–20 vs. 4–8), **c²** (16–24 vs. 8–13), **3** (12–22 vs. 8–11), **4** (16–25 vs. 9–13), **e1** (32–46 vs. 24–29), **f** (17–29 vs. 10–15), **as1** (16–22 vs. 7–11), **la2** (8 vs. 3–7); (3) lobe of pectoral fin (scaled vs. naked); (4) neuromast rows **tr** and **trp** (present vs. absent); coloration (preserved) of (5) head, nape and predorsal area (pale spots in reticulate pattern on nape and predorsal area only vs. brown spots on head, nape and predorsal area); of (6) trunk (uniformly pale fawn to brownish with no distinct markings vs. covered with pale spots and blotches); (7) habitat preference (offshore between 74 and 208 m on soft bottom vs. inshore in 6–60 m on sandy areas of rocky shores, also cave dwelling); (8) distribution (off Angola and Ghana vs. from the Mediterranean).

Thorogobius alvheimi **sp. nov.** and *Thorogobius rofeni* differ in: (1) neuromast rows **tr** and **trp** (present vs. absent); (2) number of neuromasts in head neuromast rows, e.g. **r2** (11–20 vs. 5–8), **h** (18–35 vs. 12–17), **as1** (16–23 vs. 10–13), **la2** (8 vs. 4–5); (3) upper jaw longer (42.6–45.7% vs. 33.0–37.2% in head length); (4) coloration (preserved) of (5) nape and predorsal area (with pale spots in a reticulate pattern over dark ground laterally extending on dorsal part of opercle vs. no spots on nape and predorsal area); of (6) caudal fin (uniformly dusky greyish vs. with distinct dark vertical bands).

Thorogobius laureatus **sp. nov.**

(Figures 1, 4–7; Tables 1–3)

Holotype. CAS 243854, male, standard length+caudal fin length 65.1+23.1 mm, Angola, sw. of Congo R. mouth, (6°27'S, 11°55'E) from depths of 109–108 m, R/V Dr. Fridtjof Nansen (DFN) stn. 3783, 22 April 2005.

Paratypes. (10 specimens). **Angola:** CAS 225191, 1 male 74.0+24.2 mm SL+CL, off Cape Santa Maria (11°46.28'S, 13°29.29'E), 165–164 m, DFN stn. 43, 4 March 2007; CAS 244058, 1 female 74.9+21.5 mm SL+CL, same data as for holotype; ZSM 32517, 1 female 80.2+23.9 mm SL+CL, off Sumbe (11°13'S, 13°36'E), 147–146 m, DFN stn. 3044, 8 March 2003; ZSM 35530, 1 female 78.0+21.8 mm SL+CL, same data as for ZSM 32517. **São Tomé and Príncipe:** CAS 243850, 2 females 58.1+19.3 & 58.5+18.8 mm SL+CL, off São Tomé Is. (0°08.7'N, 6°41.7'E), 65–57 m, DFN stn. 30, 18 May 2010; CAS 243851, 1 male 60.8+19.6 mm SL+CL, off São Tomé Is. (0°09.9'N, 6°42.6'E), 65–64 m, DFN stn. 34, 18 May 2010; CAS 243852, 1 male 58.3+d mm SL+CL, off São Tomé Is. (0°08.84'N, 6°41.8'E), 57–65 m, DFN stn. 40, 19 May 2010; CAS 243853, 1 female 58.8+18.4 mm SL+CL, off São Tomé Is. (0°15.8'N, 6°47.1'E), 71–60 m, DFN stn. 35, 19 May 2010; NMW 99080, 1 male 59.1+20.9 mm SL+CL, same data as for CAS 243850 (Fig. 6).

Non-type specimens. (4 specimens). Excluded from type material because of damage and/or juvenile stage. CAS 244223, 4 specimens of undetermined sex (35.7–46.9 mm SL), same data as for CAS 243850.



