Zootaxa 4344 (3): 541–559
http://www.mapress.com/j/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.4344.3.6
http://zoobank.org/urn:lsid:zoobank.org:pub:385E14F7-FB39-4A88-82A7-60548F0D213E

Redescription and new records of Jansen's goatfish, *Parupeneus jansenii* (Mullidae), from the Western Pacific and Eastern Indian Ocean

FRANZ UIBLEIN[1,2,3,6], TUAN ANH HOANG[3,4] & DANIEL GLEDHILL[5]

[1]*Institute of Marine Research, P.O. Box 1870 Nordnes, N-5817 Bergen, Norway.*
[2]*South African Institute for Aquatic Biodiversity, Grahamstown, South Africa*
[3]*Vietnam National Museum of Nature, Vietnam Academy of Science and Technology, Hanoi, Vietnam*
[4]*Graduate University of Science and Technology, Vietnam Academy of Science and Technology, Hanoi, Vietnam*
[5]*CSIRO, Oceans and Atmosphere Flagship and the National Research Collections Australia, National Fish Collection, Hobart, Australia*
[6]*Corresponding author. E-mail: franz@imr.no*

Abstract

For Jansen's goatfish, *Parupeneus jansenii* (Mullidae), taxonomic knowledge has been rather poor and occurrence information restricted to a few localities only, with verified records from northern Sulawesi and Sunda Street (Indonesia), and Luzon (Philippines). This species is here included in the so-called "*heptacanthus*" group together with the Indo-Pacific cinnabar goatfish, *P. heptacanthus*, and five Indian Ocean congenerics, based on an evenly, symmetrically rounded posterior maxilla margin and similarities in meristic characters and preserved colour. In total 29 *P. jansenii* and 53 *P. heptacanthus* consisting of types, recently collected material from south-central Vietnam, southern Indonesia, and NE Australia, and geographically related reference material were studied along with single types of the other five *heptacanthus*-group species and *P. angulatus*, a morphologically similar Western Indian Ocean species. In total 62 quantitative meristic and morphometric characters including standard length (SL) were analysed after splitting the data into two size classes (small-sized fish, < 110 mm SL, vs. large-sized fish ≥ 110 mm SL) to account for size-related differences due to allometry. Diagnoses for *P. jansenii* and *P. heptacanthus* and a redescription for *P. jansenii* were prepared. Fresh-fish colour descriptions for both large- and small-sized voucher specimens of *P. jansenii* are provided and the effects of freshness status on colour patterns is documented. New records for *P. jansenii* for Vietnam, southern Indonesia and NE Australia (= first verified record for Australia) are reported and depth information (24–100 m depth range) is given for the first time. *P. jansenii* differs from the co-occurring *P. heptacanthus* - independently of size - in shallower body and caudal peduncle, smaller maximum head depth, shorter barbels, caudal and pelvic fins, shallower first dorsal fin, shallower first ray of second dorsal fin, and lack of small dark red or reddish-brown spot on or just below the eighth lateral-line scale. The populations of *P. jansenii* from Vietnam and Australia differ from each other in a single character, the height of the eighth dorsal-fin ray, but both overlap with the intermediate population from Indonesia. This comprehensive alpha-taxonomic approach provides a useful tool for uncovering the diversity of *Parupeneus* goatfishes.

Key words: *heptacanthus* species group, NE Australia, southern Indonesia, south-central Vietnam, morphometric characters, intraspecific variation, colour patterns

Introduction

The goatfish genus *Parupeneus* (Mullidae) is the second largest of the family Mullidae consisting of 32 valid species (Randall & Heemstra 2009) which are characterized by a dorsal fin with 8 spines, 14–18 pectoral-fin rays, 24–42 total gill rakers, bluntly conical teeth in a single row on both jaws, the snout longer than postorbital length in adults, and lack of dark-brown or black markings on fins. All *Parupeneus* species occur in the Indo-Pacific (Randall 2004). Recently, one species, *P. forsskali* (Fourmanoir & Guézé, 1976), has been also encountered in several areas of the southeastern Mediterranean as a Lessepsian migrant (Mehanna *et al*. 2016).

In a taxonomic review of the goatfishes of the Western Indian Ocean (WIO) 19 *Parupeneus* species were listed and an identification key with important diagnostic characters and overall distribution information for each species

Accepted by W. Holleman: 1 Sept. 2017; published: 8 Nov. 2017

was provided by Randall & Heemstra (2009). For the other 13 species information on distribution and diagnostic characters was given by Randall (2004). The 32 *Parupeneus* species can be divided into three groups according to the form of the rear of the maxilla (Randall 2004; Randall & Heemstra 2009): one group of seven species, here termed the "*heptacanthus*" group, has an even, symmetrically rounded posterior margin; it consists of *P. fraserorum* Randall & King, 2009, *P. heptacanthus* (Lacepède, 1802), *P. jansenii* (Bleeker, 1856), *P. minys* Randall & Heemstra 2009, *P. nansen* Randall & Heemstra, 2009, *P. procerigena* Kim & Amaoka, 2001, and *P. seychellensis* (Smith & Smith, 1963); a single species, *P. angulatus* Randall & Heemstra, 2009, has a symmetrical but angular rear maxilla end; in the remaining 24 species the maxilla ends in a broad dorsoposterior extension. All seven *heptacanthus*-group species and *P. angulatus* overlap considerably in meristic characters and show uniform pale colour in preservative, but can be distinguished by body form characters and colour patterns in fresh condition (Randall & Heemstra 2009; Randall & King 2009). Three of these species were described and one species, *P. seychellensis*, was resurrected in the review by Randall & Heemstra (2009).

For the large Indo-Pacific area extending from the South China Sea to the Philippines and Indonesia and further south to Australia no recent taxonomic review of the genus *Parupeneus* exists. Among the above-listed species, the cinnabar goatfish *P. heptacanthus* and Jansen's goatfish *P. jansenii* occur in this area. *Parupeneus heptacanthus* is widely distributed from the WIO to southern Japan, the Caroline and Marshall Islands, New Guinea, Australia, New Caledonia, Lord Howe Island and Fiji. Its depth range is 15–88 m (Randall 2004). *Parupeneus jansenii* has been reported from Indonesia, Philippines, New Guinea, and northern Australia. Depth information for this species is completely lacking (Randall 2004).

Reference material of *P. jansenii* has been available only from Indonesia and Philippines (Randall 2004). The record of *P. jansenii* for New Guinea is that of Munro (1958), who listed Mansinam Island, New Britain, and Port Moresby as localities for this species. The record for northern Australia is derived from an annotated list of marine fish species of the Northern Territory by Larsen *et al.* (2013) who refer to a fish-species list by Wei *et al.* (1972) that was based on collected material. As Larsen *et al.* (2013) however state, no reference material is available for verification of that earlier record. Both Randall (2004) and Allen & Erdman (2012) emphasized that *P. jansenii* is a poorly known species with very few records, no recent sightings, and no habitat information. Furthermore, no photographs of fresh specimens have been available so far and only a painting provided by Bleeker (1877–78) was referred to in species diagnoses (Randall 2004; Allen & Erdman 2012). Because of the morphological similarities, confusion of *P. jansenii* with *P. heptacanthus* has occurred at least for the juvenile stage (Randall 2004; Randall & Heemstra 2009).

Based on collections made at fish markets and landing sites in central Vietnam and during a cruise in the area of the Great Barrier Reef to the Torres Strait, eastern Australia (Pitcher *et al*. 2007), the first two authors examined several samples of preserved goatfishes, partly associated with voucher photographs of fresh fish, at the Vietnam National Museum of Nature (VNMN), Hanoi, the Australian National Fish Collection (ANFC) at CSIRO, Hobart, and the fish reference collection at the Institute of Marine Research (HIFIRE), Bergen, Norway. A considerable number of the examined specimens was assigned to *P. heptacanthus* and *P. jansenii* using the available diagnostic information and identification keys (Randall 2004; Allen & Erdman 2012). Reliable distinction between the two species was however sometimes difficult, because relatively few diagnostic characters were listed in the previous studies, and colour patterns of. *P. jansenii* were documented only by a painting provided originally by Bleeker, reproduced in both Randall (2004) and Allen & Erdman (2012; see also further above).

Making use of the wealth of new study material of *P. jansenii* and *P. heptacanthus* now available, we adopted a comprehensive alpha-taxonomic approach (Uiblein *et al.* 2016, 2017). This approach features comparative inter- and intraspecific studies of large numbers of quantitative morphometric and meristic characters as well as colour patterns, considering size-related and population differences, and possible colour changes related to freshness status. Diagnoses for both species and a redescription and updated occurrence information for *P. jansenii* are provided. Comparisons of *P. jansenii* were made with type material of the other five species of the *heptacanthus* group and *P. angulatus*. Finally, size classes and populations of *P. jansenii* are compared. The results are discussed with respect to the need for more taxonomic studies of the genus *Parupeneus* in insufficiently explored areas of the Indo-Pacific.

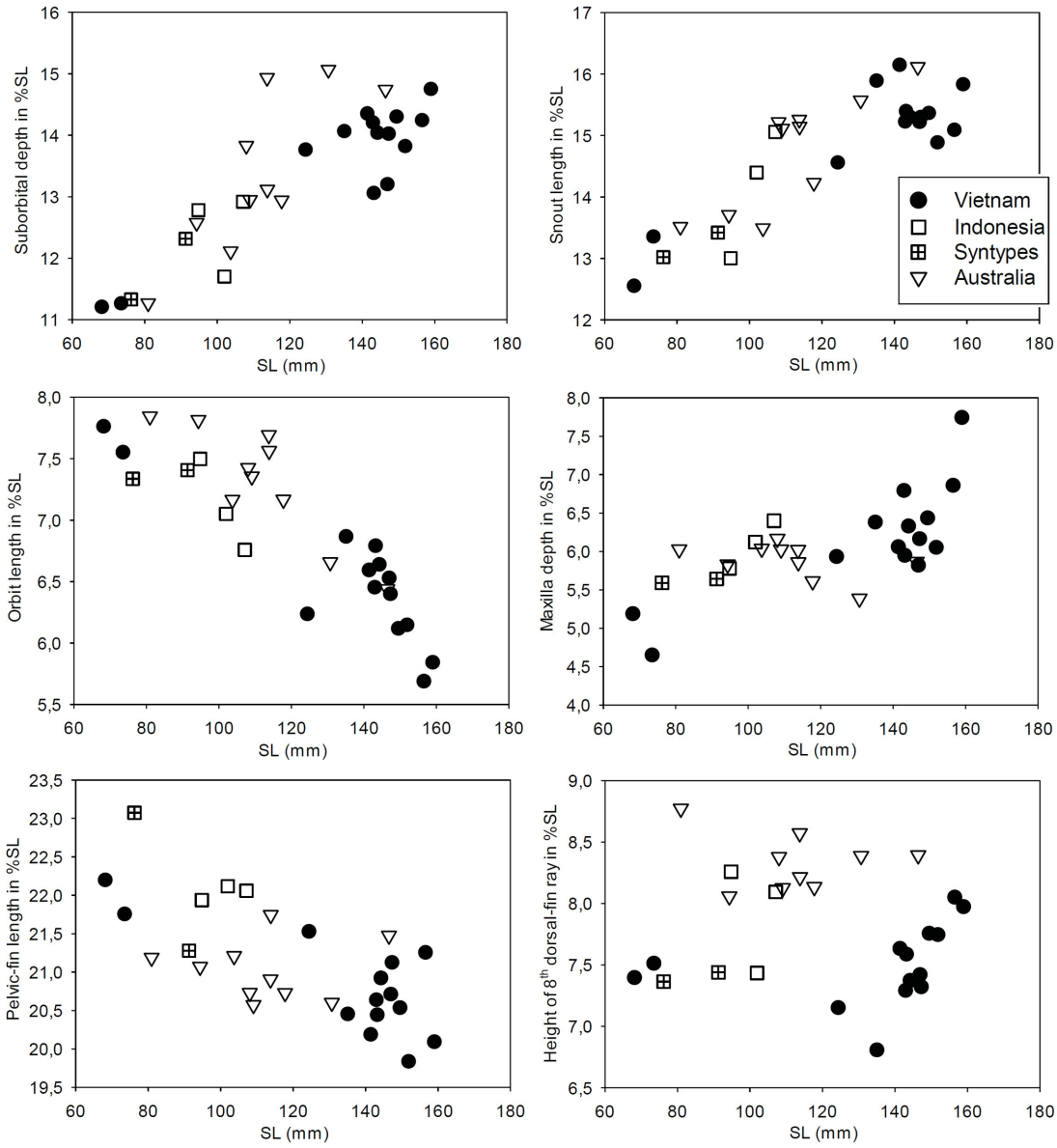

FIGURE 1. Six morphometric characters (expressed in %SL) plotted against SL for *Parupeneus jansenii* from three different areas.

