

Two new species of *Protogyrodactylus* (Monogenoidea: Dactylogyridae) from the gills of *Gerres nigri* (Teleostei: Gerreidae) from Senegal

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Abstract: *Protogyrodactylus ethiopicus* sp. n. and *P. kritskyi* sp. n. are described from the gills of *Gerres nigri* Günther (Gerreidae, Perciformes) captured from the estuary of the Sine-Saloum River (Senegal, West Africa). These new species differ from previously described species within the genus by a mid- or dextro-ventral vaginal opening (dextral in all other species). They are part of a morphological species group within *Protogyrodactylus* Johnston et Tiegs, 1922 that has the tip of the superficial root of the ventral anchor resembling a hook and two anterior projections on the anterior margin of the ventral bar. *Protogyrodactylus ethiopicus* differs from the remaining species in this group mainly by the morphology of the base of the male copulatory organ (MCO), which is disk-shaped, and the shape of the anterior projections of the ventral bar (round in the new species and relatively elongate in the other species of the group). The other new species, *P. kritskyi*, differs from all others in the same morphological group in having a MCO with a greatly expanded base that bears a heel-like subterminal sclerotization.

Keywords: *Protogyrodactylus*, *Gerres nigri*, Senegal, *Protogyrodactylus ethiopicus*, *Protogyrodactylus kritskyi*

Protogyrodactylus Johnston et Tiegs, 1922 (Monogenoidea: Ancyrocephalinae) comprises approximately 25 species that parasitize the gills of fishes of the Terapontidae and Gerreidae (see Galli and Kritsky 2008) from oceans of the eastern hemisphere. The taxonomic history of *Protogyrodactylus* is relatively complex, likely associated with inaccurate descriptions of the first species included in the genus (see Galli and Kritsky 2008 for a detailed history of the taxon). Species of *Protogyrodactylus*, however, share a unique combination of characters that makes the recognition of species of the genus simple: copulatory complex comprising a clockwise coiled tube with bulbous base; accessory sclerite associated with the tip of the superficial root of the ventral anchor; dorsal anchor with elongate superficial root usually with small distal hook-like extension, knob-like deep root, slightly curved shaft and recurved point; ventral bar rod-shaped, usually with two variable anteromedial projections; and two dorsal bars, each medially spatulated. Most taxonomic problems associated with *Protogyrodactylus* are likely due to the relatively small size of its species, some

reaching less than 250 µm in length, making study of their morphology slightly more complicated than in species of other taxa.

In this study, specimens of *Gerres nigri* Günther captured along the coast of Senegal, eastern Atlantic Ocean, were parasitized by two new species of *Protogyrodactylus*. These species are described and illustrated herein.

MATERIALS AND METHODS

During an ecological survey in the Marine Protected Area of the estuary of the Sine-Saloum River, Senegal, West Africa, from 2006 to 2009, 121 specimens of *G. nigri* were captured by purse seine and dissected immediately or frozen until examination. Gills of each fish were removed, placed into vials containing local water, and vigorously shaken and fixed in 3–5% formalin. In the laboratory, monogenoids were removed from the sediment using a small probe and a dissecting microscope. Some specimens were stained with Gomori's trichrome and mounted in Canada balsam for study of their soft anatomy; other specimens were cleared and mounted in Hoyer's or Gray and Wess' media for study of their sclerotized structures (all solutions prepared as in Humason 1979). Illustrations were

prepared with the aid of a camera lucida on an Olympus BX51 microscope equipped with phase contrast. Measurements, all in micrometres, were made following the procedures of Mizelle and Klucka (1953); the mean is followed by the range and the number of structures measured (n) in parentheses; body length includes that of the haptor (longitudinal axis of haptor added to that of body proper); and the width of the germarium is that of its bulbous portion. Numbering of the hook pairs follows that recommended by Mizelle (1936) and Mizelle and Price (1963). Type specimens are deposited in the Helminthological collection of the Muséum National d'Histoire Naturelle (MNHN), Paris, France; the United States National Parasite Collection (USNPC), Beltsville, USA; and the Coleção Helminológica do Instituto Oswaldo Cruz, Rio de Janeiro, Brazil (CHIOC) as indicated in the respective descriptions.