FIGURE 4. *Thorogobius laureatus* sp. nov. Holotype, CAS 243854, male, 65.1 mm SL; Angola. 22 April 2005. **A** dorsal view, **B** lateral view. Scale bar = 1 cm.

Diagnosis. *Thorogobius laureatus* sp. nov. is distinguished from its congeners in the combination of following characters: Fins: first dorsal fin with six spiny rays, second and third distinctly elongated; pectoral fin ray count 19–22; pelvic disc complete and short with well-developed anterior membrane (frenum), with pointed lateral lobes. Scales: scales on nape and predorsal area in lateral band; no scales on opercle; scales in longitudinal series 24–27. Pattern of free neuromasts (sensory papillae): supratemporal rows **tr** and **trp** developed, extending transversally between pores **H** and **K**; longitudinal row **g** long, passing row **m** posteriorly and relatively close to row **h**; infraorbital row **6** long, ventrally extending to lower margin of preopercle, its ventral (**6i**) and dorsal (**6s**) originating opposite to each other; posterior lateral rows: row **h** long, reaching anteriorly above middle of opercle. Body proportions: body depth (18.9–23.8% at anal-fin origin in SL), head width (48.5–56.0% in head length); upper jaw long (41.8–58.0% in head length); minimum height of caudal peduncle (45.1–59.8% in caudal peduncle length); eyes large (23.9–30.9% in head length); caudal fin long (27.9–35.5% in SL). Coloration: body pale fawn and brownish; margin of scale pockets dark brown pigmented, yielding a reticulated pattern; five brown blotches on flanks in lateral midline from below first dorsal fin to caudal peduncle; caudal fin with 6–7 distinct dark vertical bands.

Description. Profile of head steep; dorsal outline of body straight. Tubular anterior nostril short, without process from rim; branchiostegal membrane attached to side of isthmus.

Fins. D1 6 spiny rays (6*: 11); D2 1 spiny and 11 articulated rays (1+11*: 11); anal fin 1 spiny and 10 articulated rays (1+10*: 11); pectoral fin 19–22 articulated rays (19: 1, 20: 5, 21*: 4, 22: 1); dorsalmost rays of pectoral fin within fin membrane; pelvic disc 1 spiny and 5 articulated rays on each side (1+5*: 11); caudal fin 16–17 segmented rays (16: 1, 17*: 10), 14–15 of them branched (14*: 10, 15: 2). Second to fourth spiny rays of D1 longest; second spiny ray of D1 extremely elongated in males, depressed reaching to end of D2 base; depressed third dorsal spiny ray reaching approximately to half of D2 base. Pelvic disc complete (oval-shaped) with well-developed anterior membrane (frenum) that extends over approximately 75% of first (spinous) ray; lobes distinct but narrow and pointed.

Squamation. Scales in lateral series 24–27 (24: 1, 25*: 3, 26: 3, 27: 3); transversal series 8–12 (8: 3; 9*: 3, 11: 1, 12: 1). Entire trunk covered by large scales; including breast, base of pectoral fin and sides of predorsal area where a narrow band of scales runs anteriorly from origin of D1 to above opercle. Single transversal row of scales directly in front of D1 (Figs. 4, 5). Otherwise predorsal area, nape, cheek and opercle naked; scales on trunk reach

base of D2, but not base of D1, with narrow scaleless band on both sides of D1 that extends posteriorly to origin of D2.

Dentition. The premaxillary teeth arranged in an outer row of distinctly larger canine teeth and 5–6 inner rows of small conical teeth; on dentary some teeth of anteriormost row enlarged and caniniform, followed by series of 5–6 intermediate rows of small conical teeth and an innermost row of enlarged teeth.

Gill-rakers (holotype). Seven short, stout gill-rakers on ceratobranchial bone, all of about same size; each gill-raker with few (2–4) tiny denticles on its tip; no gill-rakers on epibranchial bone.

Vertebrae. Total number 28; 11 precaudal and 17 caudal, including urostyle.

