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A new species of *Pseudojuloides* (Perciformes: Labridae) from the south-western Indian Ocean

ALLAN D. CONNELL

*South African Institute for Aquatic Biodiversity, Private Bag 1015,
Grahamstown, 6140 South Africa. E-mail:alconnelli@gmail.com*

BENJAMIN C. VICTOR

*Ocean Science Foundation, 4051 Glenwood, Irvine, CA 92604
and Guy Harvey Research Institute, Nova Southeastern University,
8000 North Ocean Drive, Dania Beach, FL 33004. E-mail:ben@coralreeffish.com*

JOHN E. RANDALL

*Bishop Museum, 1525 Bernice St., Honolulu, HI 96817-2704 USA.
E-mail:jackr@hawaii.rr.com*

Abstract

The new species *Pseudojuloides polackorum* is described from seven specimens collected off the east coast of South Africa and from near Mombasa, Kenya. The species closely resembles the widespread Indo-Pacific congener *P. cerasinus* Snyder 1904 and replaces it along the continental south-western Indian Ocean, including Madagascar. The new species is distinguished from *P. cerasinus* by the absence of a blue stripe behind the eye, a salmon-tinged lower half of the head, a wider orange band along the body (vs. narrower and yellow), and a narrower blue lateral stripe along the body above the band with linear projections into the band. In addition to the color differences, there is a 9.48% divergence in the barcode DNA sequence COI from *P. cerasinus* from Hawaii, the type location of the species (minimum interspecific distance by K2P; 8.74% divergence pairwise).

Key words: new species, taxonomy, systematics, phylogeography, wrasses, mtDNA, barcoding, coral reef fishes.

Introduction

The labrid genus *Pseudojuloides* Fowler was revised by Randall & Randall (1981), who recognized eight species, including five new species. Three additional species were described since then: *Pseudojuloides kaleidos* by Kuitert & Randall (1995) from the Maldives and Indonesia, *Pseudojuloides severnsi* by Bellwood & Randall (2000), from the Maldives to the western Pacific and *Pseudojuloides edwardi* Victor & Randall 2014, from Kenya. The genus comprises a group of small fast-swimming wrasses, typically found on deeper slopes and in

habitats dominated by rubble rather than live coral. They are distinguished morphologically by having chisel-like incisiform side teeth (unusual among the labrids) and torpedo-shaped fusiform bodies with relatively large scales. Recent extensive surveys of the fishes off the east coast of South Africa revealed a new member of the genus described here. After the initial discovery, additional specimens were found in the aquarium trade originating from near Mombasa, Kenya. Photographs and specimens from Madagascar match the appearance of the new African species. The related population from Mauritius, however, have a different marking pattern and have been described as *Pseudojuloides xanthomos* Randall & Randall 1981.

The description of the new species includes sequencing of the COI mtDNA gene used in the Fish Barcode of Life project (Ward *et al.* 2009). Most recent studies have found that the majority of marine fish species are characterized by monophyletic mitochondrial lineages well separated from related species, in most cases by more than 2% (Steinke *et al.* 2009, Ward *et al.* 2009). In this case, the new species diverges from the type population of *P. cerasinus* from Hawaii by almost 10%, greater than the divergence among many genera of reef fishes.

Materials and Methods

Specimens have been examined from the Bernice P. Bishop Museum, Honolulu (BPBM). Underwater photographs were taken in South Africa and Madagascar. Specimens from Madagascar matched the appearance of the new species but were not considered type specimens since no DNA sequences were available for comparison.