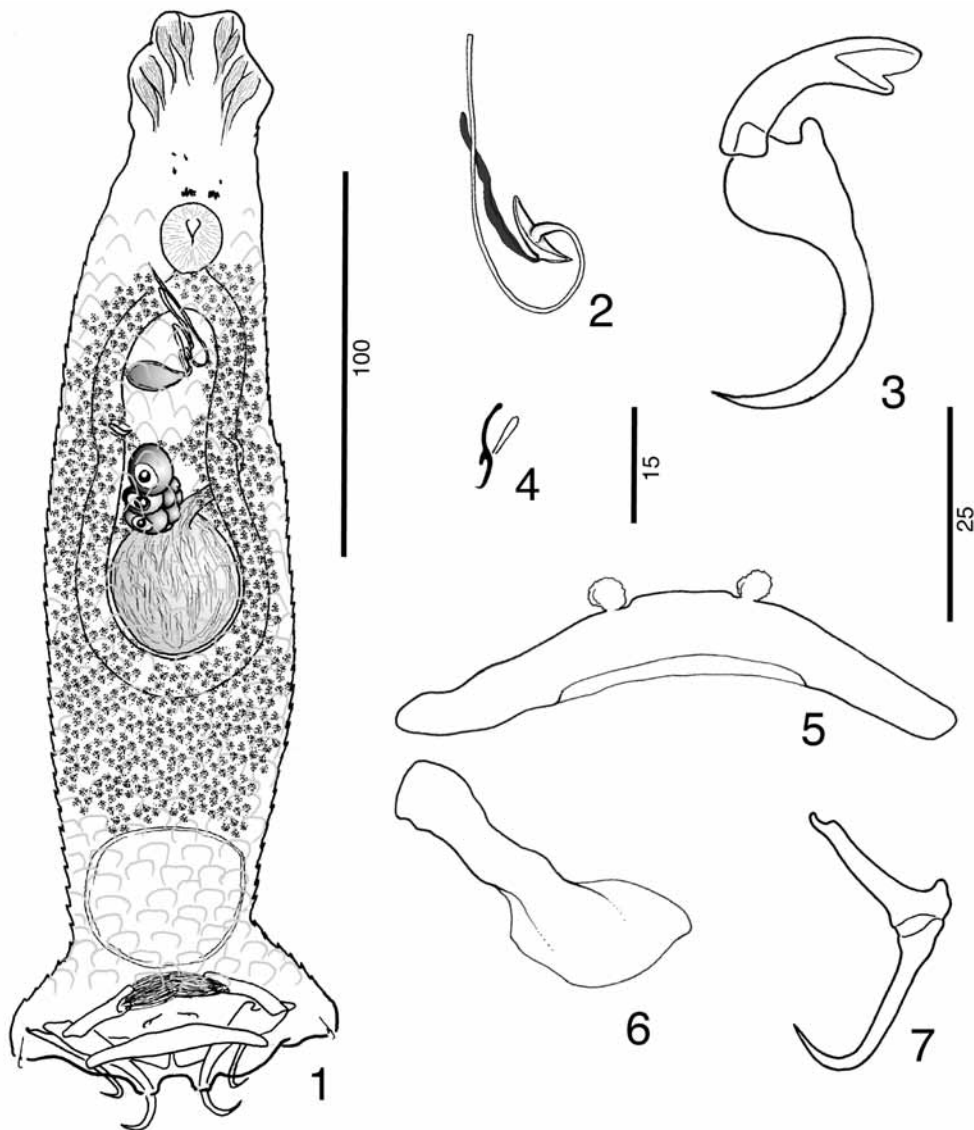
RESULTS

Dactylogyridae Bychowsky, 1933

Protogyrodactylus ethiopicus sp. n.

