



## ***Heteroconger guttatus*, a new species of garden eel (Pisces: Congridae: Heterocongrinae) from West Papua, Indonesia**

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### **Abstract**

The new species of heterocongrine garden eel, *Heteroconger guttatus*, n. sp., is described from West Papua, Indonesia, based on 42 specimens measuring 188–442 mm TL. It differs from other members of the genus by a distinctive, dense pattern of small, round, orange-brown to dark-brown spots over a pale background on the head and body, becoming smaller ventrally. In addition, the new species is characterized by the dorsal-fin origin anterior to the gill opening; pterygoid teeth present; the body depth at gill opening 28.8–40.2% head length (mean 36.1%); 59–66 preanal vertebrae (mean 63); 164–175 total vertebrae (mean 168.9); and 59–64 preanal lateral-line pores (mean 61). A key is provided for the Indo-West Pacific species of *Heteroconger*.

**Key words:** taxonomy, systematics, ichthyology, coral-reef fishes, Anguilliformes, Indo-Pacific Ocean, Bird's Head Seascape.

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## Introduction

Heterocongrine garden eels are common inhabitants of tropical sand-rubble areas, frequently in the vicinity of coral reefs. The group contains 35 species worldwide (Fricke et al. 2020) in two genera, *Gorgasia* Meek & Hildebrand, 1923 and *Heteroconger* Bleeker, 1868. The majority of species are restricted to the Indo-Pacific region, with 9 species from the eastern Pacific and Atlantic Ocean. The two genera were reviewed by Castle & Randall (1999), including descriptions of 5 new species. Prior species descriptions include those in Böhlke & Randall (1981) and Castle & Randall (1995). Since the review in 1999, an additional three species have been described: *Gorgasia thamani* Greenfield & Niesz, 2004 (Fiji), *Heteroconger mercyae*, Allen & Erdmann, 2007 (West Papua), and *Heteroconger fugax*, Koeda, Fujii & Motomura, 2018 (Japan).

Garden eels typically occur in colonies, at depths between about 2–55 m. Colony size ranges from just a few to many hundreds of individuals or more. The largest documented colony to date was reported for an undetermined *Gorgasia* species in the Red Sea, which was composed of about 10,000 eels and occupied an area of 5,752 m<sup>2</sup> (Clark et al. 1990). Members of garden eel colonies construct permanent burrows in the sand, which they apparently never leave. Spawning occurs between members of the opposite sex that occupy adjacent burrows. During spawning, the couple intertwine their bodies while the ends of their tails remain in their respective burrows (Clark 1980; personal observations). The eels rise nearly to their full extent out of their burrows when feeding on zooplankton passing in the current. When disturbed, the eels retreat backward down their burrows. When a diver swims through an extensive colony a wave effect is often created as the eels directly ahead gradually disappear into the sand, while those in the diver's wake slowly reappear. Castle & Randall (1999) provided further details of the biology and systematics of the group.

We describe here a new species of *Heteroconger* that we first observed and photographed in 2006 during initial surveys in the Fakfak Peninsula region of West Papua, Indonesia by Conservation International. Although we recognized the garden eels as a potential new species, none were collected until 13 years later, when we had the opportunity to visit the type location on two separate occasions during 2019. We succeeded in obtaining specimens and were at last able to confirm its status as an undescribed species.

## Materials and Methods

Type specimens are deposited at the Museum Zoologicum Bogoriense, Cibinong, Java, Indonesia (MZB), the Western Australian Museum, Perth, Australia (WAM); and the National Museum of Natural History, Washington, DC, USA (USNM).

Terminology and methods follow Castle & Randall (1999). Total length and head length are abbreviated as TL and HL respectively. Head length is from the snout tip to the upper extremity of the branchial aperture; snout length is snout tip to the anterior edge of the fleshy orbit; eye diameter is the horizontal span of the fleshy orbit; mouth length is snout tip to the end of the exposed maxilla; branchial aperture is distance between its upper and lower extremities; pectoral-fin length is from the middle of the base to the posterior tip; predorsal length is snout tip to the origin of the fin where it meets the body profile.

Head-pore terminology follows McCosker et al. (1989) and the following abbreviations are used: SO (supraorbital series), IO (infraorbital series), POM (preopercular-mandibular series), ST (supratemporal series).