DNA extractions were performed with the NucleoSpin96 (Machery-Nagel) kit according to manufacturer specifications under automation with a Biomek NX liquid-handling station (Beckman-Coulter) equipped with a filtration manifold. A 652-bp segment was amplified from the 5' region of the mitochondrial COI gene using a variety of primers (Ivanova *et al.* 2007). PCR amplifications were performed in 12.5 μ l volume including 6.25 μ l of 10% trehalose, 2 μ l of ultra pure water, 1.25 μ l of 10 \times PCR buffer (10mM KCl, 10mM (NH₄)₂SO₄, 20mM Tris-HCl (pH8.8), 2mM MgSO₄, 0.1% Triton X-100), 0.625 μ l of MgCl₂ (50mM), 0.125 μ l of each primer (0.01mM), 0.0625 μ l of each dNTP (10mM), 0.0625 μ l of *Taq* DNA polymerase (New England Biolabs), and 2 μ l of template DNA. The PCR conditions consisted of 94°C for 2 min., 35 cycles of 94°C for 30 sec., 52°C for 40 sec., and 72°C for 1 min., with a final extension at 72°C for 10 min. Specimen information and barcode sequence data from this study were compiled using the Barcode of Life Data Systems (Ratnasingham & Hebert 2007). The sequence data is publicly accessible on BOLD and GenBank. Sequence divergence was calculated using BOLD with the Kimura 2-parameter (K2P) model generating a mid-point rooted neighbor-joining (NJ) phenogram to provide a graphic representation of the species divergence (pairwise distances are also calculated for comparison).

The length of specimens is given as standard length (SL), measured from the median anterior end of the upper lip to the base of the caudal fin (posterior end of the hypural plate); body depth is the greatest depth from the base of the dorsal spines to the ventral edge of the abdomen (correcting for any malformation of preservation); body width is measured just posterior to the gill opening; head length from the front of the upper lip or anterior upper teeth (whichever is most anterior) to the posterior end of the opercular flap; orbit diameter is the greatest fleshy diameter of the orbital rim, and interorbital width the least bony width; snout length is measured from the median anterior point of the upper lip to the nearest fleshy rim of the orbit; caudal-peduncle depth is the least depth, and caudal-peduncle length the horizontal distance between verticals at the rear base of the anal fin and the caudal-fin base; predorsal, prepelvic and preanal lengths are angular measurements; lengths of spines and rays are measured to their extreme bases; caudal-fin and pectoral-fin lengths are the length of the longest ray; pelvic-fin length is measured from the base of the pelvic spine to the tip of the longest soft ray. Morphometric data are presented as percentages of the standard length. Proportional measurements in the text are rounded to the nearest 0.05.

The upper rudimentary pectoral ray is included in the count. Lateral-line scale counts include the last pored scale that overlaps the end of the hypural plate; scales above the lateral line are counted in an oblique row from the first pored scale to the origin of the dorsal fins, and scales below the lateral line in an oblique row from the anal fin origin rearward, not including very small scales that may be present at base of fins; median predorsal scale counts are only approximate counts because these scales are not in a regular series. The count of gill rakers is made on the first gill arch and includes all rudiments. The range of counts and measurements for the paratypes are shown in parentheses following data for the holotype.



Figure 1. *Pseudojuloides polackorum*, BPBM 41207, holotype, 64 mm SL TP male, Mombasa, Kenya (B.C. Victor).

***Pseudojuloides polackorum*, n. sp.**

Pseudojuloides cerasinus (non Snyder) Gomon in Fischer & Bianchi 1984: 10 (WIO fish list); Randall in Smith & Heemstra 1986: 701 (Sodwana Bay, KwaZulu-Natal, South Africa).

Figures 1–5; Table 1.

Holotype. BPBM 41207, 64 mm SL, male, Mombasa region, Kenya, aquarium-trade collectors, March 1, 2014.

Paratypes. BPBM 41208, 68.5 mm SL, male, Mombasa region, Kenya, aquarium-trade collectors, March 1, 2013; BPBM 27354, 69 mm SL TP male, Sodwana Bay, KwaZulu-Natal, South Africa, 27 m, J. Randall, G. Allen, P. Heemstra & M. Smale, April 23, 1979; BPBM 41153 (4), 62 and 57 mm SL males, 45 and 52.5 mm SL females, Sodwana Bay, KwaZulu-Natal, South Africa, A.D. Connell, May 24, 2013.

Diagnosis. Dorsal rays IX,11; anal rays III,12; pectoral rays 13; lateral-line scales 27 (+1 on tail); no scales on head; gill rakers 15–18; a single pair of large, projecting, and slightly recurved canine teeth anteriorly in each jaw, the upper pair slightly out-flaring, the lowers curving forward and fitting between uppers when mouth closed; a short irregular row of 4–7 chisel-like incisiform teeth on each side of upper and lower jaws, no canine posteriorly at corner of mouth; elongate body, body depth 3.9–4.4 in SL; moderately compressed, body width 1.8–2.3 in depth; caudal fin truncate; initial phase (IP) reddish orange to pink, with yellow tint, particularly on median fins



Figure 2. *Pseudojuloides polackorum*, BPBM 27354, paratype, 69 mm SL TP male, Sodwana Bay, KwaZulu-Natal, South Africa (J.E. Randall).