Material and methods

In total 29 specimens of *Parupeneus jansenii*, 53 specimens of *P. heptacanthus* from an area overlapping largely with the distribution of *P. jansenii*, and single types of each of the other five species of the *heptacanthus* group as well as *P. angulatus* were examined. Standard length (SL) and 62 quantitative morphometric and meristic characters were studied, taking the most recent taxonomic studies of relevant *Parupeneus* species into consideration (Randall 2004; Randall & Heemstra 2009; Randall & King 2009). The quantitative characters are listed in Table 1, partly accompanied by additional descriptions. Because the anal-fin spine is considerably reduced and sometimes hidden below the skin, measurements of this character were taken only when the spine was visible. All morphometric data are given as percentage of SL or as a ratio of SL or other characters as specified. Ranges of the resulting values below 10 were rounded to one decimal place or to the nearest 0.05. The means of all measurements and counts were rounded to one or two decimals. All *Parupeneus* species have eight dorsal-fin spines, and hence this meristic character is only listed in Table 1.

Size-related changes in morphometric characters were accounted for by splitting the data into two size classes, one of specimens ≥ 110 mm SL ("large-sized fish") and the other specimens < 110 mm SL ("small-sized fish"). The size class threshold was established by plotting and subsequent inspection of the relationships between SL and

all quantitative characters. Several morphometric characters showed strong positive or negative allometry in both species including several head characters and pelvic-fin length (examples for *P. jansenii* shown in Figure 1). Except for a slightly increasing number of developed vs. a slightly decreasing number of rudimentary gill rakers in *P. heptacanthus* (Figure 2), meristic characters did not vary with size.

For the diagnoses and comparisons of data generated by this study, all morphometric data are expressed in % SL. For the redescription and for additional comparisons of *P. jansenii* and *P. heptacanthus* with earlier published morphological data (Randall 2004), selected morphological characters were given as ratios of SL or other characters.

Colour patterns of fresh and preserved specimens were described and compared taking into consideration possible population differences and possible colour changes during life, after capture, or during preservation. Colour was identified using photographic documentation. Care was taken to consider artificial light effects when inspecting the photographs and applying colour corrections. Freshness status was determined by distinguishing photographs of specimens taken while still on board of a fishing vessel or at landing sites (= freshly caught) from those taken on fish markets (= still relatively fresh) or later in the laboratory (= less fresh). *In-situ* photographs or direct observations of *P. jansenii* colour patterns were not available for this study.

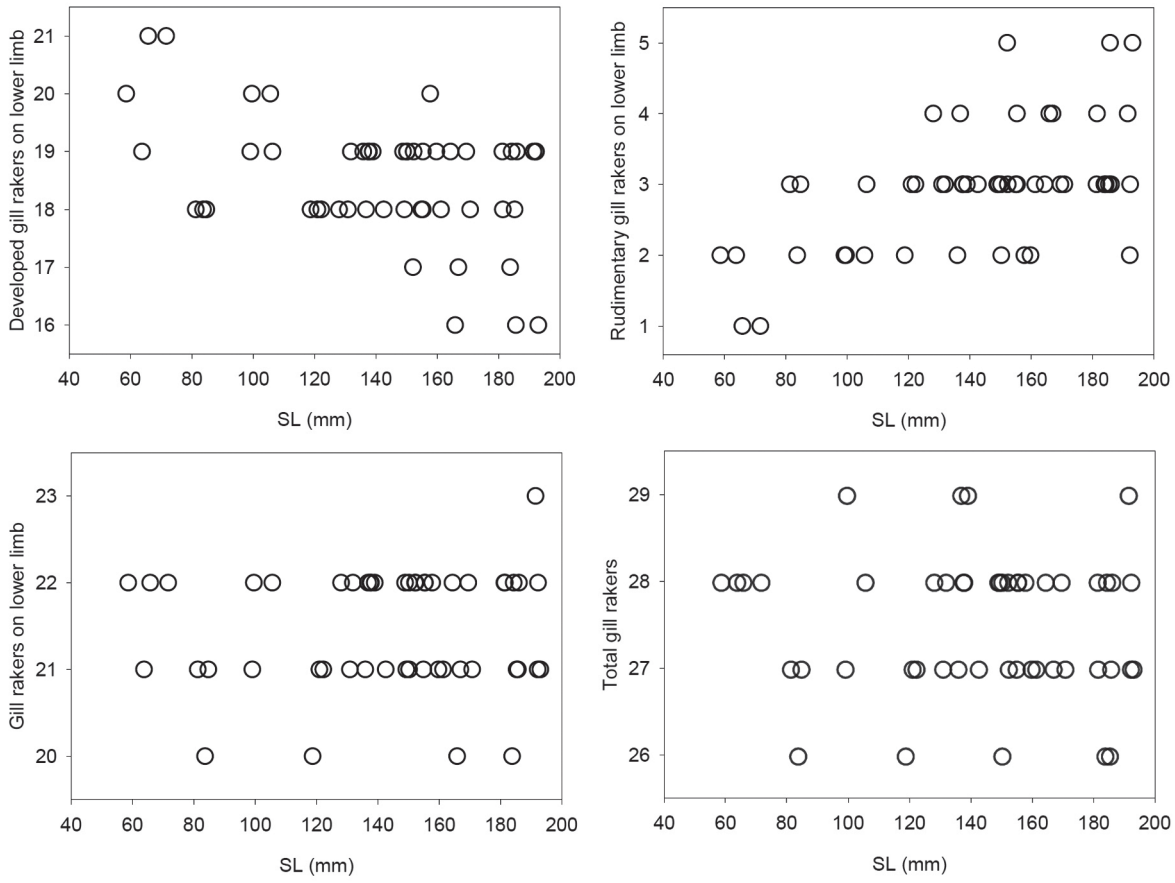

FIGURE 2. Counts of gill rakers plotted against SL for *Parupeneus heptacanthus*

In the comparisons, attention was focused on the most diagnostic characters only, considering both sample size and intraspecific variation in *P. jansenii* and *P. heptacanthus*. In comparisons with the other six species, all represented by single type specimens, only characters showing values lying clearly outside the ranges for *P. jansenii* are given. In addition, meristic data of the two species were statistically compared using Chi-square test for trends for larger tables (one degree of freedom in all cases) and Fisher's exact test for 2x2 tables (GraphPad Prism version 5.00 for Windows, GraphPad Software, La Jolla California USA, www.graphpad.com). Significance level was at $p<0.05$.

Institutional acronyms follow Fricke & Eschmeyer (2017). Other acronyms or abbreviations are as follows: HIFIRE = Fish reference collection of the Institute of Marine Research, Bergen, Norway; HT = holotype; LL = lateral-line scales; PT = paratype(s); VNMN = Vietnam National Museum of Nature, Hanoi, Vietnam.

TABLE 1. List and descriptions of size, morphometric, and meristic characters.

Characters	Descriptions
Size and morphometric characters	
Standard length (SL; in mm)	distance from snout tip to caudal fin base at mid-body (posterior end of hypural plate)
Body depth at first dorsal-fin origin	
Body depth at anal-fin origin	
Half body depth at first dorsal fin origin	depth from lateral line downwards
Half body depth at anal fin origin	depth from lateral line downwards
Caudal-peduncle depth	minimum depth anterior to caudal-fin dorsal origin
Caudal-peduncle width	width at position of caudal-peduncle depth measurement
Maximum head depth	vertical distance at ventral edge of operculum
Head depth through eye	distance along a vertical midline through eye
Suborbital depth	distance between lower edge of orbit to ventral midline of head
Interorbital length	least distance between upper bony edges of orbits
Head length	distance from snout tip to posterior-most margin of operculum
Snout length	distance from snout tip to anterior margin of orbit
Postorbital length	distance from posterior edge of orbit to posterior margin of operculum
Orbit length	horizontal bony orbit diameter
Orbit depth	vertical bony orbit diameter
Upper-jaw length	distance from symphysis to posterior end of upper jaw
Lower-jaw length	distance from symphysis to posterior end of upper jaw
Maxilla depth	maximum vertical depth of posterior end of upper jaw
Snout width	least distance between hinder margins of upper jaw, with closed mouth
Barbel length	
Maximum barbel width	horizontal width measured at base of soft part of barbel
First pre-dorsal length	distance from snout tip to origin of first dorsal fin
Second pre-dorsal length	distance from snout tip to origin of second dorsal fin
Interdorsal distance	distance from last spine of first dorsal fin to first ray of second dorsal fin
Caudal-peduncle length	distance from last anal-fin ray to ventral origin of caudal fin
Pre-anal length	distance from snout tip to origin of anal fin
Pre-pelvic length	distance from snout tip to origin of pelvic fin
Pre-pectoral length	distance from snout tip to dorsal origin of pectoral fin
Second dorsal-fin depth	distance from origin of second dorsal fin to origin of anal fin
Pelvic-fin depth	distance from origin of first dorsal fin to origin of pelvic fin
Pectoral-fin depth	distance from origin of first dorsal fin to dorsal origin of pectoral fin
Length of first dorsal-fin base	
Length of second dorsal-fin base	
Caudal-fin length	distance from dorsal caudal-fin origin to upper caudal-lobe tip
Length of anal-fin base	
Anal-fin height	distance from origin to anterior tip of anal fin (= to tip of second anal-fin ray)
Height of anal-fin spine	
Height of first anal-fin ray	
Height of seventh anal-fin ray	
Length of pelvic-fin spine	
Pelvic-fin length	distance from pelvic-fin origin to pelvic-fin tip
Pectoral-fin length	distance from pectoral-fin dorsal origin to pectoral-fin tip
Pectoral-fin width	width of pectoral-fin base
Height of minute first dorsal-fin spine	
First dorsal fin height	height of first long dorsal-fin spine (= second dorsal-fin spine in *Parupeneus*)
Height of third dorsal-fin spine	
Height of fourth dorsal-fin spine	
Height of first dorsal-fin ray	
Second dorsal-fin height	height of second dorsal-fin ray
Height of eighth dorsal-fin ray	
Height of ninth dorsal-fin ray	
Meristic characters	
First dorsal-fin spines	
Pectoral-fin rays	
Rudimentary gill rakers on upper limb	tiny gill rakers with a width larger than or equal to their depth on distal upper limb
Developed gill rakers on upper limb	long gill rakers with a width larger than their depth on upper limb
Developed gill rakers on lower limb	long gill rakers with a width larger than their depth on lower limb, including the gill raker in limb corner
Rudimentary gill rakers on lower limb	tiny gill rakers with a width larger than or equali to their depth on distal lower limb
Gill rakers on upper limb	
Gill rakers on lower limb	
Total gill rakers	
Lateral-line scales	scales along lateral line to caudal-fin base (excluding scales on caudal fin)

Taxonomy

Genus *Parupeneus* Bleeker, 1863

Parupeneus jansenii (Bleeker, 1856)

Jansen's goatfish
(Figs. 1, 3–5; Tables 2, 3)

Upeneus jansenii Bleeker, 1856 (type locality Manado, Sulawesi).
Parupeneus jansenii: Bleeker 1875; Randall 2004; Allen & Erdmann 2012

Syntypes. RMNH 5748, 2 specimens, 76–91 mm SL, Indonesia, Sulawesi, Manado.