Body proportions. Presented in table 2.

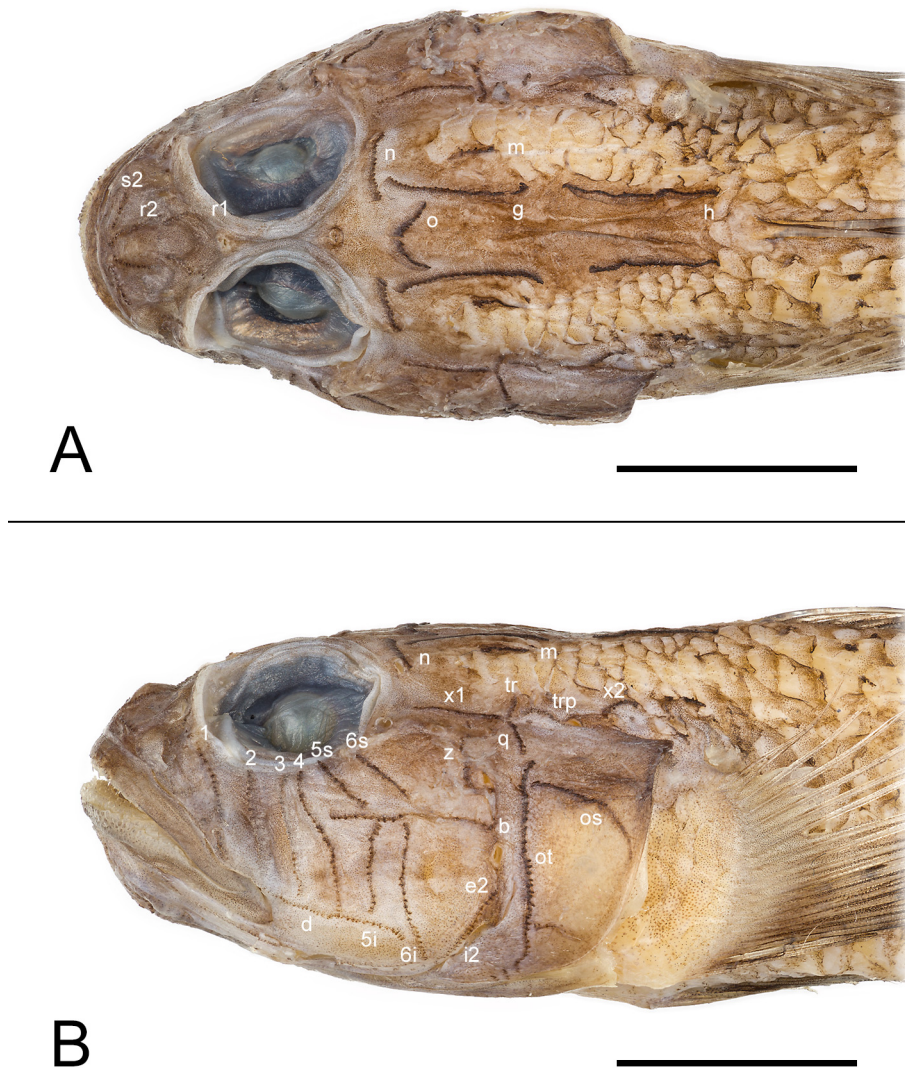


FIGURE 5. *Thorogobius laureatus* sp. nov. Holotype. Detailed view of cephalic neuromast rows and lateral bands of scales on nape and predorsal area. Neuromast rows: s1, n, o, r1, r2, 1, 2, 3, 4, 5s, 5i, 6s, 6i, b, d, z, ot, oi, os, e2, i2, g, m, x1, x2, tr, trp, q, h. **A** dorsal view, **B** lateral view. Scale bar = 1 cm.