Vertebral counts were made from digital radiographs, based on the holotype and 34 paratypes, morphological measurements on 25 specimens, 300–442 mm TL, and fin-ray counts on 10 specimens, and head pore counts on 16 specimens. The vertebral formula consists of three parts, composed of predorsal vertebrae, preanal vertebrae, and total vertebrae, counted respectively to the dorsal-fin origin, anal-fin origin, and hypural (including the hypural). Values of counts and measurements are given first for the holotype followed in parentheses by the range for the paratypes and mean of all the specimens.

## *Heteroconger guttatus*, n. sp.

### Spotted Garden Eel

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Figures 1–3.

**Holotype.** MZB 24902, 425 mm TL, male, Indonesia, West Papua Province, Venu Island, -4.3230°, 133.5004°, 10–15 m, rotenone, M.V. Erdmann, M.U. Mongdong & G.R. Allen, 19 April 2019.

**Paratypes.** (all collected at same location and date as holotype unless otherwise indicated) MZB 24903, (9) 345–442 mm TL; MZB 24905, (5) 188–373 mm TL, 22–25 m depth, 25 February 2019; USNM 446980, (5) 326–368 mm TL, collected with MZB 24905; WAM 34972-004, (12) 195–407 mm TL, collected with MZB 24905; WAM P.34976-004, (10) 228–409 mm TL, collected with holotype.

**Diagnosis.** A relatively slender species of *Heteroconger* (Congridae) with dorsal-fin origin anterior to gill opening, pterygoid teeth present, body depth at gill opening 28–40 percent of HL, preanal vertebrae 59–66 (mean 63), total vertebrae 164–175 (mean 168.9), preanal lateral-line pores 59–64 (mean 61), and color in life whitish to pale yellow with dense, small, round, orange-brown to dark-brown spots.

**Description.** Vertebral formula 3/65/168 (2–4/59–66/164–175); mean total vertebrae 168.9; lateral-line pores before pectoral fin 6 (5–7; 6); lateral-line pores before anus 62 (59–64; 61); total lateral-line pores 160 (144–158; 155); dorsal-fin rays before anus 177 (158–179; 165.5); total dorsal-fin rays 490 (435–496; 479); anal-fin rays 280 (274–301; 288.7); pectoral-fin rays 11 (10–11; 10.6); head pores on left side: SO 1+3, IO 3+3, POM 4+5, ST 1+1.

Measurements: snout-anus length 38.5 (35.9–40.7; 38.4)% of TL; HL 13.6 (10.3–15.7; 14.2)% of snout-anus length; predorsal length 9.3 (8.9–12.7; 10.5)% of snout-anus length; all following as % of HL: snout 12.7 (10.9–19.1; 13.4); eye 20.4 (19.0–28.4; 22.1); fleshy interorbital 17.8 (13.6–18.8; 16.1); mouth 26.3 (21.4–32.9; 24.6);



**Figure 1.** *Heteroconger guttatus*, underwater photo of live paratype, dark-brown spotted markings, approximately 400 mm TL, Venu Island, West Papua Province, Indonesia (G.R. Allen).

gill opening 6.6 (6.7–11.7; 8.7); branchial interspace 28.6 (21.5–36.4; 24.3); pectoral-fin length 6.7 (5.5–8.7; 7.5); depth at gill opening 37.6 (28.8–40.2; 36.1); depth at anus 31.3 (26.8–37.7; 33.5).

Body relatively elongate, slightly compressed along head, progressively more compressed to tail tip; greatest depth at pectoral fins; anus at about 38% TL; head slightly depressed, flexed downward at pectoral fins; lower jaw slightly protruding; snout short and rounded; upper and lower lips well developed, upper lip confluent medially, enclosing anterior nostril and turned back on anterolateral face of snout, lower lip similarly turned back on lower jaw; anterior nostril a minute tube close to midline of snout, posterior nostril a simple opening near anterodorsal corner of eye; mouth oblique, reaching to below anterior edge of pupil; eye relatively large, oval, scarcely intruding into dorsal profile; throat with moderately developed folds extending to branchial aperture; gill opening before pectoral fins, slightly oblique with ventral end more posterior than dorsal end; pectoral fins small rounded flaps; dorsal-fin origin about 1.5 eye diameters anterior to gill opening, low and inconspicuous in preserved specimens; anal fin similarly low; caudal fin much reduced, tip of tail bluntly pointed.

Head pores inconspicuous, with very slightly raised rims; lateral-line pores minute and difficult to distinguish, especially on posterior one-fourth of body, total number less than number of vertebrae.