Non-type material (n = 27, 68–159 mm SL). Vietnam, South-central coast: MUL.PA.CHR.04, Hai Phong Fisheries Research Institute Reference Collection, 125 mm SL; Vietnam, Khanh Hoa province, Nha Trang: HIFIRE 58155, 5 specimens, 143–152 mm SL, VNMN-I 54, 147 mm SL, and VNMN-I 64, 157 mm SL, fish market; VNMN-I 50, 143 mm SL, VNMN-I 51, 135 mm SL, and VNMN-I 52, 142 mm SL, Binh Tan fish market, 12°12.793' N; 109°11.825' E; VNMN-I 4, 159 mm SL, Hon Ro landing site, 12°12.07' N, 109°11.66' E; VNMN-I 134, 74 mm SL, and VNMN-I 135, 68 mm SL, Hon Tre Island, 12°10'–12°14' N; 109°14'–109°21'E, obtained from fishermen; Indonesia: RMNH 25006, 102 mm SL, and RMNH 25008, 1 (of 2), 107 mm SL; southern Bali: CSIRO H 5972-19, 146 mm SL, Jimbaran Bay, Kedonganan fish market, 8°45' S 115°10' E; southern Lombok: NTM S 10740-006, 95 mm SL, 9°0' S 116°12' E, 100 m depth; NE Australia, Queensland, Torres Strait: Torres Strait: CSIRO H 6148-03, 118 mm SL, NE of Cape York Peninsula, 10°19.87' S 143°33.42' E, 37 m depth; CSIRO H 6926-10, 4, 94–114 mm SL, NE of Cape York Peninsula, 10°21.84' S 143°40.26' E, 40 m depth; S of Torres Strait: CSIRO H 3446-04, 114 mm SL, E of Cape York Peninsula, Blackwood Channel, 11°43.4' S, 143°42.6' E, 23 m depth; CSIRO H 7462-03, 131 mm SL, E of Newcastle Bay, 10°55.1' S 143°54.6' E, 32 m depth; Great Barrier Reef: CSIRO H 7460-04, 104 mm SL, NE of Townsville, 18°31.48' S 147°34.9' E, 76 m depth; CSIRO H 8154-01, 81 mm SL, NE of Lizard Island, 14°35.38' S 145°33.98' E, 26 m depth.

Diagnosis. Dorsal fins VIII + 9; pectoral fins 14–16; gill rakers 6–7 + 20–23 = 26–29; measurements in % SL, large-sized fish: body depth at first dorsal-fin origin 23–26; body depth at anus 19–21; caudal-peduncle depth 8.2–9.0; maximum head depth 22–24; head depth through eye 19–21; interorbital length 8.1–10; head length 31–34; snout length 14–16; postorbital length 11–12; orbit length 5.7–7.7; upper jaw length 12–15; barbel length 22–25; caudal-peduncle length 21–24; caudal-fin length 25–27; anal-fin height 12–14; pelvic-fin length 20–22; pectoral-fin length 21–25; first dorsal-fin height 17–20; second dorsal-fin height 11–14; small-sized fish: body depth at first dorsal-fin origin 22–26; body depth at anus 18–21; caudal-peduncle depth 7.8–8.8; maximum head depth 20–24; head depth through eye 18–21; interorbital length 8.1–9.7; head length 32–34; snout length 13–15; postorbital length 11–13; orbit length 6.8–7.8; upper jaw length 11–14; barbel length 22–26; caudal-peduncle length 21–24; caudal-fin length 25–29; anal-fin height 12–14; pelvic-fin length 21–23; pectoral-fin length 22–23; first dorsal-fin height 17–19; second dorsal-fin height 11–14; maxilla posterior margin evenly, symmetrically rounded; body and head rose, pink, or vermillion, colour may become paler below lateral line and eye; scale edges darker; body silvery white ventrally; one yellow-orange mid-lateral stripe sometimes visible from behind operculum along lateral line; caudal fin red or dark orange along proximal exterior sides of lobes, the remaining parts orange-yellowish to hyaline; dorsal fins and anterior part of pelvic fins pale red or pale orange; anal fin crossed by weakly indicated red-greenish stripes; barbels white or rose to red at basis, tips white; preserved fish pale or pale brown to pale grey, head or dorsal body and head margin sometimes darker.

Description. Morphometric data as ratios of SL for large-sized fish, data for small-sized fish (including syntypes) in squared brackets: body elongated, its depth at first dorsal-fin origin 3.8–4.3 [3.9–4.5]; body depth at anal-fin origin 4.8–5.3 [4.8–5.4]; caudal peduncle depth 11–12 [11–13], subequal to interorbital length (10—12 [10–12]); maximum head depth 4.1–4.5 [4.2–4.9], subequal to barbel length (4.0–4.6 [3.9–4.6]); head depth through eye 4.7–5.2 [4.9–5.6]; head length 2.9–3.2 [3.0–3.2], larger than maximum depth of body and caudal-fin length (3.7–4.0 [3.5–4.0]); snout length 6.2–7.0 [6.6–8.0], shorter than postorbital length (8.0–9.4 [7.5–8.9]) in large-sized fish; orbit length 13–18 [13–15]; anal-fin height 7.2–8.4 [7.0–8.1]; second dorsal-fin height 7.3–9.3 [7.0–8.8]; pectoral-fin length 4.0–4.7 [4.3–4.6], subequal to barbel length and subequal to pelvic-fin length (4.6–5.0 [4.3–4.9]) in small-sized fish.

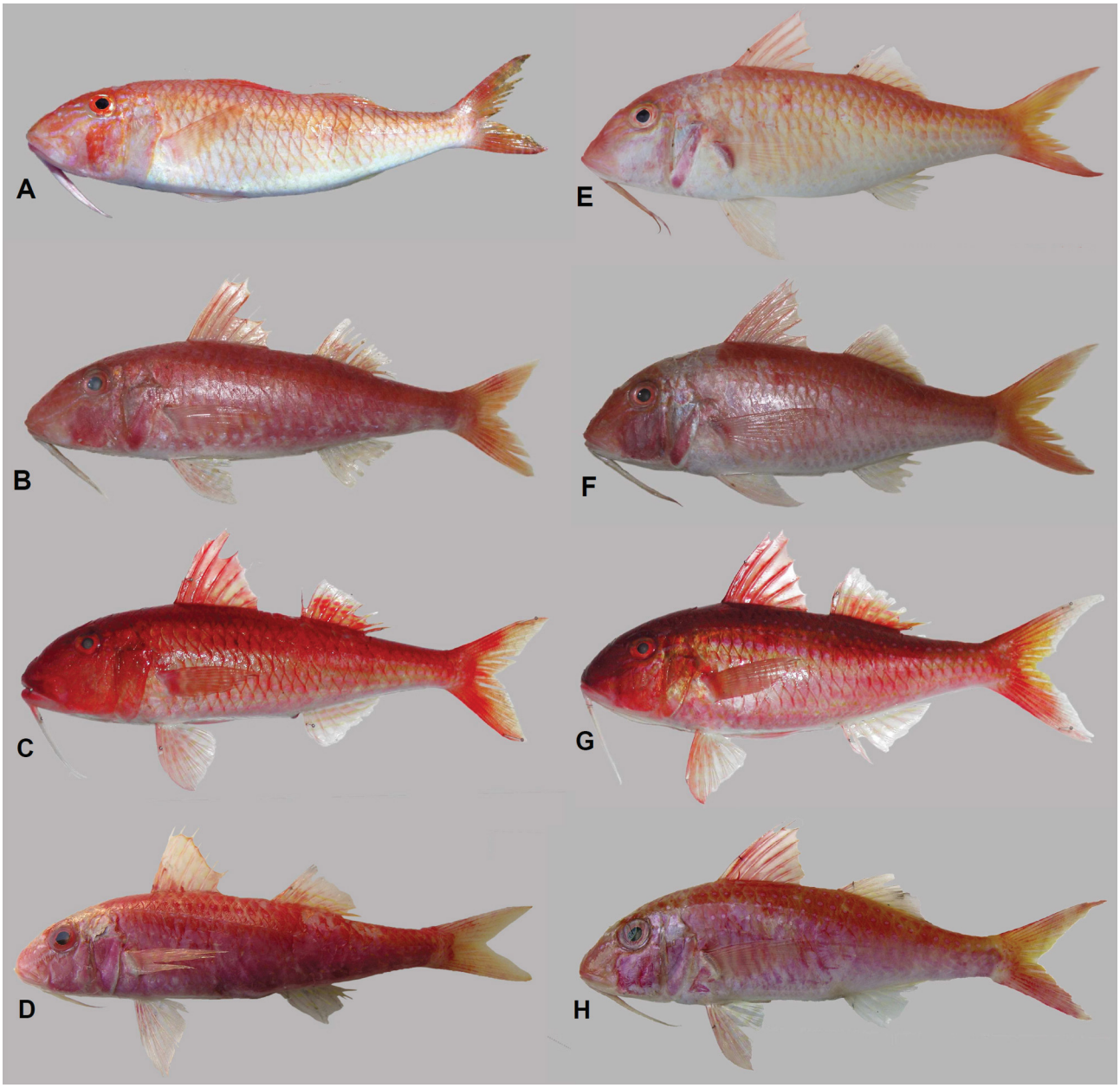

FIGURE 3. *Parupeneus jansenii* (left side) and *P. heptacanthus* (right side). (A) VNMN-I 4, 159 mm SL, Hon Ro landing site, Nha Trang City, Vietnam (Franz Uiblein); (B) VNMN-I 51, 135 mm SL, Binh Tan fish market, Nha Trang City, Vietnam (Tuan Anh Hoang); (C) CSIRO H 5972-19, 146 mm SL, Kedonganan, Jimbaran Bay (S coast of Bali), Indonesia (William T. White); (D) CSIRO H 8154-01, 81 mm SL, NE of Lizard Island, Queensland, Australia (Daniel C. Gledhill); (E, F) VNMN-I 49, 170 mm SL, Binh Tan fish market, Nha Trang, Vietnam (Tuan Anh Hoang); (G) CSIRO H 5972-17, 150 mm SL, Kedonganan, Jimbaran Bay (S coast of Bali), Indonesia (William T. White); (H) CSIRO H 7379-07, 122 mm SL, NE of Cairns, Great Barrier Reef, Queensland, Australia (Daniel C. Gledhill).

Fresh colour: freshly landed large-sized fish (Figure 3A, VNMN-I 4, 159 mm SL): body and head vermillion dorsally, becoming paler ventrally, starting from below eye and from scale row above lateral line; head with four slightly bending, thin, pink stripes: the uppermost stripe starting from behind dorsal third of eye, interrupted by orbit, to head margin in front of mid-eye, paralleled by a stripe of similar length right below; a longer pink stripe starting anterior to lower eye margin and ending close to nose tip; and the lowermost pink stripe from behind eye to below eye and ending anteriorly at half distance of snout length; jaws pink; further below eye the specimen has a large vertically oriented vermillion broad band that touches the lowermost rose stripe (see above) dorsally and ends well above ventral head margin; the preopercle is pale rose with vermillion margin; the black pupil of the eye is surrounded by an almost entirely red iris; all scales on body, apart from the ventral-most scale row, have dark reddish margins that contrast with the lighter scale colour; the lateral-line scales along the anterior half of the body

show small red, mid-posteriorly placed spots; a broad, pale orange-yellow stripe in width of about scale vertical length runs along lateral line from behind preopercle to caudal-fin base; belly silvery white; caudal fin pale pink at base, with vermillion bands reaching along exterior margins of lobes to tips, covering in the anterior halves of lobes 5 to 6 of the distalmost rays; the remaining inner part of the caudal fin is covered by brighter yellow-orange colour reaching from distal-most part of fin base to close to lobe tips; dorsal fins vermillion, pelvic fins with some rose traces, and pectoral fins hyaline; anal-fin colour not identified, because folded in photograph; barbels white to pale rose, tips white.