Figs. 1–7, 14, 16, 17

Description (based on 37 specimens): Body 259 (188–309; n = 13) long, fusiform; greatest width 72 (58–82; n = 13) at level of gonads. Tegumental scales of variable shape present from haptor to pharyngeal region. Cephalic lobes moderately to poorly developed; each lobe with 2–3 head organs. One pair of eyespots; accessory granules sparse or absent in cephalic region. Pharynx sub-spherical, 23 (20–27; n = 11) wide. Testis sub-spherical, 36 (28–46; n = 7) long, 34 (23–43; n = 7) wide; vas deferens looping left intestinal caecum; seminal vesicle not observed; prostatic reservoir fusiform. Copu-



Figs. 1–7. *Protogyrodactylus ethiopicus* sp. n. **Fig. 1.** Holotype (ventral view). **Fig. 2.** Male copulatory organ. **Fig. 3.** Ventral anchor and accessory sclerite complex. **Fig. 4.** Hook. **Fig. 5.** Ventral bar. **Fig. 6.** Member of the pair of dorsal bars. **Fig. 7.** Dorsal anchor. Scale bars: 2, 3, 5–7 = 25 μ m.

latory complex composed by articulated male copulatory organ (MCO) and accessory piece; MCO 43 (29–57; n = 14) long, an incomplete spiral; base of MCO slightly bulbous with large disk-shaped flange; accessory piece single, unbranched. Germarium 33 (27–37; n = 8) long, 25 (19–30; n = 8) wide; uterus inconspicuous; vaginal pore ventral to right intestinal caecum; vagina apparently non-sclerotized, inconspicuous; vitellaria dense. Peduncle containing apparent reservoir of haptoral secretions (Fig. 1). Haptor 39 (33–46; n = 13) long, 89 (81–100; n = 11) wide, bilaterally expanded. Hooks 7 pairs, with ancyrocephaline distribution, 12 (9–16; n = 60), similar in shape, with erect thumb, evenly curved point and shaft, short shank. Ventral anchor 41 (36–45; n = 15) long, robust, with expanded base, short roots, evenly curved shaft and point; ventral anchor sclerite 35 (29–48; n = 16) long,

robust, terminally indented and concave. Dorsal anchor 34 (27–40; n = 14) long, delicate, with short deep root, elongate superficial root with terminal hook, hinge-line located between base and shaft, elongate straight point, strongly recurved point; base and shaft often positioned at about 90 degrees from each other. Ventral bar 68 (58–82; n = 16) long, with slightly tapering ends; antero-bilateral projections (muscle attachments). Dorsal bars 30 (20–43; n = 7) long, with thin spatulate medial end.

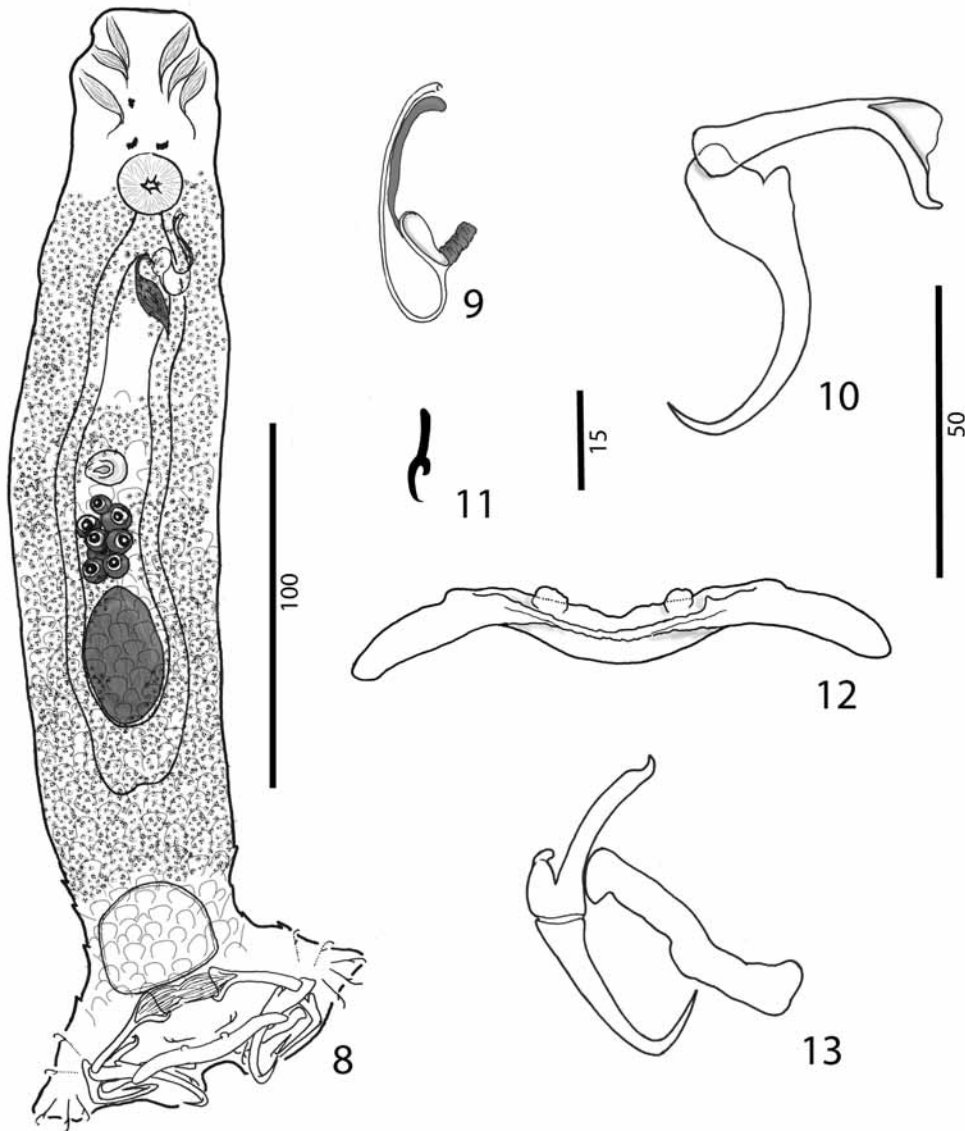
Type host: *Gerres nigri* Günther (Gerreidae, Perciformes).