Teeth of jaws small and numerous, slightly enlarged on pterygoid, rear portion of vomer, and posterior maxillary; maxillary teeth in about 5 rows, tapering to one or two rows posteriorly; dentary teeth in about 6 or 7 irregular rows, tapering to one or two rows posteriorly; intermaxillary-vomerine teeth in about 8 rows anteriorly, tapering to two rows posteriorly, combined intermaxillary-vomerine tooth patch about equal in length to maxillary patch; pterygoid teeth biserial, a patch on each side about midway between vomerine and maxillary patches.

**Color in life.** (Figs. 1 & 2) Generally whitish to pale yellow with a dense pattern of small, round, orange-brown to dark-brown spots, generally smaller and less vivid on ventral half of body; dorsal and anal fins translucent with widely spaced brown spots to flecks on dorsal fin; iris pearl white to pale yellowish with a broad blackish bar dorsally and a similar, but less conspicuous, marking ventrally; lips dusky brown laterally; white bar frequently present below eye extending to below rear edge of mouth.



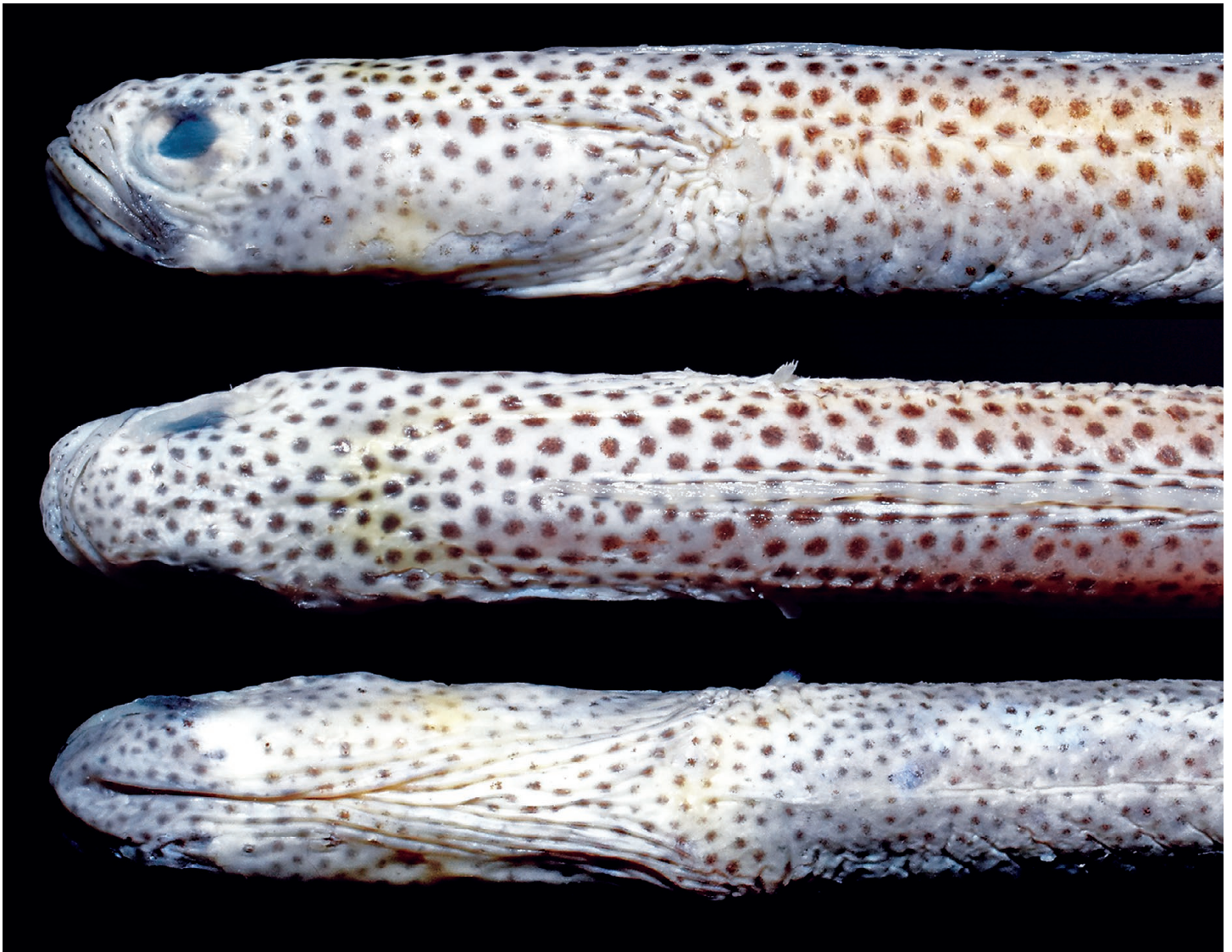
**Figure 2.** *Heteroconger guttatus*, underwater photo of live paratype, orange-brown spotted markings, approximately 400 mm TL, Venu Island, West Papua Province, Indonesia (G.R. Allen).