Large-sized fish encountered at fish market (Figure 3C, CSIRO H 5972-19, 146 mm SL): body and head mostly entirely vermillion, dorsally darker; ventral underside of head white; eye with black pupil surrounded by red iris that contrasts weakly with the darker vermillion head colour; body colour changing laterally towards ventral side from dark to bright vermillion to beige and rose and pale pink below lateral line; belly pale pink; scales with dark red or reddish margins that contrast with the lighter colour of scale surface, apart from the scales adjacent to the anterior dorsal body margin where body colour is darkest and the contrast is diminished; caudal fin entirely vermillion at base, the colour spreading along exterior margins of lobes to tips, covering at anterior halves of lobes 5 and 6 of the distalmost rays, then continuing along the two distalmost rays until tips, becoming much weaker close to tip, especially on upper lobe; the remaining posterior part of the caudal fin is yellow-orange to beige in colour; dorsal fins are mostly vermillion or rose, spines and anterior base of first dorsal fin most intensely coloured, rays of second dorsal fin proximally vermillion and pale on tips, the beige interspaces partly covered by one to three rounded, partly connected, vertically arranged vermillion patches; pelvic fins hyaline with pale rose spine and all rays except for innermost ray with three to four beige to pale brown patches proximally; pectoral fins hyaline; anal fin hyaline with three thin pale green to pale brown stripes covering entire length of fin, one close to base, the distalmost stripe thinnest, positioned at about two thirds of fin height. Barbels vermillion at base, distal two thirds white including tip.

Freshly caught small-sized fish (Figure 4A, VNMN-I 135, 68 mm SL): body and head dark orange dorsally, becoming ventrally paler, starting from below eye and lateral line; head yellowish-orange below and behind ventral half of eye, with two weakly indicated pink dashes anterior to lower half of eye; snout tip and jaws dark orange; the black pupil of the eye is surrounded by a red iris; nearly all scales on body have reddish, orange or yellowish margins that contrast with the lighter scale-surface colour; the lateral-line scales form a thin bright orange to yellow stripe from posterior of the preopercle to behind second-dorsal fin base; this stripe is surrounded by a broader yellow pigmentation starting below first dorsal-fin base that widens from ca. mid-body to caudal fin base, almost entirely covering the dorsal part of the caudal peduncle; belly silvery white; caudal fin and dorsal fins dark orange; pelvic fins hyaline with pale orange spine and first three rays; pectoral fins hyaline with orange basis; anal fin hyaline; barbels pale rose along proximal two thirds and white distally including tip.

Preserved colour (syntype, RMNH 5748, 91 mm SL): body dorsally dark brown grey, lighter from lateral line, with weakly pale brown ventral half of body; head mostly dark grey brown, except for tiny pale-brown area in front of eye and pale brown region behind jaws, pale brown opercle and preopercle; fins pale, partly hyaline; other specimens often entirely pale brown or with darker, grey brown dorsal margin on head and body;

Distribution, depth range, and size. *Parupeneus jansenii* occurs in the Western Pacific and Eastern Indian Ocean in the area ranging from south-central Vietnam and northern Philippines to southwestern Indonesia and NE Australia, with verified records from Nha Trang Bay (this study), Luzon (Randall 2004), northern Sulawesi (type locality Manado), Sunda Strait off southern Sumatra (Randall 2004), southern Bali and southern Lombok (this study), and Torres Strait to Great Barrier Reef (this study). Depth range is 24–100 m, maximum size is 159 mm SL.

***Parupeneus heptacanthus* (Lacepède, 1802)**

Cinnabar goatfish
(Figs. 2–5; Table 2)

Sciaena heptacantha Lacepède, 1802 (type locality not given)
Upeneus cinnabarinus Cuvier in Cuvier and Valenciennes, 1829
Upeneus pleurospilos Bleeker, 1853 (type locality Ambon, Moluccas, Indonesia)
Parupeneus heptacanthus Kim & Amaoka 2001, Randall 2004, Randall & Heemstra 2009, Allen & Erdman 2012

Holotype. MNHN 5438, 153 mm SL, dried specimen, type locality not given (probably Indonesia).

Syntype. *Parupeneus pleurospilus*, RMNH 5743, 106 mm SL, Indonesia, Moluccas, Ambon.

Non-type material (n = 51, 59–193 mm SL). Vietnam: MNHN 1967-547, 185 mm SL; South-central coast: MUL.PA.HEP.02, Hai Phong Fisheries Research Institute Reference Collection, 171 mm SL; Da Nang province, Da Nang: VNMN-I 5, 121 mm SL, and VNMN-I 6, 119 mm SL, Tho Quang, Hoang Sa street landing site,

16°06.01' N 108°15.65' E; Khanh Hoa province, Nha Trang: VNMN-I 44, 186 mm SL, and VNMN-I 45, 192 mm SL, Vinh Luong landing site, 12°20.110' N, 109°12.228' E; VNMN-I 48, 139 mm SL, and VNMN-I 47, 155 mm SL, Xom Moi market, 12°14.566' N, 109°11.426' E; VNMN-I 40, 181 mm SL, VNMN-I 41, 164 mm SL, VNMN-I-42, 161 mm SL, VNMN-I 46, 184 mm SL, VNMN-I 49, 170 mm SL, VNMN-I 66, 2 specimens: 131–138 mm SL, and VNMN-I 128, 191 mm SL, Binh Tan fish market, 12°12.793' N; 109°11.825' E; VNMN-I 137, 5 specimens: 81–106 mm SL, VNMN-I 138, 3 specimens: 64–72 mm SL, and VNMN-I 139, 2 specimens, 136–158 mm SL, Vinh Truong district, Cua Be landing site, 12°12.09' N; 109°12.122' E; VNMN-I 1, 167 mm SL, VNMN-I 2 152 mm SL, and VNMN-I 3, 128 mm SL, Hon Ro landing site, 12°12.07' N 109°11.66' E; VNMN-I 136, 59 mm SL, Hon Tre Island, 12°10'–12°14' N 109°14'–109°21' E, obtained from fishermen; Philippines: MNHN 1979-90, 1 (of 3), 149 mm SL; Indonesia: RMNH 5737, 3(of 6), 160–166 mm SL; North Sulawesi, Manado: NCIP 5033, 162 mm SL, Manado fish market, 1°29.85' N 124°50.45' E; Java Sea: RMNH 13339, 84 mm SL; southern Bali: CSIRO H 5972-17, 150 mm SL, CSIRO H 5972-18, 132 mm SL, CSIRO H 7695-03, 137 mm SL, and CSIRO H 8157-01, 184 mm SL, Jimbaran Bay, Kedonganan fish market, 8°45' S 115°10' E; Australia, Western Australia: CSIRO CA 2881, 181 mm SL, off Port Hedland, 20°00' S 117°49' E, 37–38 m depth; CSIRO CA 3859, 143 mm SL, CSIRO CA 3860, 155 mm SL, and CSIRO CA 3861, 186 mm SL, NW of Port Hedland, 19°16' S 117°55' E, 82-84 m depth; Northern Territory: CSIRO CA 2037, 193 mm SL, NW of Bathurst Island, 11°12' S 128°35' E, 38 m depth; CSIRO CA 2061, 155 mm SL, NE of N Goulburn-Island, 10°43' S 134°00' E, 62 m depth; Queensland, South of Torres Strait: CSIRO H 3894-01, 152 mm SL, and CSIRO H 3894-02, 150 mm SL, NE of Cape Grenville, 11°38' S 143°35' E, 18 m depth; Great Barrier Reef: CSIRO H 7379-07, 122 mm SL, NE of Cairns, 16°32' S 146°02' E, 54 m depth; CSIRO H 8155-01, 138 mm SL, NE of Yeppoon, 22°44' S 151°27' E, 60 m depth; CSIRO H 8156-01, 193 mm SL, N of North Reef, Capricorn Group, 23°02' S 151°55' E, 67 m depth.

Diagnosis. Dorsal fins VIII + 9; pectoral fins 15–17; gill rakers 5–7 + 20–23 = 26–29; measurements in % SL, large-sized fish: body depth at first dorsal-fin origin 29–35; body depth at anus 23–29; caudal-peduncle depth 10–12; maximum head depth 26–31; head depth through eye 21–25; interorbital length 7.7–9.2; head length 31–34; snout length 14–17; postorbital length 10–13; orbit length 5.8–8.1; upper jaw length 12–14; barbel length 25–29; caudal-peduncle length 21–25; caudal-fin length 29–33; anal-fin height 13–16; pelvic-fin length 22–25; pectoral-fin length 23–28; first dorsal-fin height 20–23; second dorsal-fin height 11–15; small-sized fish: body depth at first dorsal-fin origin 28–30; body depth at anus 23–26; caudal-peduncle depth 10–11; maximum head depth 24–27; head depth through eye 19–22; interorbital length 7.7–8.4; head length 30–34; snout length 13–15; postorbital length 10–13; orbit length 6.6–8.3; upper jaw length 12–13; barbel length 26–28; caudal-peduncle length 22–25; caudal-fin length 29–32; anal-fin height 14–16; pelvic-fin length 23–24; pectoral-fin length 24–26; first dorsal-fin height 19–21; second dorsal-fin height 13–15; maxilla posterior margin evenly, symmetrically rounded; body and head purple red or vermillion, colour may become paler below lateral line and eye; scale edges darker; scales often with pale violet or pearly iridescent spot; body silvery white ventrally; one or two indistinct narrow yellow-orange stripes sometimes visible, one of them just above or along lateral line and more conspicuous, the other further below; a small dark red or reddish-brown spot on or just below the eighth lateral-line scale in both large- and small-sized fish; caudal fin red at base and ventrally of lower lobe, the remaining parts yellowish to pale orange; dorsal and anterior parts of anal and pelvic fins red or orange; barbels white or pale orange except for the white tips; preserved fish pale or pale brown to pale grey, head or dorsal body and head margin sometimes darker.

Comparisons (Figures 1, 3–5, Tables 2, 3)

Parupeneus jansenii differs from *P. heptacanthus* - independently of size - in shallower body and caudal peduncle, smaller maximum head depth, shorter barbels, caudal and pelvic fins, shallower first dorsal fin, shallower first ray of second dorsal fin, and lack of small dark red or reddish-brown spot on or just below the eighth lateral-line scale; furthermore, small-sized *P. jansenii* differs in shorter second dorsal-fin base, shallower anal fin, shorter pelvic-fin spine, and shorter pectoral fins; and large-sized *P. jansenii* differs in shallower head depth through eye and longer anal-fin base. Regarding meristic characters, *Parupeneus jansenii* differs from *P. heptacanthus* statistically with signifcantly fewer pectoral-fin rays, more gill rakers on upper limb, and constantly 27 lateral-line scales in contrast to 27–28 scales in the latter species (Figure 5). The currently known maximum size of *P. jansenii* is 159 mm SL (this study), while *P. heptacanthus* has been reported to reach a much larger size of 290 mm SL (Randall 2004).

FIGURE 4. Small-sized *Parupeneus jansenii* (A, B) and *P. heptacanthus* (C) from Hon Tre Island, Nha Trang, Vietnam (D. A. Pavlov): (A) VNMN-I 135, 68 mm SL; (B) VNMN-I 134, 74 mm SL; (C) VNMN-I 136, 59 mm SL.