Site of infection: Gills.

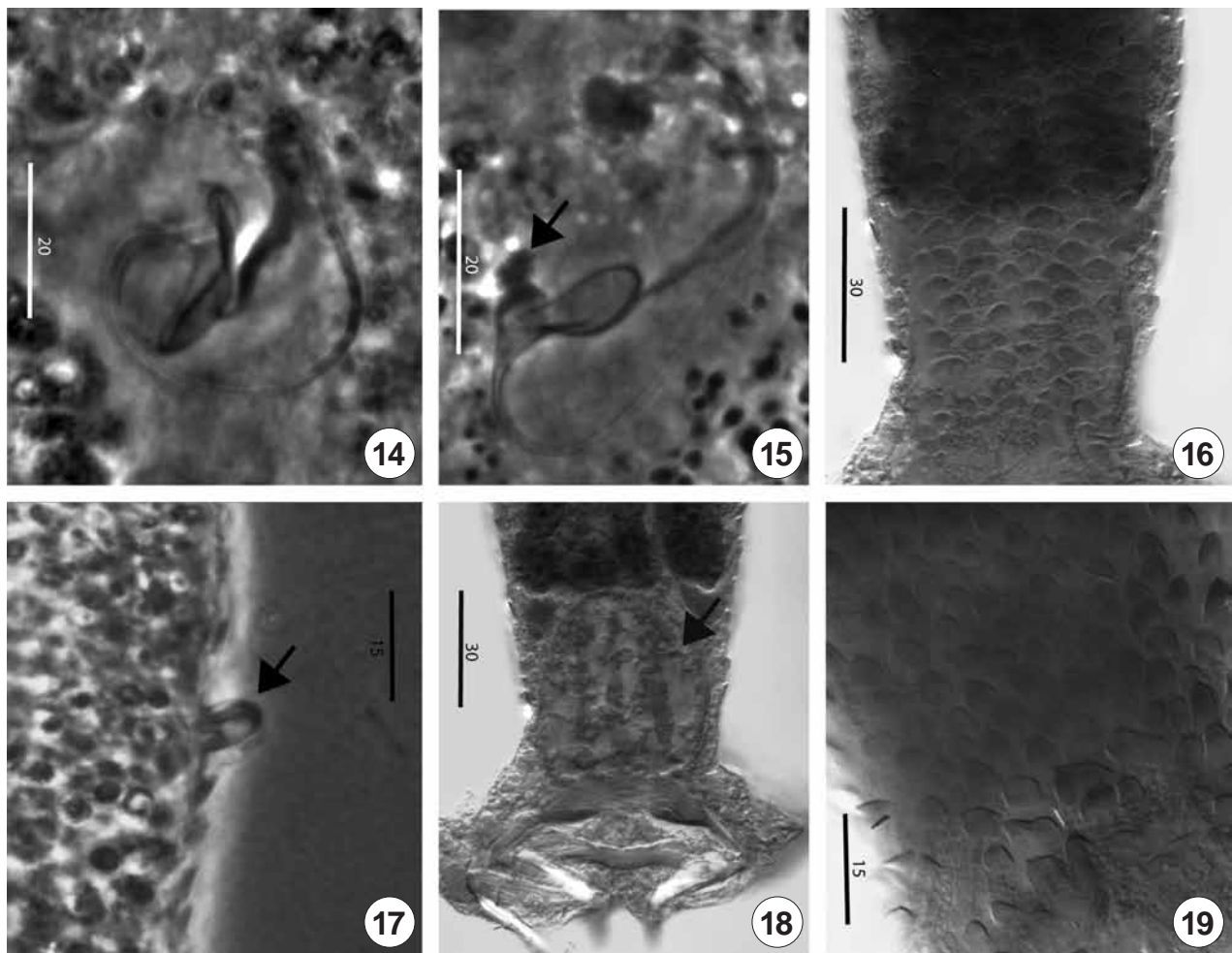
Type locality: Bamboung, Sine-Saloum River, Senegal (13°49'30.5"N, 16°31'44"W); collections between May 2006 and October 2009.