**Color in preservative.** (Fig. 3) Generally tan or pale grey with a dense brown pattern of variably intense spots; posterior part of lips dusky brown; whitish bar sometimes evident below eye extending to below rear edge of mouth.

**Etymology.** The new species is named *guttatus* (Latin for spotted or speckled), with reference to the color pattern and treated as a masculine singular adjective.

**Distribution and habitat.** The new species is currently known only from the type locality situated about 80 km southwest of the town of Kaimana, West Papua Province, Indonesia (Fig. 4). The type specimens were obtained from two separate colonies in 13–25 m, each occupying about 50–100 m<sup>2</sup> and containing approximately 50–100 eels. The gently sloped bottom consisted of clean white sand and was more than 200 m from the nearest reef habitat.

**Remarks.** The new species differs from all congeners by the combination of color pattern and total number of vertebrae (164–175, mean 168.9). The general color pattern is most similar to that of *Heteroconger fugax*, described from a single specimen from Amami-oshima Island, Japan by Koeda et al. (2018) and subsequently photographed by us at the Anambas Islands, South China Sea (Fig. 5). Both species possess numerous small brownish spots on a pale background. *Heteroconger fugax* differs in having a large, rectangular, white blotch on the opercle. It further differs in lacking pterygoid teeth, having a dorsal-fin origin behind the gill opening, and higher counts of predorsal vertebrae (8 vs. 2–4), total vertebrae (197 vs. 164–175), dorsal-fin rays (590 vs. 435–496), and anal-fin rays (425 vs. 274–301).



**Figure 3.** *Heteroconger guttatus*, preserved holotype, MZB 24902, 425 mm TL, Venu Island, West Papua Province, Indonesia (G.R. Allen).



**Figure 4.** Satellite map of Bird's Head Peninsula region of West Papua Province, Indonesia; yellow star is type locality of *Heteroconger guttatus*.



**Figure 5.** *Heteroconger fugax*, underwater photo, approx. 600 mm TL, Anambas Islands, Indonesia (G.R. Allen).



**Figure 6.** *Heteroconger taylori*, underwater photo, approx. 400 mm TL, Anilao, Luzon, Philippines (G.R. Allen).

Two other western Pacific species, *Heteroconger tomberua* Castle & Randall, 1999 from Fiji and *Heteroconger tricia* Castle & Randall, 1999 from Indonesia, have a somewhat similar pattern but, unlike the variably sized spots of *H. guttatus*, they possess mostly uniform-sized spots with no difference between the dorsal and ventral portions. The individual spots are also much larger (to nearly pupil size) and relatively widely spaced, with less than 15 spots on each side of the head in *H. tomberua* and only one or two spots in *H. tricia*. The two species also differ in having higher vertebral counts (188–210) and lacking pterygoid teeth. The only other species that *H. guttatus* might be confused with is *Heteroconger taylori* Castle & Randall, 1995 (Fig. 6), which ranges from Papua New Guinea to Bali and the Philippines. It shares a similar vertebral count (169–172) as well as a dark-spotted pattern, however its spots are intensely black, irregularly shaped or in a maze-like network, and extend conspicuously onto the dorsal fin.