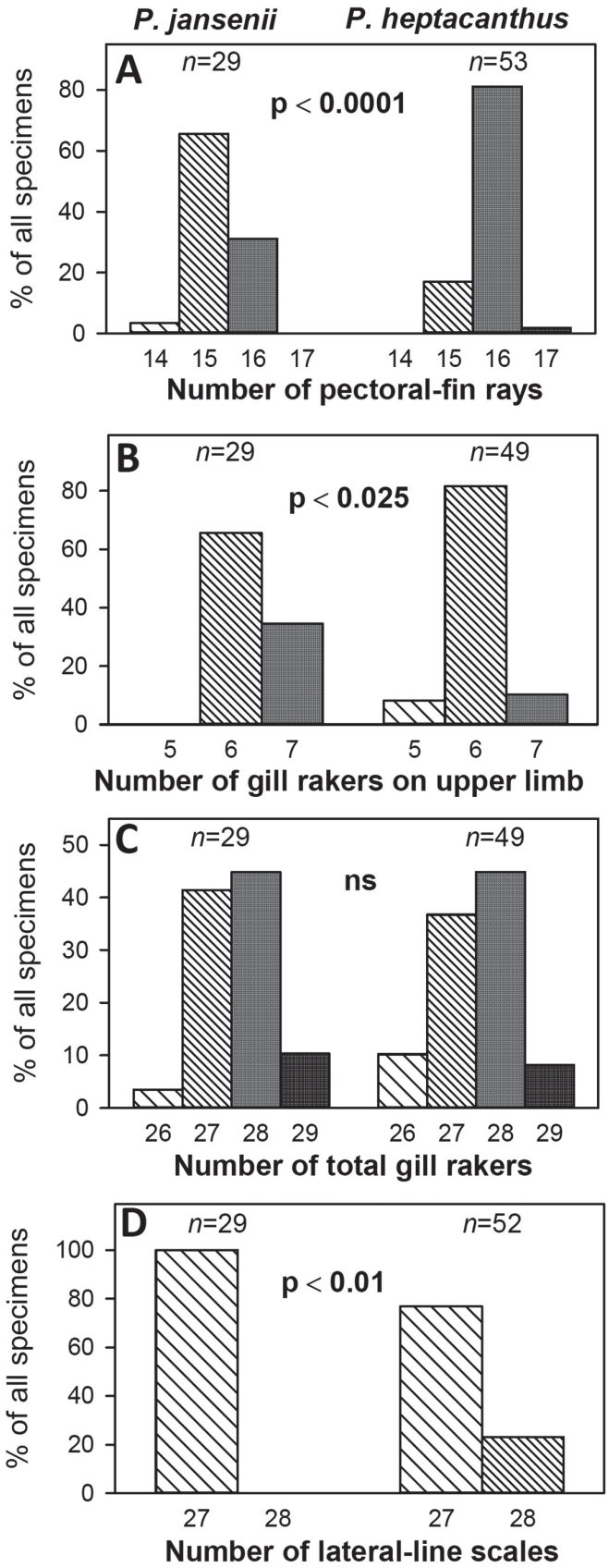

FIGURE 5. Four meristic characters for *Parupeneus jansenii* and *P. heptacanthus*, with results of statistical interspecific comparisons indicating significant differences based on $\chi 2$ test for trends (upper three charts) or Fisher's exact test for 2x2 tables (lowermost chart).

TABLE 2. Quantitative morphological characters for *Parupeneus jansenii*, *P. heptacanthus* (both species separated into two size classes), and six other congeneric species. Values revealing differences from *P. jansenii* are indicated in bold italics.

	Parupeneus jansenii								*P. heptacanthus*								*P. angulatus*	*P. fraserorum*	*P. minys*	*P. nansen*	*P. procerigena*	*P. seychellensis*
	Small-sized fish				Large-sized fish				Small-sized fish				Large-sized fish									
	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	HT	PT	PT	HT	PT	HT
SL (mm)	68	92.4	109	12	114	139.2	159	17	59	83.6	106	11	119	158.1	193	42	140	150	82	122	156	195
Morphometric characters in % SL																						
Body depth at first dorsal-fin origin	22	23.9	26	12	23	25.1	26	17	***28***	***28.7***	***30***	11	***29***	***31.1***	***35***	42	26	***34***	23	***27***	***37***	***31***
Body depth at anal-fin origin	18	19.3	21	12	19	19.9	21	17	***23***	***24.2***	***26***	11	***23***	***26.1***	***29***	42	21	***28***	19	21	***28***	***26***
Half body depth at first dorsal fin origin	19	20.2	21	12	20	21.1	22	17	***22***	***23.5***	***25***	11	***22***	***24.9***	***28***	41	21	***26***	20	22	***29***	***26***
Half body depth at anal fin origin	14	14.8	16	12	14	15.3	16	17	***17***	***18.6***	***20***	11	***17***	***19.3***	***22***	41	16	***19***	16	16	***20***	***20***
Caudal-peduncle depth	7.8	8.4	8.8	12	8.2	8.6	9.0	17	***10***	***11.0***	***11***	11	***10***	***11.1***	***12***	42	8.8	***12***	8.4	8.9	***11***	***11***
Caudal-peduncle width	3.4	4.1	4.9	12	3.8	4.3	4.9	17	3.6	4.5	4.9	11	3.8	4.6	5.7	41	4.0	4.3	4.1	4.0	4.3	4.5
Maximum head depth	20	21.9	24	12	22	23.4	24	17	***24***	***25.8***	***27***	11	***26***	***27.6***	***31***	42	24	-	21	24	***34***	***28***
Head depth through eye	18	19.0	21	12	19	20.3	21	17	19	20.6	22	11	***21***	***23.0***	***25***	42	21	***25***	20	20	***29***	***24***
Suborbital depth	11	12.2	14	12	13	14.0	15	17	12	12.5	13	11	13	14.9	16	42	15	15	14	14	***19***	***16***
Interorbital length	8.1	8.6	9.7	12	8.1	8.9	10	17	7.7	8.0	8.4	11	7.7	8.5	9.2	41	9.1	9.2	8.3	8.9	8.5	8.9
Head length	32	32.4	34	12	31	32.5	34	17	30	32.7	34	11	31	32.1	34	42	33	34	33	33	34	31
Snout length	13	13.8	15	12	14	15.3	16	17	13	14.3	15	11	14	15.5	17	42	15	***18***	14	16	***19***	***17***
Postorbital length	11	12.1	13	12	11	11.6	12	17	10	11.8	13	11	10	11.3	13	42	**13**	12	12	12	***13***	12
Orbit length	6.8	7.4	7.8	12	5.7	6.6	7.7	17	6.6	7.5	8.3	11	5.8	6.8	8.1	42	6.1	7.7	***6.6***	7.1	7.3	***5.3***
Orbit depth	6.1	6.6	7.0	12	5.1	5.8	6.7	17	6.1	6.9	7.7	11	5.3	6.0	7.3	42	5.2	***7.0***	***6.0***	6.3	6.4	***4.9***
Upper-jaw length	11	12.2	14	12	12	13.1	15	17	12	12.1	13	11	12	13.0	14	42	14	12	13	13	13	13
Lower-jaw length	10	11.6	13	12	11	12.7	14	17	11	11.6	12	11	11	12.6	14	41	14	12	12	13	13	12
Maxilla depth	4.6	5.8	6.4	12	5.4	6.2	7.7	17	4.9	5.4	5.8	11	4.8	5.7	6.8	42	7.0	6.1	5.5	6.1	6.7	5.4
Snout width	7.6	8.8	10	11	8.4	9.5	10	17	7.2	8.4	9.3	11	8.5	9.8	12	39	9.8	9.6	8.6	10	9.7	***11***
Barbel length	22	23.3	26	12	22	23.4	25	17	***26***	***26.8***	***28***	11	***25***	***26.7***	***29***	41	24	***26***	22	24	***27***	24
Maximum barbel width	1.0	1.1	1.3	12	1.0	1.2	1.4	17	1.0	1.1	1.3	11	1.0	1.2	1.4	41	1.1	1.1	***0.9***	***0.9***	1.0	1.1
First pre-dorsal length	37	39.5	41	12	37	39.2	42	17	38	39.1	41	11	38	39.2	41	42	39	***44***	41	40	***43***	39
Second pre-dorsal length	63	65.3	68	12	63	64.8	68	17	62	63.5	66	11	61	63.7	66	42	65	65	65	66	66	63
Interdorsal distance	12	13.6	15	12	11	13.5	15	17	11	12.1	14	11	11	12.3	15	42	13	11	13	14	***10***	12
Caudal-peduncle length	21	22.8	24	12	21	22.4	24	17	22	23.8	25	11	21	23.5	25	42	***20***	***20***	23	21	***20***	23
Pre-anal length	63	65.5	67	12	64	65.7	67	17	62	63.5	65	11	61	63.3	66	42	64	63	66	65	65	**63**
Pre-pelvic length	32	33.1	35	12	31	33.0	35	17	33	33.5	34	11	31	33.0	36	42	33	32	34	35	33	32
Pre-pectoral length	31	33.0	35	12	32	33.2	35	17	32	33.4	34	11	31	32.5	35	42	33	35	34	33	35	32
Second dorsal-fin depth	18	19.6	21	12	19	20.7	22	17	***23***	***24.8***	***26***	11	***24***	***27.0***	***30***	42	21	***29***	20	22	***29***	***27***

……continued on the next page

TABLE 2. (Continued)

	Parupeneus jansenii								*P. heptacanthus*								*P. angulatus*	*P. fraserorum*	*P. minys*	*P. nansen*	*P. procerigena*	*P. seychellensis*
	Small-sized fish				Large-sized fish				Small-sized fish				Large-sized fish									
	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*	HT	PT	PT	HT	PT	HT
Pelvic-fin depth	22	24.1	26	12	24	25.5	27	17	***28***	***28.6***	***30***	11	***28***	***30.9***	***35***	42	27	***34***	23	27	***37***	***31***
Pectoral-fin depth	14	16.0	18	12	16	17.3	19	17	17	18.0	19	11	18	20.1	22	42	18	***21***	16	18	***26***	***20***
Length of first dorsal-fin base	15	15.7	16	12	15	16.3	18	17	15	15.8	17	11	15	16.6	18	42	17	16	16	17	18	16
Length of second dorsal-fin base	13	14.2	15	12	14	14.6	17	17	***15***	***16.1***	***17***	11	15	16.8	18	42	16	***18***	15	15	17	16
Caudal-fin length	25	26.8	29	10	25	26.0	27	17	***29***	***30.5***	***32***	11	***29***	***31.3***	***33***	37	***28***	***28***	26	***29***	27	-
Length of anal-fin base	11	11.6	13	12	11	11.4	12	17	12	12.9	14	11	***12***	***13.3***	***15***	42	***13***	***14***	11	11	***15***	***13***
Anal-fin height	12	13.5	14	12	12	12.9	14	17	***14***	***15.2***	***16***	11	13	14.2	16	42	13	***11***	14	13	11	-
Height of anal-fin spine	1.4	1.8	2.3	9	1.3	1.8	2.3	17	1.0	1.9	2.6	10	1.2	2.0	3.0	41	1.6	-	1.4	***1.2***	2.3	1.6
Height of first anal-fin ray	7.4	8.3	9.0	12	7.7	8.3	8.8	16	***9.0***	***10.1***	***11***	11	***8.7***	***9.8***	***12***	42	***8.9***	***11***	8.0	8.5	***11***	-
Height of seventh anal-fin ray	8.1	8.8	9.7	12	8.4	9.1	10	17	8.2	9.6	10	11	9.1	10.2	12	38	9.5	***13***	9.7	9.3	***14***	10
Length of pelvic-fin spine	14	15.0	16	12	13	13.7	16	17	***16***	***17.0***	***17***	11	14	15.9	17	42	13	***17***	15	15	16	16
Pelvic-fin length	21	21.6	23	12	20	20.8	22	17	***23***	***23.5***	***24***	11	***22***	***23.7***	***25***	41	22	***25***	21	***23***	***25***	***23***
Pectoral-fin length	22	22.4	23	12	21	22.7	25	17	***24***	***25.3***	***26***	11	23	25.1	28	42	22	***29***	***21***	24	***29***	24
Pectoral-fin width	5.1	5.3	5.6	12	5.1	5.6	6.2	17	5.2	5.5	5.9	11	5.3	5.9	6.6	42	5.4	***6.6***	***5.0***	5.2	5.7	6.0
Height of first dorsal-fin spine	1.9	2.4	3.2	12	1.9	2.5	3.4	17	2.5	2.8	3.4	11	2.3	3.3	4.1	41	2.4	3.2	***3.5***	2.5	3.1	3.2
First dorsal fin height	17	17.6	19	12	17	18.2	20	14	***19***	***19.9***	***21***	11	***20***	***21.7***	***23***	40	19	18	18	18	***21***	-
Height of third dorsal-fin spine	17	19.5	21	12	18	19.6	21	16	19	20.4	21	11	20	21.9	24	41	***22***	18	18	***22***	***23***	21
Height of fourth dorsal-fin spine	16	18.5	20	11	17	18.7	20	16	18	18.6	20	11	18	19.4	21	40	19	18	18	20	***21***	18
Height of first dorsal-fin ray	6.7	7.7	8.7	12	6.8	7.4	8.2	17	***9.6***	***10.0***	***10***	10	***8.9***	***9.7***	***11***	40	***8.3***	***9.3***	7.2	8.0	***11***	-
Second dorsal-fin height	11	12.9	14	12	11	11.9	14	17	13	14.3	15	11	11	13.2	15	41	12	11	14	12	11	11
Height of eighth dorsal-fin ray	7.4	7.9	8.8	11	6.8	7.8	8.6	17	8.0	8.2	8.4	9	7.5	8.8	9.7	41	7.9	***8.9***	8.6	8.0	***11***	***8.8***
Height of ninth dorsal-fin ray	7.4	8.2	9.0	12	7.4	8.5	10	17	8.1	9.0	11	11	8.9	9.9	11	41	8.9	10	7.7	8.2	***13***	9.8
Meristic characters																						
Pectoral-fin rays	15	15.4	16	12	14	15.2	16	17	15	15.7	16	11	15	15.9	17	42	16	***17***	15	16	16	16
Rudimentary gill rakers on upper limb	0	1.3	3	12	0	1.4	3	17	1	1.2	2	10	0	1.2	2	39	3	1	0	3	2	1
Developed gill rakers on upper limb	3	5.0	6	12	3	5.0	7	17	4	5.0	6	10	4	4.7	5	39	4	5	6	3	5	5
Developed gill rakers on lower limb	16	18.3	20	12	15	17.2	19	17	18	19.4	21	11	16	18.3	20	40	17	***21***	15	17	20	16
Rudimentary gill rakers on lower limb	1	3.0	5	12	2	4.1	6	17	1	2.1	3	11	2	3.2	5	40	3	***1***	6	3	2	3
Gill rakers on upper limb	6	6.3	7	12	6	6.4	7	17	6	6.2	7	10	5	6.0	7	39	7	6	6	6	7	6
Gill rakers on lower limb	20	21.3	22	12	20	21.3	23	17	20	21.4	22	10	20	21.5	23	40	20	22	21	20	22	***19***
Total gill rakers	27	27.5	29	12	26	27.7	29	17	26	27.6	29	10	26	27.5	29	39	27	28	27	26	29	***25***
Lateral-line scales	27	27.0	27	10	27	27.0	27	15	27	27.5	28	11	27	27.2	28	41	***28***	27	27	***28***	27	27