Figure 3. *Pseudojuloides polackorum*, large IP female, Sodwana Bay, KwaZulu-Natal, South Africa (D. Polack)

and upper part of head, and grading to lighter or white ventrally on head and abdomen, and a dark midline spot on snout before upper jaw; terminal-phase (TP) male in life with green body, lighter ventrally, with a wide orange lateral midline band bounded above by a narrow blue line, often broken, with linear extensions of blue extending into orange band, upper half of head yellowish-green and lower half salmon pink, separated by a narrow blue line, iris yellow, dorsal and anal fins usually with basal and distal blue bands, caudal fin with broad black distal bar, outlined anteriorly and at distal edge by narrow blue lines.

Description. Dorsal rays IX,II; anal rays III,12, all soft dorsal and anal segmented rays branched, last split to base; pectoral rays 13, the first rudimentary, the second unbranched; pelvic rays I,5; principal caudal rays 14, the upper and lower unbranched; upper and lower procurent caudal rays 6 or 7 (usually 6); pored lateral-line scales 27 (+1 on caudal-fin base); scales above lateral line to origin of dorsal fin 4 (3–4); scales below lateral line to origin of anal fin 8; median predorsal scales about 7–9; gill rakers 15–18.

Body elongate, the depth 4.2 (3.9–4.4) in SL, and moderately compressed, the width 1.8 (1.9–2.3) in depth; head length 3.0 (3.0–3.2) in SL; dorsal profile of head nearly straight on snout, forming low angle of about 20° to horizontal axis of body, and slightly convex on nape; snout sharply pointed, its length 3.4 (2.8–3.4) in head length; orbit relatively small, diameter 5.3 (4.2–5.8) in head length; interorbital space broadly convex, the least bony width 5.7 (5.3–6.5) in head length; caudal peduncle least depth 2.8 (2.5–3.0) in head length, caudal-peduncle length 3.3 (2.9–3.9) in head length.

Mouth very small, terminal, the corner of gape with closed jaws well anterior to anterior nostril; end of maxilla buried, even when jaws gape. Lips moderately thick, the upper puffed with striations along the underside, the lower lip with prominent ventral-projecting flap along side of jaw. A pair of large, moderately projecting, and slightly recurved canine teeth anteriorly in each jaw, the upper pair slightly out-flaring, the lowers curving forward and fitting between uppers when mouth closed; a short row of 4–7 irregularly placed chisel-like incisiform teeth along each side of upper and lower jaw; no canine tooth posteriorly on upper jaw. Upper preopercular margin free nearly to level of lower edge of orbit; lower margin free anterior to a vertical through anterior nostril. Gill rakers short, the longest on first arch (at angle) about one-fifth to one-tenth length of longest gill filament. Nostrils small, in front of upper edge of orbit, the anterior in a short membranous tube elevated posteriorly, the posterior in advance of a vertical through front of orbit by a distance slightly less than internarial space. Pores on lower half of head comprise one over rear maxilla, then two anterior to orbit, followed by a curving suborbital series (counting up to rear mid-eye level) numbering 5–7 in single series; preopercular pores in a curved series after start of free edge near mandible, numbering 10 or 11 along free margin of preopercle, plus 1 or 2 more up to rear mid-eye level, in a single series at distal tips of canals.