Prevalence: 98% (119 infected / 121 fish examined).

Specimens deposited: Holotype No. MNHN HEL222.



Figs. 8–13. *Protogyrodactylus kritskyi* sp. n. **Fig. 8.** Holotype (ventral view). **Fig. 9.** Male copulatory organ. **Fig. 10.** Ventral anchor and accessory sclerite complex. **Fig. 11.** Hook. **Fig. 12.** Ventral bar. **Fig. 13.** Dorsal anchor and member of the pair of dorsal bars. Scale bars: 9, 10, 12, 13 = 50 µm.



Figs. 14–19. *Protogyrodactylus ethiopicus* sp. n. and *P. kritskyi* sp. n.; phase contrast micrographs. **Fig. 14.** Copulatory complex of *P. ethiopicus*. **Fig. 15.** Copulatory complex of *P. kritskyi*. Arrow indicates the heel-like sclerotization of the base of the male copulatory organ. **Fig. 16.** Tegumental scales on the peduncular region of *P. ethiopicus*. **Fig. 17.** Vaginal opening of *P. ethiopicus* (arrow). **Fig. 18.** Peduncular reservoir of *P. kritskyi* (arrow). **Fig. 19.** Tegumental scales on the peduncular region of *P. kritskyi*.

Paratypes: MNHN HEL223 to HEL 235 (n = 13); USNPC 105078 to 105079 (n = 10); CHIOC 37744 a–n (n = 14).

E t y m o l o g y : The specific name is derived from the Ethiopian Biogeographic Realm, from which the species was collected.

Remarks. *Protogyrodactylus ethiopicus* is a member of the morphological species group of the genus that has the tip of the superficial root of the ventral anchor resembling a hook. All members of this group are parasites of *Gerres* spp. (Gerreidae). Within this species group, some are likely closer to the new species by sharing two anterior projections on the margin of the ventral bar (*Protogyrodactylus pricei* Venkatanarasaiah, 1982; *P. alatus* Galli et Kritsky, 2008; *P. federicae* Galli et Kritsky, 2008). The new species, however, can be easily differentiated from all species of this group by the morphology of the MCO base, which is disk-shaped, and the shape of the anterior projections of the ventral bar (round in the new species and relatively elongate in the other species of the group).

Additional differences among these species are conspicuous on the comparative morphology of the remaining haptor sclerites, in special of the ventral and dorsal anchors.

***Protogyrodactylus kritskyi* sp. n.**

Figs. 8–13, 15, 18, 19

Description (based on 8 specimens). Body 282 (205–329; n = 15) long, fusiform; greatest width 82 (61–95; n = 16) at level of gonads. Tegumental scales of variable shape present from haptor to body midlength. Cephalic lobes moderately to poorly developed; each lobe with 1–2 head organs. One pair of eyespots; anterior eyespots present or accessory granules sparse or absent in cephalic region. Pharynx sub-spherical, 28 (20–34; n = 17) wide. Testis sub-spherical, 44 (30–54; n = 14) long, 37 (24–48; n = 14) wide; vas deferens not observed; seminal vesicle fusiform; prostatic reservoirs not observed. Copulatory complex articulated; MCO 48 (43–57; n = 6) long, J-shaped; base of MCO large, labiate with a sclerotized,