TABLE 3. Quantitative morphological characters for *Parupeneus jansenii* populations, separated into two size classes. Values revealing differences between the single large-sized fish from Indonesia from ranges of small-sized fish from Indonesia are indicated in bold.

	Small-sized fish																Large-sized fish											
	Indonesia						Vietnam		Australia				All				Indonesia	Vietnam				Australia				All			
	Syntypes		Min	Mean	Max	*n*	*n*=2		Min	Mean	Max	*n*	Min	Mean	Max	*n*	*n*=1	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*
SL (mm)	76	91	76	94.3	107	5	68	74	81	99.2	109	5	68	92.4	109	12	146	125	145.4	159	12	114	119.0	131	4	114	139.2	159	17
Morphometric characters in % SL																												
Body depth at first dorsal-fin origin	22	24	22	23.9	25	5	23	24	23	24.2	26	5	22	23.9	26	12	***26***	23	24.9	26	12	24	25.3	26	4	23	25.1	26	17
Body depth at anal-fin origin	19	21	19	19.6	21	5	20	19	18	18.9	20	5	18	19.3	21	12	20	19	20.0	21	12	19	19.5	20	4	19	19.9	21	17
Half body depth at first dorsal fin origin	19	21	19	20.1	21	5	20	20	19	20.4	21	5	19	20.2	21	12	***22***	20	20.9	22	12	21	21.4	22	4	20	21.1	22	17
Half body depth at anal fin origin	15	16	14	15.0	16	5	15	15	14	14.6	15	5	14	14.8	16	12	15	14	15.3	16	12	15	15.4	16	4	14	15.3	16	17
Caudal-peduncle depth	8.5	8.8	8.3	8.5	8.8	5	8.6	8.7	7.8	8.2	8.7	5	7.8	8.4	8.8	12	8.6	8.4	8.7	9.0	12	8.2	8.4	8.6	4	8.2	8.6	9.0	17
Caudal-peduncle width	3.8	4.1	3.4	3.9	4.4	5	3.6	3.4	3.6	4.5	4.9	5	3.4	4.1	4.9	12	***4.8***	3.8	4.2	4.8	12	4.1	4.4	4.9	4	3.8	4.3	4.9	17
Maximum head depth	20	22	20	21.8	23	5	21	21	21	22.4	24	5	20	21.9	24	12	***24***	22	23.3	24	12	23	23.3	24	4	22	23.4	24	17
Head depth through eye	18	19	18	19.1	20	5	18	18	18	19.4	21	5	18	19.0	21	12	***21***	19	20.2	21	12	19	20.4	21	4	19	20.3	21	17
Suborbital depth	11	12	11	12.2	13	5	11	11	11	12.5	14	5	11	12.2	14	12	***15***	13	14.0	15	12	13	14.0	15	4	13	14.0	15	17
Interorbital length	8.3	8.2	8.1	8.4	8.9	5	8.2	8.4	8.3	9.0	9.7	5	8.1	8.6	9.7	12	***9.5***	8.1	8.6	9.5	12	8.9	9.5	10	4	8.1	8.9	10	17
Head length	32	32	32	32.2	33	5	33	32	32	32.7	34	5	32	32.4	34	12	32	31	32.4	33	12	32	33.0	34	4	31	32.5	34	17
Snout length	13	13	13	13.8	15	5	13	13	13	14.2	15	5	13	13.8	15	12	***16***	15	15.3	16	12	14	15.1	16	4	14	15.3	16	17
Postorbital length	13	13	11	12.3	13	5	12	12	11	12.0	13	5	11	12.1	13	12	12	11	11.5	12	12	12	11.9	12	4	11	11.6	12	17
Orbit length	7.3	7.4	6.8	7.2	7.5	5	7.8	7.5	7.2	7.5	7.8	5	6.8	7.4	7.8	12	***6.4***	5.7	6.4	6.9	12	6.7	7.3	7.7	4	5.7	6.6	7.7	17
Orbit depth	6.5	6.7	6.1	6.4	6.7	5	7.0	7.0	6.1	6.5	6.9	5	6.1	6.6	7.0	12	***5.5***	5.1	5.6	6.2	12	6.0	6.2	6.7	4	5.1	5.8	6.7	17
Upper-jaw length	12	12	11	11.9	13	5	11	11	12	12.8	14	5	11	12.2	14	12	***15***	12	13.0	15	12	12	13.2	14	4	12	13.1	15	17
Lower-jaw length	11	11	11	11.5	13	5	11	10	11	12.2	13	5	10	11.6	13	12	***14***	12	12.6	14	12	11	12.7	14	4	11	12.7	14	17
Maxilla depth	5.6	5.6	5.6	5.9	6.4	5	5.2	4.6	5.8	6.0	6.2	5	4.6	5.8	6.4	12	5.9	5.8	6.4	7.7	12	5.4	5.7	6.0	4	5.4	6.2	7.7	17
Snout width	8.3	9.3	8.3	9.0	9.3	4	7.6	7.6	8.1	9.2	10	5	7.6	8.8	10	11	***9.6***	8.4	9.5	10	12	8.6	9.6	10	4	8.4	9.5	10	17
Barbel length	22	23	22	22.9	24	5	22	23	23	24.0	26	5	22	23.3	26	12	23	22	23.4	25	12	22	23.6	24	4	22	23.4	25	17
Maximum barbel width	1.2	1.3	1.0	1.2	1.3	5	1.0	1.0	1.0	1.1	1.2	5	1.0	1.1	1.3	12	1.0	1.0	1.2	1.4	12	1.0	1.1	1.3	4	1.0	1.2	1.4	17
First pre-dorsal length	37	40	37	39.3	40	5	39	38	39	40.0	41	5	37	39.5	41	12	40	37	38.6	40	12	39	40.5	42	4	37	39.2	42	17
Second pre-dorsal length	66	66	64	65.8	67	5	64	63	64	65.6	68	5	63	65.3	68	12	65	63	64.6	66	12	64	65.4	68	4	63	64.8	68	17
Interdorsal distance	13	14	12	13.5	15	5	12	12	12	14.2	15	5	12	13.6	15	12	14	11	13.0	15	12	14	14.7	15	4	11	13.5	15	17
Caudal-peduncle length	21	22	21	22.2	23	5	23	24	23	23.2	23	5	21	22.8	24	12	22	21	22.2	23	12	22	23.0	24	4	21	22.4	24	17
Pre-anal length	66	67	65	66.3	67	5	65	63	64	65.2	66	5	63	65.5	67	12	66	64	65.7	67	12	65	65.7	67	4	64	65.7	67	17
Pre-pelvic length	32	32	32	33.4	35	5	33	33	32	32.8	34	5	32	33.1	35	12	34	31	32.7	34	12	33	33.6	35	4	31	33.0	35	17
Pre-pectoral length	31	33	31	33.0	35	5	33	34	33	32.9	33	5	31	33.0	35	12	34	32	32.9	34	12	32	33.8	35	4	32	33.2	35	17
Second dorsal-fin depth	19	20	19	20.1	21	5	19	19	18	19.3	20	5	18	19.6	21	12	21	20	20.8	22	12	19	20.3	21	4	19	20.7	22	17
Pelvic-fin depth	22	24	22	24.1	26	5	23	23	23	24.5	26	5	22	24.1	26	12	***27***	24	25.3	27	12	25	25.7	26	4	24	25.5	27	17

……continued on the next page

TABLE 3. (Continued)