### Key to the Indo-West Pacific species of *Heteroconger*

[adapted from Castle & Randall (1999) and Allen & Erdmann (2009)]

- 1a. Body white with numerous narrow black bars on head and trunk, some bars on trunk merging ventrally with bar on opposite side; no pectoral fins; total vertebrae 153–159 (central Indonesia to Japan & Vanuatu) ..... *H. polyzona* Bleeker, 1868
- 1b. Color pattern not as in 1a; pectoral fins present ..... 2
- 2a. Body plain brown, with or without pale head markings ..... 3
- 2b. Body with round or irregular spots and/or with prominent additional dark markings on head and body.... 5

3a.	Body plain medium brown with a whitish to yellow patch on postorbital and white margins on median fins; pterygoid teeth present; lateral-line pores before anus 54–59; total vertebrae 173–176 (Philippines & Indonesia) .....	<i>H. perissodon</i> Böhlke & Randall, 1981	
3b.	Body dark brown without light head markings or white margins on median fins; pterygoid teeth present or absent; lateral-line pores before anus 47–55 .....		4
4a.	Pterygoid teeth present on most specimens; total vertebrae 154–163 (eastern Indonesia) .....	<i>H. enigmaticus</i> Castle & Randall, 1999	
4b.	Pterygoid teeth absent; total vertebrae 144 (Nicobar Islands, India) .....	<i>H. obscurus</i> (Klausewitz & Eibl-Eibesfeldt, 1959)	
5a.	Body with large, evenly spaced, round, dark-tan spots (orange in life in <i>H. balteatus</i> ) .....		6
5b.	Body with small, closely packed, dark spots or freckles on a pale background, spots may form irregular mottling or a maze-like network .....		7
6a.	Trunk with a wide oblique white bar; postorbital head with a less prominent white patch; lateral-line pores before anus 52–56; HL 15.0–18.0% of snout-anus length; total vertebrae 158–161 (Red Sea) .....	<i>H. balteatus</i> Castle & Randall, 1999	
6b.	Trunk without a white bar, head without a white patch; lateral-line pores before anus 64–68; HL 13.5–14.5% of snout-anus length; total vertebrae 210 (central Indonesia) .....	<i>H. tricia</i> Castle & Randall, 1999	
7a.	Body with a relatively widely spaced pattern of small, round, dark spots on a light background, no other markings .....		8
7b.	Body with relatively closely packed dark round or irregular spots and/or irregular mottling and/or a maze-like network, with or without additional bars, bands, or blotches .....		10
8a.	Dorsal-fin origin well-forward of gill opening; pterygoid teeth present; vertebrae 164–175, mean 168.9 (West Papua Province, Indonesia) .....	<i>H. guttatus</i> , n. sp.	
8b.	Dorsal-fin origin behind gill opening; pterygoid teeth absent; total vertebrae 188–208 .....		9
9a.	Dorsal-fin origin anterior to adpressed pectoral-fin tip; chin cirri absent; no white blotch on opercle (Fiji) .....	<i>H. tomberua</i> Castle & Randall, 1999	
9b.	Dorsal-fin origin posterior to adpressed pectoral-fin tip; numerous conical cirri on chin; large, rectangular, white blotch on opercle (Ryukyu Islands & South China Sea) ...	<i>H. fugax</i> Koeda, Fujii & Motomura, 2018	
10a.	Dorsal-fin origin well anterior to gill opening .....		11
10b.	Dorsal-fin origin over gill opening or slightly behind .....		13



- 11a. Head with zebra-like black and white bars grading to maze-like network on body; total vertebrae 204–213 (Indonesia & Philippines) ..... *H. mercyae* Allen & Erdmann, 2009
- 11b. Head without zebra-like black and white bars; body with even or irregular spotting and/or a maze-like network; total vertebrae 169–176 ..... 12
- 12a. Head and body evenly covered with irregular black spots and/or a maze-like network, extending conspicuously onto dorsal fin; total lateral-line pores 157–160; mouth 24–30% of HL; pterygoid teeth present; total vertebrae 169–172 (Indonesia & Papua New Guinea) ..... *H. taylori* Castle & Randall, 1995
- 12b. Body evenly and closely spotted, with a blackish anterior head and light throat; total lateral-line pores 161–168; mouth 18–21% of HL; pterygoid teeth absent; total vertebrae 173–176 (Marshall Islands & French Polynesia) ..... *H. lentiginosus* Böhlke & Randall, 1981
- 13a. Head and body with three prominent black patches, at gill opening and pectoral fin, then halfway along midlateral trunk, then encompassing anus; total vertebrae 164–175 (Indo-Pacific) .....  
..... *H. hassi* (Klausewitz & Eibl-Eibesfeldt, 1959)
- 13b. Head and body with three prominent U-shaped saddles, one on postorbital and two spaced along anterior trunk; vertebrae 198–204 (Solomon Islands & Indonesia) ..... *H. cobra* Böhlke & Randall, 1981

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