Head lateral line system (Fig. 5). Anterior and posterior oculoscapular canals complete with pores (from anterior to posterior) **B**, **C** (unpaired), **D** (unpaired), **E**, **F**, **G**, **H** and **K** and **L** respectively. Preopercular canal with pores (from dorsal to ventral) **M**, **N** and **O**; these pores larger than pores of other head canals. Rows and number of neuromasts (sensory papillae) given in table 1. Generally, a high number of papillae in most neuromast rows.

Coloration (preserved in ethanol). Body pale fawn and brown; head, except nape, darker than trunk; lips not distinctly darker than head; neuromasts (sensory papillae) dark brown; margin of scale pockets dark brown, yielding a reticulated pattern. Two large brown blotches on flanks in lateral midline below center of first and of

anterior half of second dorsal fin, respectively; no dark patches at bases of dorsal fins; brownish marking at origin of caudal fin faint; pectoral fin with distinct dark brown vertical band on its base, otherwise, like pelvic fins, uniformly dusky greyish; first dorsal and anal fins light dusky greyish; second dorsal fin with faint oblique stripes; caudal fin yellowish with 6–7 distinct dark vertical bands (Fig. 6).



FIGURE 6. *Thorogobius laureatus* sp. nov. Paratype, NMW 99080, male, 59.1 mm SL; São Tomé and Príncipe. 18 May 2010. Scale bar = 1 cm.

Etymology. From the Latin word *laureatus* meaning *crowned with a laurel*. The name refers to the shape of the scaled areas in the predorsal region.

Distribution and habitat. So far *Thorogobius laureatus* sp. nov. is only known from the type localities off Angola and from São Tomé and Príncipe, off the island of São Tomé. Specimens were dredged on upper slope of the continental shelf from 109–57 m depth on soft bottom.

Remarks. *Thorogobius laureatus* sp. nov. differs distinctly from other species of the genus in the following specific characters (also see table 3 for an additional character matrix).

Thorogobius laureatus sp. nov. and *Thorogobius alvheimi* sp. nov. differ in: (1) squamation of nape and predorsal area (sides of nape and predorsal area scaled vs. naked) (Figs. 3, 5, 7); (2) pattern of head neuromast lateral line system (distance between both rows half-length of row **g** or less vs. distance between rows **g** and **h** as least as long as row **g**; rows **6i** and **6s** opposite to each other vs. row **6i** originates anterior to **6s**); coloration (preserved) of (3) nape and predorsal area (no spots on nape and predorsal area vs. with pale spots in a reticulate pattern over dark ground laterally extending on dorsal part of opercle) (Figs. 3, 5); of (4) pectoral fin (dark band on base of pectoral fin vs. no dark vertical band on dorsal half of pectoral fin base) (Figs. 2, 4, 6); of (5) caudal fin (with six to seven distinct dark vertical bands vs. uniformly dusky greyish) (Figs. 2, 6).

Thorogobius laureatus sp. nov. and *Thorogobius angolensis* differ in: (1) squamation of nape and predorsal area (only sides of nape and/or of predorsal area with narrow band of scales vs. predorsal area and nape completely covered with scales) (Fig. 7); (2) squamation of opercle (no scales on dorsal part of opercle vs. scales on dorsal part of opercle); (3) scales in lateral midline (24–27 vs. 28–31); (4) gap between neuromast rows **g** and **h** (short vs. distinct); (5) number of neuromasts in head neuromast rows, e.g. neuromast row **i1** (9–12 vs. 19–25) and row **i2** (9–11 vs. 12–26); (6) length of row **r2** (long, anteriorly passing row **s3** and reaching upper lip vs. short, anteriorly not passing supraorbital row **s2** and distant to upper lip); (7) coloration (preserved) of trunk (pale fawn to brownish with five brown blotches on flanks in lateral midline from below first dorsal fin to caudal peduncle vs. pale fawn to brownish with two brown blotches on flanks in lateral midline below rear of first dorsal and center of second dorsal fin); (8) dark vertical bands on caudal fin (6–7, first not more distinct than following bands vs. 6, first much darker than following); (9) dark blotch in pectoral fin (anteriorly on dorsal half of pectoral fin vs. pectoral fin uniformly dusky greyish).