	Small-sized fish																Large-sized fish											
	Indonesia					Vietnam			Australia				All				Indonesia	Vietnam				Australia				All			
	Syntypes		Min	Mean	Max	*n*	*n*=2		Min	Mean	Max	*n*	Min	Mean	Max	*n*	*n*=1	Min	Mean	Max	*n*	Min	Mean	Max	*n*	Min	Mean	Max	*n*
Pectoral-fin depth	15	16	15	16.3	17	5	15	14	15	16.2	18	5	14	16.0	18	12	***19***	16	17.1	18	12	17	17.5	18	4	16	17.3	19	17
Length of first dorsal-fin base	16	16	15	15.9	16	5	15	16	15	15.7	16	5	15	15.7	16	12	16	16	16.5	18	12	15	15.8	17	4	15	16.3	18	17
Length of second dorsal-fin base	14	15	13	14.0	15	5	14	15	14	14.2	15	5	13	14.2	15	12	15	14	14.6	17	12	14	14.7	16	4	14	14.6	17	17
Caudal-fin length	26	25	25	26.0	27	4	-	29	25	27.0	28	5	25	26.8	29	10	26	25	26.1	27	12	25	26.0	27	4	25	26.0	27	17
Length of anal-fin base	13	12	11	11.7	13	5	11	11	11	11.9	13	5	11	11.6	13	12	11	11	11.3	12	12	11	11.6	12	4	11	11.4	12	17
Anal-fin height	14	14	12	13.5	14	5	14	14	13	13.4	14	5	12	13.5	14	12	13	12	12.7	13	12	13	13.6	14	4	12	12.9	14	17
Height of anal-fin spine	1.5	1.8	1.5	1.8	1.9	5	0.0	0.0	1.4	1.8	2.3	4	1.4	1.8	2.3	9	***2.2***	1.3	1.7	2.1	12	2.0	2.1	2.3	4	1.3	1.8	2.3	17
Height of first anal-fin ray	8.5	7.4	7.4	8.2	9.0	5	8.6	8.9	7.7	8.3	8.7	5	7.4	8.3	9.0	12	8.7	7.7	8.1	8.7	11	8.3	8.5	8.8	4	7.7	8.3	8.8	16
Height of seventh anal-fin ray	8.1	8.4	8.1	8.8	9.5	5	8.3	8.4	8.6	9.1	9.7	5	8.1	8.8	9.7	12	9.2	8.4	9.0	10	12	8.4	9.2	10	4	8.4	9.1	10	17
Length of pelvic-fin spine	16	14	14	15.0	16	5	15	15	14	14.8	16	5	14	15.0	16	12	14	13	13.5	14	12	14	14.2	16	4	13	13.7	16	17
Pelvic-fin length	23	21	21	22.1	23	5	22	22	21	21.0	21	5	21	21.6	23	12	21	20	20.6	22	12	21	21.0	22	4	20	20.8	22	17
Pectoral-fin length	23	22	22	22.2	23	5	22	23	22	22.3	23	5	22	22.4	23	12	23	22	23.0	25	12	21	21.8	23	4	21	22.7	25	17
Pectoral-fin width	5.3	5.4	5.2	5.3	5.4	5	5.1	5.3	5.1	5.3	5.6	5	5.1	5.3	5.6	12	5.3	5.2	5.7	6.2	12	5.1	5.3	5.5	4	5.1	5.6	6.2	17
Height of first dorsal-fin spine	2.3	2.0	1.9	2.2	2.8	5	1.9	2.2	2.4	2.8	3.2	5	1.9	2.4	3.2	12	***3.2***	1.9	2.4	2.9	12	2.4	2.8	3.4	4	1.9	2.5	3.4	17
First dorsal fin height	17	17	17	17.5	18	5	17	17	17	18.0	19	5	17	17.6	19	12	***19***	17	18.1	20	10	18	18.7	19	3	17	18.2	20	14
Height of third dorsal-fin spine	18	17	17	19.2	21	5	19	19	19	20.2	21	5	17	19.5	21	12	20	18	19.5	21	11	19	19.7	20	4	18	19.6	21	16
Height of fourth dorsal-fin spine	18	-	18	18.5	20	4	18	18	19	19.4	20	4	16	18.5	20	11	19	17	18.6	20	12	18	18.9	20	3	17	18.7	20	16
Height of first dorsal-fin ray	7.6	6.8	6.7	7.4	8.1	5	8.4	8.7	7.0	7.7	8.2	5	6.7	7.7	8.7	12	7.9	6.8	7.3	7.7	12	7.6	7.7	8.2	4	6.8	7.4	8.2	17
Second dorsal-fin height	12	12	11	12.2	13	5	14	14	12	13.4	14	5	11	12.9	14	12	13	11	11.4	12	12	12	13.0	14	4	11	11.9	14	17
Height of eighth dorsal-fin ray	7.4	7.4	7.4	7.7	8.3	5	7.4	7.5	8.1	8.3	8.8	4	7.4	7.9	8.8	11	***8.4***	6.8	7.5	8.0	12	8.1	8.3	8.6	4	6.8	7.8	8.6	17
Height of ninth dorsal-fin ray	7.8	7.5	7.5	8.3	9.0	5	7.8	8.1	7.4	8.2	8.9	5	7.4	8.2	9.0	12	8.5	7.4	8.2	9.7	12	8.1	9.2	10	4	7.4	8.5	10	17
Meristic characters																													
Pectoral-fin rays	15	16	15	15.6	16	5	15	15	15	15.4	16	5	15	15.4	16	12	15	14	15.3	16	12	15	15.0	15	4	14	15.2	16	17
Rudimentary gill rakers on upper limb	0	0	0	1.0	3	5	1	2	1	1.4	2	5	0	1.3	3	12	2	0	1.2	3	12	1	2.0	3	4	0	1.4	3	17
Developed gill rakers on upper limb	6	6	3	5.2	6	5	5	5	4	4.8	5	5	3	5.0	6	12	4	3	5.3	7	12	4	4.5	6	4	3	5.0	7	17
Developed gill rakers on lower limb	19	20	16	18.6	20	5	20	19	16	17.4	18	5	16	18.3	20	12	***15***	16	17.6	19	12	16	16.8	18	4	15	17.2	19	17
Rudimentary gill rakers on lower limb	2	2	2	2.8	5	5	1	3	3	3.6	4	5	1	3.0	5	12	***6***	2	3.8	6	12	3	4.3	5	4	2	4.1	6	17
Gill rakers on upper limb	6	6	6	6.2	7	5	6	7	6	6.2	7	5	6	6.3	7	12	6	6	6.4	7	12	6	6.5	7	4	6	6.4	7	17
Gill rakers on lower limb	21	22	21	21.4	22	5	21	22	20	21.0	22	5	20	21.3	22	12	21	20	21.4	23	12	20	21.0	22	4	20	21.3	23	17
Total gill rakers	27	28	27	27.6	28	5	27	29	27	27.2	28	5	27	27.5	29	12	27	26	27.8	29	12	27	27.5	28	4	26	27.7	29	17
Lateral-line scales	-	27	27	27.0	27	4	27	27	27	27.0	27	4	27	27.0	27	10	27	27	27.0	27	11	27	27.0	27	3	27	27.0	27	15

Parupeneus jansenii differs from all other similar species (*heptacanthus* group and *P. angulatus*) as follows: from *P. fraserorum*, *P. procigerena*, and *P. seychellensis* in shallower body, shallower caudal peduncle, shallower head, shorter snout, shorter anal-fin base, shorter pelvic fin, and shallower eighth dorsal-fin ray; additional important differences from *P. fraserorum* are: fewer pectoral-fin rays, shorter barbels, shorter second dorsal-fin base, higher anal fin, shallower first ray of second dorsal fin, and wider pectoral fin; from *P. procigerena*: shorter postorbital length, wider interdorsal distance, shorter barbels, longer caudal peduncle, higher anal fin, shorter pectoral fins, shallower first dorsal fin, and shallower ninth ray of second dorsal fin; and from *P. seychellensis*: fewer gill rakers, shorter and narrower snout, and longer anal-fin base.

Parupeneus jansenii differs from *P. angulatus* and *P. nansen* in shorter caudal fin, shallower third dorsal-fin spine, and fewer lateral-line scales; furthermore, it differs from *P. angulatus* in round vs. angular rear end of maxilla, in shorter postorbital, longer caudal peduncle, shorter anal-fin base, slightly higher first anal-fin ray and first ray on second dorsal fin; and from *P. nansen* it differs in shallower maximum body depth, wider barbel, and shorter pelvic fin.

Parupeneus jansenii is morphologically rather similar to *P. minys*, especially, when comparing the 104 mm SL paratype of *P. minys* with *P. jansenii* small-sized fish. Accordingly, similar-sized *P. jansenii* differs in larger eyes, wider barbels, longer and wider pectoral fins, and shallower first dorsal-fin spine. *Parupeneus jansenii* reaches at least 159 mm SL (this study), while for *P. minys* a maximum size of only 106.5 mm SL has been reported (Randall & Heemstra 2009).

Parupeneus jansenii shows intraspecific differences among size classes and populations (Figure 1; Table 3). The single large-sized fish from Indonesia differs from co-occurring small-sized fish in several morphometric characters. Small-sized fish of the NE Australian population differ from the other populations in having a higher eighth ray on the second dorsal fin. This difference applies also for the large-sized fish of the NE Australian population when compared with similar-sized specimens from Vietnam. The values for the geographically intermediate population from Indonesia largely overlap with those of the two other populations.

Discussion

This study highlights a goatfish species that to date has been poorly known and/or viewed as rare, having a much wider distribution and of more frequent occurrence than previously assumed. We report new records of *Parupeneus jansenii* for Vietnam, southern Indonesia (SE Indian Ocean), and NE Australia (Queensland), as well as the first verified record of this species for Australia. Earlier occurrence reports from the Australian Northern Territory (Wei *et al.* 1972) and from New Guinea (Munro 1958) have remained unverified.

Most of the specimens of *Parupeneus jansenii* studied (22 of 29 specimens) derive from collections made at fish markets and landing sites in south-central Vietnam and southern Indonesia during the last ten years, and from several trawling stations in the areas of the Torres Strait and Great Barrier Reef, NE Australia during a fairly recently conducted research cruise (Pitcher *et al.* 2007). Hence, one can assume that this species is not uncommon, but may have been misidentified or overlooked. Evidence for wrong or incomplete identification comes from labels attached to lots of specimens reading e.g. "*Parupeneus* sp." or "*Parupeneus heptacanthus*". In a recently published book featuring short diagnoses and colour photographs of market fishes of Indonesia (White *et al.* 2013) the specimen of *P. jansenii* from southern Bali (CSIRO H 5972-19, Figure 3C) has been wrongly referred to as *Mulloidichthys pfluegeri* (Steindachner, 1900). Another identification error has been discovered by Randall (2004) who stated that "the record of *P. jansenii* from the Seychelles by Randall and van Egmond (1994) is based on a misidentification of juvenile specimens of *P. heptacanthus*.". During later examinations, however, these specimens turned out to belong to *P. minys*, described by Randall and Heemstra (2009).

Misidentifications may happen especially when similar species cannot be sufficiently well distinguished based on available diagnostic information and identification keys. Table 4 provides a direct comparison of quantitative character data obtained in the current study with those listed in the diagnoses for *Parupeneus jansenii* and *P. heptacanthus* by Randall (2004). The two data sets largely overlap for individual characters and species (thus confirming consistency among authors) and both reveal clear interspecific differences in body depth and barbel length. They disagree however regarding pectoral-fin length which does not allow species distinction with our data set, possibly as a result of the larger number of specimens, wider size range, and more populations studied by us. On the other hand, many of the characters we studied that show high diagnostic value for correct identification of *P. jansenii* were not listed in earlier taxonomic studies (e.g., Randall 2004, Allen & Erdman 2012). For example, caudal-peduncle depth is introduced as a diagnostic character in this study, because it allows clear distinction of *P. jansenii* from *P. heptacanthus* if expressed as a ratio of head length (Table 4), or as a proportion of SL (Table 2).

TABLE 4. Quantitative morphological characters expressed as ratios resulting from the present study (size classes merged for comparability) and from Randall (2004). Ranges of ratios are rounded to the nearest 0.05. Data of *Parupeneus heptacanthus* showing differences from *P. jansenii* are emphasized in bold italics.

	Parupeneus jansenii						*P. heptacanthus*					
	Present study				Randall (2004)		Present study				Randall (2004)	
	Min	Mean	Max	*n*	Min	Max	Min	Mean	Max	*n*	Min	Max
SL (mm)	68	119.9	159	29	77	153	59	142.6	193	53	60	257
Ratio of SL												
Body depth at first dorsal-fin origin	3.80	4.07	4.55	29	3.60	4.20	*2.85*	*3.28*	*3.60*	53	*2.95*	*3.55*
Head length	2.95	3.08	3.20	29	2.85	3.10	2.95	3.11	3.30	53	2.90	3.25
Ratio of head length												
Caudal peduncle depth *	3.55	3.81	4.10	29	-	-	*2.60*	*2.91*	*3.25*	53	-	-
Snout length	2.00	2.22	2.60	29	1.85	2.30	1.95	2.12	2.55	53	1.75	2.10
Barbel length	1.30	1.44	1.55	29	1.35	1.50	*1.10*	*1.21*	*1.30*	52	*1.15*	*1.35*
Pelvic-fin length	1.40	1.54	1.65	29	1.50	1.70	1.30	1.37	1.50	52	1.40	1.60
Pectoral-fin length	1.30	1.44	1.55	29	1.45	1.65	1.15	1.28	1.45	53	*1.25*	*1.40*
Height of third dorsal-fin spine **	1.45	1.66	1.90	28	1.65	2.00	1.35	1.50	1.70	52	1.45	1.75
Ratio of height of ninth dorsal-fin ray												
Height of eighth dorsal-fin ray	0.90	1.07	1.25	28	1.05	1.15	1.00	1.12	1.25	50	1.05	1.25
Meristic characters	14	15.3	16	29	15	16	15	15.8	17	53	15	16
Pectoral-fin rays	14	15.3	16	29	15	16	15	15.8	17	53	15	16
Gill rakers on upper limb	6	6.3	7	29	6	7	5	6.0	7	49	6	7
Gill rakers on lower limb	20	21.3	23	29	20	22	20	21.5	23	50	21	23
Total gill rakers	26	27.6	29	29	26	29	26	27.5	29	49	27	30
Lateral-line scales	27	27.0	27	25	27	27	27	27.2	28	52	27	27

* Character not included in Randall (2004)
** Longest dorsal-fin spine in Randall (2004)

Using colour pattern for the diagnosis of the *Parupeneus* species compared in this study, considerable caution is required, as colour in fresh fish is highly variable, insufficiently documented, or not yet known at all, as for *P. angulatus* (Randall & Heemstra 2009; Randall & King 2009). As we show, body and head colour vary considerably with freshness status, and also with size, in both *P. jansenii* and *P. heptacanthus*. While freshly caught or landed specimens (Figure 3 A, E; Figure 4) are often pale pink to orange-yellowish at flanks of body and at the head below eyes and show one or two yellow lateral body stripes (more evident in smaller fish), less fresh fish—as they may be offered at fish markets—may turn entirely into vermillion (Figure 3 B–D; F–H). This can be documented by photographing specimens in different freshness status (Figure 3E, F). The most reliable (and possibly the only) colour character that clearly distinguishes the two species is the small dark red or reddish-brown spot on or just below the eighth lateral-line scale. This spot has been encountered in all examined photographs of large- and small-sized *P. heptacanthus* with varying degrees of freshness (Figure 3 E–H, Figure 4 C; and personal observations by the authors). This colour character is however lost with preservation. Preserved fishes of all seven species of the *heptacanthus* group as well as *P. angulatus* have pale to pale grey or pale brown bodies and heads.