Scales thin and cycloid; scales on side of thorax less than half as high as largest scales on side of body, becoming still smaller ventroanteriorly; head naked except for small partially embedded scales on nape in irregular rows; median predorsal scales extending forward to slightly posterior to a vertical through upper free end of preopercular margin; fins naked except for several progressively smaller scales on basal region of caudal fin and mid-ventral scale projecting posteriorly from base of pelvic fins. Lateral line continuous, nearly following

contour of back to 18th pored scale, below base of eighth dorsal soft ray, where deflected sharply ventrally to straight peduncular portion, single small pore per scale, last pored scale on caudal-fin base. Origin of dorsal fin above anterior edge of second lateral-line scale; dorsal spines progressively longer, the first 4.7 (5.1–6.1) and the ninth 3.3 (3.0–3.6) in head; longest dorsal soft ray 2.7 (2.3–3.0) in head; origin of anal fin below base of last dorsal spine; first anal spine very short, 15.0 (11.9–15.1) in head; second anal spine 5.7 (4.9–6.2) in head; third anal spine 4.1 (3.6–4.2) in head; longest anal soft ray 2.9 (2.6–3.0) in head; caudal fin truncate, caudal-fin length 1.6 (1.6–1.8) in head; second or third pectoral-fin ray longest, 1.9 (1.8–1.9) in head; pelvic fins short, 2.1 (1.8–2.1) in head.

Color in life. (Figs. 1–5) Terminal-phase males with yellowish green to emerald green body, lighter ventrally, with a wide orange lateral midline band starting well after pectoral-fin base (below about fifth dorsal-fin spine base); band bounded above by an irregular narrow blue line, usually broken from one scale to next, with short linear extensions of blue onto individual scales within orange band; upper half of head uniform yellowish-green and lower half salmon pink grading ventrally to light green or white, separated by a narrow blue line; iris yellow; dorsal and anal fins yellow-green usually with basal and distal blue bands, caudal fin basally yellow-green with central pattern of blue spots or short stripe, followed by a blue bar and then a broad black distal bar with narrow blue line at edge of fin membrane. Initial-phase females reddish orange to pink, with yellow tint, particularly on median fins and upper part of head, grading to lighter or white ventrally on head and abdomen; a dark midline spot on snout before upper jaw; iris yellow.

Color in alcohol. Females uniform pale yellowish brown, males yellowish brown with pale lateral midline band and dark bar distally on caudal fin.

Etymology. This species is named for Dennis and Sally Polack, whose underwater photographs first brought this species to our attention. The specific epithet is a noun in the genitive case (plural).

Distribution. The new species is found on the continental African coast from at least Sodwana Bay in Kwa-Zulu-Natal, South Africa up to the Kenyan coastline. Photographs from Madagascar (Fig. 4) indicate that the



Figure 4. *Pseudojuloides polackorum*, Madagascar; **top:** TP male; **bottom:** IP female (G.R. Allen).

TABLE 1

Proportional measurements of type specimens of *Pseudojuloides polackorum*
as percentages of the standard length

	holotype			paratypes			
	BPBM	BPBM	BPBM	BPBM			
	41207	41208	27354	41153			
	TP	TP	TP	TP	TP	IP	IP
Standard length (mm)	64.0	68.5	62.0	57.0	69.0	52.5	45.0
Body depth	23.8	23.1	24.0	23.5	25.4	22.9	23.1
Body width	13.1	12	12.1	11.1	12.8	11.6	10.2
Head length	32.8	30.8	33.5	32.8	31.3	32.6	31.8
Snout length	9.7	10.2	11.8	10.4	10.0	9.9	9.3
Orbit diameter	7.2	6.9	7.1	7.0	7.0	7.8	8.0
Interorbital width	5.8	5.5	5.6	6.1	5.5	5.7	4.9
Caudal-peduncle depth	11.7	11.5	11.3	11.1	12.5	12.0	10.4
Caudal-peduncle length	10.0	10.5	8.7	10.7	10.3	10.1	10.9
Predorsal length	32.2	30.5	32.7	33.7	31.6	31.8	32.7
Preanal length	54.2	55.5	57.9	56.7	54.3	60.4	59.1
Prepelvic length	37.0	35	37.1	34.7	35.2	36.8	35.6
Base of dorsal fin	58.4	55.8	53.7	52.5	57.7	54.9	54.7
First dorsal spine	7.0	5.8	5.5	5.6	6.1	5.9	5.3
Ninth dorsal spine	9.8	10.2	9.4	10.0	8.7	10.5	10.7
Longest dorsal ray	12.0	12.1	11.3	11.8	11.2	13.9	13.6
Base of anal fin	36.1	34.9	37.6	36.5	36.1	33.5	34.7
First anal spine	2.2	2	2.3	2.3	2.2	2.5	2.7
Second anal spine	5.8	6.1	6.1	5.6	5.1	5.9	6.4
Third anal spine	8.0	8.6	8.4	7.9	7.4	7.8	8.7
Longest anal ray	11.3	11.5	12.1	11.1	10.7	11.2	12.2
Caudal-fin length	20.3	19	18.7	20.9	18.8	20.0	20.0
Pectoral-fin length	16.9	16.9	17.3	17.7	16.4	18.3	18.0
Pelvic-spine length	10.6	11.2	10.0	10.2	10.1	10.9	11.1
Pelvic-fin length	15.8	16.9	16.6	15.8	15.9	16.2	16.9