Thorogobius laureatus sp. nov. and *Thorogobius ephippiatus* differ in: (1) scales in lateral midline (24–27 vs. 33–42); (2) lobe of pectoral fin and sides of nape and predorsal area (scaled vs. naked) (Fig. 7); (3) neuromast rows **tr** and **trp** (present vs. absent); (4) neuromast rows **g** and **h** (long vs. short); (5) coloration (preserved) of body (uniformly brownish vs. covered with brown spots and blotches); (6) habitat preference (offshore between 57 and 165 m on soft bottom vs. inshore in 6–60 m on sandy areas of rocky shores, also cave dwelling); (7) distribution (off Angola and from São Tomé and Príncipe, off the island of São Tomé vs. Norwegian Sea to Canary Islands).

Thorogobius laureatus sp. nov. and *Thorogobius macrolepis* differ in: (1) number of pectoral fin rays (19–21

vs. 17–18); (2) lobe of pectoral fin and sides of nape and predorsal area (scaled vs. naked) (Fig. 7); (3) number of neuromasts in head neuromast rows, e.g. **r1** (11–19 vs. 5–8), **r2** (9–23 vs. 4–8), **2** (13–20 vs. 7–12), **3** (15–22 vs. 8–11), **4** (16–27 vs. 9–13), **5s** (8–15 vs. 3–6), **b** (20–27 vs. 11–17), **e1** (32–46 vs. 24–29), **e2** (34–44 vs. 20–30), **f** (17–31 vs. 10–15), **as1** (14 vs. 7–11); (4) neuromast rows **tr** and **trp** (present vs. absent); (5) neuromast rows **g** and **h** (long vs. short); (6) coloration (preserved) of body (uniformly brownish vs. covered with pale spots and blotches); (7) habitat preference (offshore between 57 and 165 m on soft bottom vs. inshore in 6–60 m on sandy areas of rocky shores, also cave dwelling); (8) distribution (off Angola and from São Tomé and Príncipe, off the island of São Tomé vs. from the Mediterranean).

Thorogobius laureatus **sp. nov.** and *Thorogobius rofeni* differ in: (1) squamation of nape and predorsal area (sides of nape and predorsal area scaled vs. naked) (Fig. 7); (2) scales in lateral midline (24–27 vs. 30–31); (3) neuromast rows **tr** and **trp** (present vs. absent); (4) number of neuromasts in head neuromast rows, e.g. **r1** (11–19 vs. 5–8), **r2** (9–23 vs. 5–8), **m** (7–13 vs. 4–8), **h** (20–31 vs. 12–17), **as1** (14 vs. 10–13), **la1** (8 vs. 5–7), **la2** (6–8 vs. 4–5); (5) body deeper and wider (18.9–23.8% and 11.2–14.4% vs. 15.4–17.2% and 8.1–9.7% in SL); (6) caudal peduncle deeper (10.9–13.7% vs. 9.1–9.8% in SL); (7) upper jaw longer (41.8–58.0% vs. 33.0–37.2% in head length); (8) coloration (preserved) of trunk (two large brown blotches on flanks in lateral midline below center of first and of anterior half of second dorsal fin, respectively vs. no blotches).