An important goal of this study has been to consider size- and population-related variation in quantitative morphological characters, similar to recent approaches featuring the taxonomy of the genus *Upeneus* (Uiblein & Gledhill 2015, Uiblein *et al.* 2016, 2017). Detection of allometric changes in body-form characters has relevancy beyond taxonomy, as it may assist to reveal important ontogenetic shifts in overall biology. For instance, the size-related changes in head form in *P. jansenii* with a larger forehead (deeper suborbital and maxilla, longer snout) may reflect ontogenetic changes in foraging behavior towards selection of larger prey with the onset of sexual maturity. Species of the genus *Parupeneus* have been documented to undergo considerable changes in life history, behavioural ecology, and resource use with increasing size and age (e.g. Uiblein 1991, 2007).

A rather weak indicator of population differences in *P. jansenii* was found in a single morphometric character: the eighth dorsal-fin ray, which is higher in the Australian population than in the Vietnam population, the values of both populations closely overlap with those of the intermediate Indonesian population (Figure 1, Table 2). Phenotypic diversification among allopatric populations depends on several factors including gene flow and plasticity (Uiblein *et al.* 1998). Based on our results, follow-up studies could be conducted to test the hypothesis that gene flow among the three populations of *P. jansenii* is considerable, as suggested by the low phenotypic geographical diversity. In this context, it may be worthwhile to compare the degree of phenotypic and genetic diversification among *P. jansenii* with the much wider ranging *P. heptacanthus*, involving populations from the entire distributional range.

Comparative material examined

Parupeneus angulatus: SAIAB 82215, holotype, 140 mm SL, Seychelles Bank, SW Denis Island, 03°54' S 55°49' E, 57 m depth.
Parupeneus fraserorum: SAIAB 81386, paratype, 150 mm SL, South Africa, Kwa-Zulu Natal, reef off Pumula (near Hibberdene), 30°38.1' S, 30°33.6' E, 39 m depth.
Parupeneus minys: MNHN 2008-2473, paratype, 104 mm SL, India, Kerala, Vizhinjam, fishing habour.
Parupeneus nansen: SAIAB 81380, holotype, 122 mm SL, Mozambique, 24°33.7' S 35°15.6' E, 50–51 m depth.
Parupeneus procerigena: AMS I.40281-001, paratype, 156 mm SL, Mascarene Plateau, Saya de Malha Bank. 10°43' S, 61°19' E, 120 m depth.
Parupeneus seychellensis: SAIAB 32, holotype, 195 mm SL, Seychelles, Mahé, fish market.

Acknowledgements

We thank the following colleagues for hospitality and assistance during collection visits or for providing other collection-related favors: Mark McGrouther, Amanda Hay and Sally Reader (AMS); Alastair Graham, William T. White, Carlie Devine, Peter Last, and John Pogonoski (CSIRO); Nguyen Khac Bat, Fisheries Research Institute, Hai Phong, Vietnam; Le Hung Anh, Institute of Ecology and Biological Resources (IEBR), Vietnam Academy of Science and Technology, Hanoi; Rupert Wienerroither (HIFIRE); Philippe Béarez, Romain Causse, and Patric Pruvost (MNHN), Dimitri A. Pavlov (Moscow State University and Russian-Vietnamese Tropical Center); Fahmi, Inayat Al Hakim, Wanwan Kurniawan and Selvia Oktaviyani (NCIP); Gavin Dally and Michael Hammer (NTM); Nkosinathi Mazungula, Roger Bills, Bafo Konobe and the SAIAB National Fish Collection staff; Elaine Heemstra (SAIAB); Farnis Boneka, University of Sam Ratulangi (UNSRAT), Manado, Indonesia; and Nguyen Thien Tao and Pham Hong Thai (VNMN). Numerous specimens of *Parupeneus heptacanthus* and *P. jansenii* were collected during an extensive scientific project undertaken in the Torres Strait (Pitcher *et al.* 2007) and hence we thank the crew of the FRV Gwendoline May for assistance and support. For providing photographs of fresh fish we thank Dimitri A. Pavlov and William T. White. The first author (FU) thanks John E. Randall, Bishop Museum, Honolulu, USA for providing raw data from his earlier examination of the holotype of *Parupeneus cinnabarinus*. Furthermore, we thank an anonymous reviewer and Wouter Holleman for helping to improve the ms. FU thanks also CSIRO Hobart, Australia, the Nansen Programme of the Center for Developmental Fisheries at the Institute of Marine Research (IMR), Bergen, Norway, the Russian-Vietnamese Tropical Research and Technological Center (Nha Trang, Vietnam), SAIAB, and VNMN for travel support and/or logistic support during research stays.

References

Allen, G.R. & Erdmann, M.V. (2012) *Reef fishes of the East Indies*. *Vols. I–III*. Tropical Reef Research, Perth, 1292 pp.
Bleeker, P. (1875) Révision des espèces insulindiennes de la famille des Mulloïdes. *Verhandelingen der Koninklijke Akademie van Wetenschappen te Amsterdam*, 15, 1–40.
Bleeker, P. (1877–78) *Atlas Ichthyologique des Indes Orientales Néêrlandaises. Vol. 9*. Frédéric Muller, editeur, Amsterdam, 80 pp.
Fricke, R. & Eschmeyer, W.N. (2017) Guide to fish collections. Available from: http://researcharchive.calacademy.org/research/ichthyology/catalog/collections.asp (accessed 11 July 2017)

Kim, B.-J. & Amaoka, K. (2001) A new species, *Parupeneus procerigena*, from the Saya de Malha Bank in the western Indian Ocean (Perciformes: Mullidae). *Ichthyological Research*, 48, 48–50.
https://doi.org/10.1007/s10228-001-8115-8

Larson, H.K., Williams, R.S. & Hammer M.P. (2013) An annotated checklist of the fishes of the Northern Territory, Australia. *Zootaxa*, 3696 (1), 001–293.

Mehanna, S.F., Usama, M.M. & Hassanien, E.M. (2016) First occurrence of the Red Sea goatfish, *Parupeneus forsskali* (Fourmanoir & Guézé, 1976) in the coastal waters of Egyptian Mediterranean Sea. *International Journal of Fisheries and Aquaculture*, 8 (9), 94–97.
https://doi.org/10.5897/IJFA2016.0556

Munro, I.S.R. (1958) The fishes of the New Guinea region. A check- list of the fishes of New Guinea incorporating records of species collected by the Fisheries Survey Vessel "Fairwind" during the years 1948–1950. *Fishery Bulletin of Papua*, 1, 1–16.

Pitcher, R., Haywood, M., Hooper, J., Coles, R., Bartlett, C., Browne, M., Cannard, T., Carini, G., Carter, A., Cheers, S., Chetwynd, D., Cook, S., Davie, P., Ellis, N., Fellegara, I., Forcey, K., Furey, M., Gledhill, D., Hendriks, P., Jacobsen, I., Johnson, J., Jones, M., Last, P., Marks, S., McLeod, I., Sheils, J., Sheppard, J., Smith, G., Strickland, C., Van der Geest, C., Venables, B., Wassenberg, T. & Yearsley, G. (2007) *Mapping and Characterisation of Key Biotic & Physical Attributes of the Torres Strait Ecosystem*. *CSIRO/ QM/QDPI CRC Torres Strait Task Final Report*. CSIRO Marine & Atmospheric Research, Brisbane, 145 pp.

Randall, J.E. (2004) *Revision of the goatfish genus Parupeneus (Perciformes: Mullidae), with descriptions of two new species*. *Indo-Pacific Fishes*, 36, 1–64.

Randall, J.E. & Heemstra, E. (2009) Three new goatfishes of the genus *Parupeneus* from the Western Indian Ocean, with resurrection of *P. seychellensis. Smithiana Bulletin*, 10, 37–50.

Randall, J.E. & King, D.R. (2009) *Parupeneus fraserorum*, a new species of goatfish (Perciformes: Mullidae) from South Africa and Madagascar. *Smithiana Bulletin*, 10, 23–29.

Randall, J.E. & van Egmond, J. (1994) Marine fishes from the Seychelles: 108 new records. *Zoologische Verhandelingen Leiden*, 297, 43–83.

Uiblein F. (1991) Ontogenetic shifts in resource use and shoaling tendency related to body size in Red Sea goatfish (*Parupeneus forsskali,* Mullidae). *Marine Ecology*, 12, 153–161.
https://doi.org/10.1111/j.1439-0485.1991.tb00249.x

Uiblein, F. (2007) Goatfishes (Mullidae) as indicators in tropical and temperate coastal habitat monitoring and management. *Marine Biology Research*, 3, 275–288.
https://doi.org/10.1080/17451000701687129

Uiblein, F. & Gledhill, D.C. (2015) A new goatfish of the genus *Upeneus* (Mullidae) from Australia and Vanuatu, with inter- and intraspecific comparisons. *Marine Biology Research*, 11, 475–491.
https://doi.org/10.1080/17451000.2014.958088

Uiblein, F., Gledhill, D.C., Peristiwady, T. (2017) Two new goatfishes of the genus *Upeneus* (Mullidae) from Australia and Indonesia. *Zootaxa*, 4318 (2), 295–311.
https://doi.org/10.11646/zootaxa.4318.2.4

Uiblein, F., Gouws, G., Gledhill, D.C. & Stone, K. (2016) Just off the beach: intrageneric distinctiveness of the bandtail goatfish *Upeneus taeniopterus* (Mullidae) based on a comprehensive alpha taxonomy and barcoding approach. *Marine Biology Research*, 12, 675–694.
https://doi.org/10.1080/17451000.2016.1190458

Uiblein, F., Köhler, C. & Tian, M.C. (1998) Quantitative examination of morphological variability among goatfishes of the genus *Upeneus* from the Malayan Province (Pisces: Perciformes: Mullidae). *Senckenbergiana Maritima*, 28, 123–132.
https://doi.org/10.1007/BF03043143

White, W.T., Last, P.R., Dharmadi, Faizah, R., Chodrijah, U., Prisantoso, B.I., Pogonoski, J.J., Puckridge, M. & Blaber, S.J.M. (2013) *Market Fishes of Indonesia. ACIAR Monograph No. 155*. Australian Centre for International Agricultural Research, Canberra, 438 pp.

Wei, S.-F., Chi, T.-S. & Chen, T.-S. (1972) *The investigation of bottom trawl grounds in the Arafura Sea. Fisheries Survey No. 37*. Taiwan Fisheries Research Institute, Keelung, 48 pp.