elongate, subterminal projection (Figs. 9, 15). Germarium 32 (27–36; n = 13) long, 26 (17–36; n = 13) wide; uterus inconspicuous; vaginal pore near body mid-length, anterior to germarium; vagina apparently non-sclerotized, inconspicuous, ventral; vitellaria dense. Haptor 52 (38–87; n = 17) long, 102 (75–124; n = 17) wide; bilaterally expanded. Hooks 7, with ancyrocephaline distribution, 13 (11–15; n = 28) long, similar in shape and size, with erected thumb, evenly curved point and shaft, short robust shank. Ventral anchor 49 (46–53; n = 8) long, with short deep root, robust superficial root, slightly curved shaft, recurved point; ventral anchor sclerite 47 (43–51; n = 10) long, delicate, terminally wide, strongly indented, concave. Dorsal anchor 46 (42–57; n = 9) long, delicate, with short deep root, elongate superficial root with terminal hook, hinge-area located between base and shaft (often positioned at 90° from each other), elongate straight shaft, strongly recurved point. Ventral bar 95 (86–110; n = 11) long, with antero-bilateral projections (muscle attachments) and longitudinal ridge in its medium third. Dorsal bars 43 (30–50; n = 10) long, with slightly expanded medial end.

Type host: *Gerres nigri* Günther (Gerreidae, Perciformes).

Site of infection: Gills.

Type locality: Bamboung, Sine-Saloum River, Senegal (13°49'30.5"N, 16°31'44"W); collection made in May 2006.

Prevalence: 59% (71 infected / 121 fish examined).

Specimens deposited: Holotype No. MNHN HEL208.

Paratypes: MNHN HEL209 to HEL221 (n = 13); USNPC 105077 (n = 13); CHIOC 37743 a–k (n = 11).

Etymology: The specific epithet was chosen in honour to Dr. Delane C. Kritsky (Idaho State University, USA) for his impressive contributions on the taxonomy of fresh water and marine Monogeneoidea.

Remarks. *Protogyrodactylus kritskyi* is also a member of the species group from the gills of *Gerres* spp. that

has the tip of the dorsal anchor resembling a hook. The new species closely resembles *P. ethiopicus* by the presence of two round projections on the anterior margin of the ventral bar. Differentiation of these two species is, however, relatively simple. *Protogyrodactylus kritskyi* has a distinct morphology of the MCO, with a greatly expanded base that bears a heel-like subterminal sclerotization (Figs. 9 and 15). Further, the hook of *P. kritskyi* is more robust and the ventral anchor more delicate, with a recurved point (*P. ethiopicus* has an evenly curved shaft and point).

DISCUSSION

The two new parasites described here raise to 13 the number of species of *Protogyrodactylus* recorded from Gerreidae: *P. scapulasser* (Mamaev, 1970) Gussev, 1973 (syn. *Ancyrocephalus scapulasser* Mamaev, 1970); *P. alienus* Bychowsky et Nagibina, 1974; *P. delicatus* Bychowsky et Nagibina, 1974; *P. elegantis* Bychowsky et Nagibina, 1974; *P. fissilis* Bychowsky et Nagibina, 1974; *P. sprostonae* Bychowsky and Nagibina, 1974; *P. youngi* Bychowsky et Nagibina, 1974; *P. pricei*, *P. alatus*, *P. federicae*, and *P. zullinii* Galli et Kritsky, 2008. *Protogyrodactylus ethiopicus* and *P. kritskyi* appear to be host specific. Another gerreid, *Eucinostomus melanopterus* (Bleeker), occurs in the same area (the Sine-Saloum Estuary, Casamance, and other rivers in Senegal) and has been extensively examined for ectoparasites. However, this host species is not infected by any species of *Protogyrodactylus* but harbours a species of Diplectanidae (see Domingues et al. 2011). This is the first record of *Protogyrodactylus* in Senegal. The ongoing examination of species of Gerreidae by one of us (AD) in the same area will likely uncover additional described and undescribed species of monogenoids. Although the Gerreidae includes about 50 valid species (Froese and Pauly 2011), only 7 are known to host species of *Protogyrodactylus*.

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