range extends to northern Madagascar. The new species does not apparently occur on the oceanic islands of the south-western Indian Ocean, where it is replaced by *P. xanthomos*.

Barcode DNA sequence. A 652-nucleotide sequence of the segment of the mitochondrial COI gene used for barcoding by the BOLD informatics database (Ratnasingham & Hebert 2007) was obtained for the holotype (GenBank accession number KP975967), one paratype BPBM41208 (KP975996), and three additional specimens (KP975998, KP975978 & KF489719), which all proved to be identical haplotypes. Following the database management recommendation of the BOLD, the sequence of the holotype is presented here as well:

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CCTTTATTTAGTATTCGGTGCCTGAGCCGGGATGGTGGGCACAGCCCTAAGCCTGCTCATTGAGCA  
GAACTAAGCCAACCCGGCGCTCTCCTCGGAGACGACCAAATTTATAACGTAATTGTTACCGCCCAC  
GCGTTCGTAATAATTTTCTTTATAGTAATACCAATTATGATCGGAGGTAATGATTGGAGCCCCGACA  
TGGCCTTCCCTCGAATGAACAACATGAGCTTCTGACTTCTCCCCCTTCCTTCTCCTACTCCTTGC  
CTCCTCAGGCGTAGAAGCAGGAGCCGGAACCGGTTGAACAGTCTACCCCCCTCTGGCAGGCAATC  
TCGC CCATGCAGGGGCCTCCGTAGACCTTACCATCTTTTCCCTACATTTGGCAGGTATTTTCATCAATT  
CTAGGGGCAATTAATTTTCATTACAACATCATTAAACATGAAACCTCCAGCTATCTCCAATACCAGAC  
ACCCCTCTTTGTCTGAGCCGTCCTAATCACGGCAGTCTTCTTCTTCTCTCCCTACCCGTCCTTGCAG  
CTGGCATTACTATGCTCTTAACAGACCGTAATCTTAACACTACCTTCTTCGATCCTGCCGGCGGAGGA  
GATCCTATTCTTTACCAACACTTA
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Figure 5. top: *Pseudajuloides polackorum*, TP male, Sodwana Bay, KwaZulu-Natal, South Africa (D. Polack); **bottom:** *Pseudajuloides cerasinus*, TP male, Pawai Bay, Hawaii, USA (B. Parda).

Comparisons. *Pseudojuloides polackorum* differs from *P. cerasinus* from the type location in Hawaii by a variety of markings (Fig. 5): by the absence of the prominent blue stripe on the snout in front of the eye and across the head behind the eye; a salmon-tinged lower half of the head (vs. blue-green); a wider orange band along the body (vs. narrower and yellow), starting well after the pectoral-fin base, under the fifth dorsal-fin spine insertion (vs. starting just after the pectoral-fin base, under the first or second dorsal-fin spine insertion); and a narrower blue lateral stripe above the orange band with linear blue projections into the band (vs. a wide blue line without ventral projections).

DNA Comparisons. The mtDNA barcode sequences (COI) of *Pseudojuloides polackorum* differ substantially from the corresponding barcode sequences for *P. cerasinus* from the type population in Hawaii (GenBank accession numbers JQ839570 & JQ839571). The genetic divergence calculated following the neighbor-joining Kimura two-parameter model (K2P) generated by BOLD (Barcode of Life Database) shows a 9.48% minimum interspecific distance (8.74% distance in a pairwise comparison). In contrast, intraspecific differences are minimal, with a 0.31% maximum intraspecific distance in the two sets of sequences (0.31% also pairwise).

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