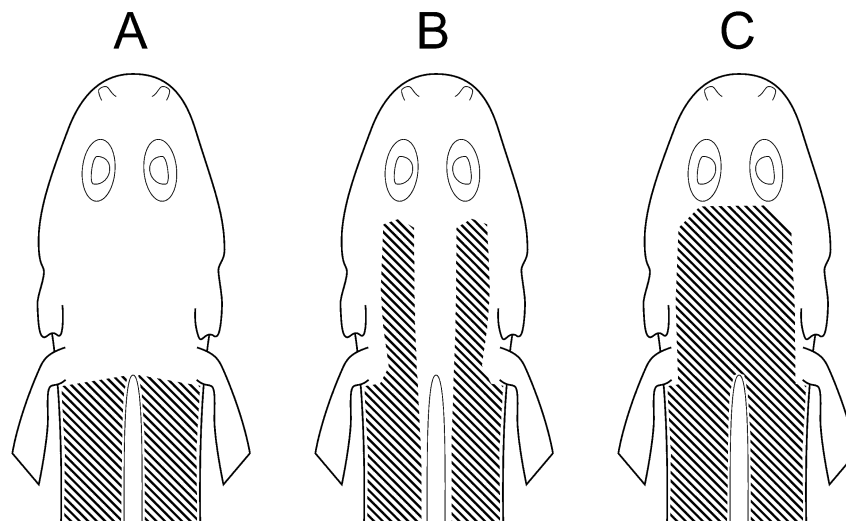


FIGURE 7. Sketch of the three different squamation patterns (dashed areas) in the predorsal area of the genus *Thorogobius*. Dorsal view of the head and anteriormost part of the body. **A** predorsal area without squamation (*Thorogobius alvheimi* **sp. nov.**, *Thorogobius ehippiatus*, *Thorogobius macrolepis*, *Thorogobius rofeni*), **B** predorsal area with scaled lateral strips (*Thorogobius laureatus* **sp. nov.**), **C** predorsal area with complete squamation (*Thorogobius angolensis*).

Discussion

In their atlas of deep-living demersal fishes, Haedrich & Merrett (1988) list *T. angolensis* as the sole species of the deep-living demersal fish of the family Gobiidae in the North Atlantic Basin. With the description of *T. rofeni* by Miller (1988) and, in this study, of *T. alvheimi* **sp. nov.** and *T. laureatus* **sp. nov.**, the number of demersal deep-living Gobiidae in the Eastern Central Atlantic is now increased to four. All four species were dredged on the outer continental shelf or upper continental slope, areas of high diversity and endemism of deep-living demersal fishes (Haedrich and Merrett 1988).

The distributions of three of these species are relatively limited: *T. alvheimi* **sp. nov.** (Angola and Ghana), *T. laureatus* **sp. nov.** (Angola and São Tomé and Príncipe), and *T. rofeni*, (Angola and Equatorial Guinea), but the distribution of *T. angolensis* ranges from Angola to Senegal (Domain 1972, Schliewen 2011, Costa *et al.* 2002).

The species of the genus *Thorogobius* are geographically split into two groups, a northern group (*T. ehippiatus* and *T. macrolepis*) and a southern group (*T. alvheimi* **sp. nov.**, *T. angolensis*, *T. laureatus* **sp. nov.** and *T. rofeni*), separated by a gap of about 1400 km between the Canary Islands (southern limit of the northern group) and Senegal (northern limit of the southern group). Seemingly the species of these two groups differ in their life style.

The two species of the northern group are adapted to inshore habitats near rocky shelters (Miller 1986, Ahnelt & Kovačić 1997). The four species of the southern group occur in deep-waters on soft bottom (Miller 1988, 1990; pers. observation T. Iwamoto). Due to their occurrence in deep water the ecology of these species and their role in the ecosystems of the outer continental shelf and upper slope is not known. Possibly the disjunct distribution of the genus *Thorogobius* is attributed to the high inshore temperatures of the tropical eastern Atlantic. *T. ephippiatus* and *T. macrolepis* occur in temperate seas. They range no further south than the Canary Islands, and their occurrence in the Mediterranean Sea is limited to the northern parts (Miller 1986). The species of the southern group occur in the tropical Atlantic south of 15° N in deep waters, possibly with the exception of *T. angolensis* (Carpenter *et al.* 2015). Nevertheless, gobiid fishes are often misidentified (Schliewen 2011), and the occurrence of this goby in a shallow lagoon in Angola (Costa *et al.* 2002) needs confirmation.

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