Records of *Chelidoperca maculicauda* and *C. occipitalis* (Serranidae) from the Arabian Sea, with Comments on Diagnostic Characters

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Eight specimens of *Chelidoperca maculicauda* Bineesh and Akhilesh, 2013 from the Gulf of Aden and five of *C. occipitalis* Kotthaus, 1973 from the Gulf of Oman represent the first records of those species from the respective localities, and suggest a wide distribution of both along the Arabian Sea coast. *Chelidoperca maculicauda* was previously recorded only from its type locality on the southwest coast of India, and *C. occipitalis*, only from the west coast of India, Pakistan, and Socotra Island (Yemen; type locality), western Arabian Sea. The two are compared with all currently known congeners and their diagnostic characters are reviewed.

Key Words: fishes, ontogenetic change, morphology, diagnosis, distribution, Indian Ocean.

Introduction

The Indo-West Pacific serranid fish genus *Chelidoperca* Boulenger, 1895 comprises small, bottom-dwelling fishes usually collected in benthic trawls. The genus includes nine nominal species, all currently recognized as valid (Bineesh *et al.* 2013; Williams and Carpenter 2015; Matsunuma and Motomura 2016): *C. hirundinacea* (Valenciennes in Cuvier and Valenciennes, 1831), *C. pleurospilus* (Günther, 1880), *C. investigatoris* (Alcock, 1890), *C. margaritifera* Weber, 1913, *C. occipitalis* Kotthaus, 1973, *C. lecomi* Fourmanoir, 1982, *C. maculicauda* Bineesh and Akhilesh in Bineesh *et al.*, 2013, *C. santosi* Williams and Carpenter, 2015, and *C. stella* Matsunuma and Motomura, 2016. Among these, *C. maculicauda* was originally described by Bineesh *et al.* (2013) on the basis of three specimens collected off Kollam, southwest coast of India facing the eastern Arabian Sea, but has not been recorded since. *Chelidoperca occipitalis* was originally described by Kotthaus (1973) from a single specimen collected southwest of Socotra Island (Yemen), western Arabian Sea. The species was later re-described by Bineesh *et al.* (2014) on the basis of the holotype and 14 non-type specimens, also collected at Kollam.

During a study of *Chelidoperca* from the Indian Ocean, seven *C. maculicauda* and five *C. occipitalis*, collected from the Gulf of Aden and Gulf of Oman, respectively, were found in the collection of the National Museum of Natural History, Smithsonian Institution. They are described herein as the first specimen-based records of each species from the respective localities. The two species are compared with their congeners in detail.

Materials and Methods

Counts and measurements follow Williams and Carpenter (2015) and Matsunuma and Motomura (2016), with the following additions: upper caudal-peduncle length—the direct distance from the last dorsal-fin soft ray base to the mid-point of the caudal-fin base; and circumpeduncular scales—the total number of transverse scale rows around the narrowest portion of the caudal peduncle. The last two soft rays of the dorsal and anal fins were counted as single rays, each pair being associated with a single pterygiophore. The dorsal-most scale in the transverse row beneath the dorsal-fin spine base was much smaller than the lower adjacent scales (about half their size) and was counted as 0.5. Counts of preopercular, interopercular, subopercular, and posttemporal serrae follow Matsunuma and Motomura (2016). Counts and measurements were made on the left side wherever possible, except for counts of the pectoral-fin rays and head serrae (counted on both sides). Developed gill rakers include only those with a length greater than their basal width. Standard length is abbreviated as SL. The distribution map was prepared using Quantum GIS 2.2 (Quantum GIS Development Team 2014), with data from ETOPO1 (Amante and Eakins 2009). Institutional codes are abbreviated as follows: Central Marine Fisheries Research Institute, Cochin (CMFRI); University of the Philippines Visayas Museum of Natural Sciences Ichthyology Collection, Iloilo (UPVMI); Museum Support Center, Smithsonian Institution National Museum of Natural History, Suitland (USNM); and Zoologisches Institut und Zoologisches Museum, Universität Hamburg, Hamburg (ZMH).

Chelidoperca maculicauda Bineesh and Akhilesh
in Bineesh *et al.*, 2013

(Figs 1A, 2A, 3A–B, 4–6; Tables 1–2)

Chelidoperca maculicauda: Bineesh and Akhilesh in Bineesh *et al.* 2013: 71, figs 1–6 (type locality: off Kollam, Kerala, India); Bineesh *et al.* 2015: 104 (off Kollam, Kerala, India; molecular phylogenetic analysis based on type specimens).

Examined specimens. Eight specimens, 85.3–114.2 mm SL (all from Somalia, Gulf of Aden, western Arabian Sea): USNM 306446, 2 specimens, 103.9–114.2 mm SL, off Habo, 11°50'42"N, 50°22'12"E, 165–208 m depth, coll. G. Small, RV *Beinta*, cruise 19, station HAUL 27, bottom trawl, 17 February 1987; USNM 306448, 3 specimens, 85.3–91.3 mm SL, off Bosaso, 11°17'42"N, 48°57'24"E, 179 m depth, coll. G. Small and J. Small, RV *Beinta*, cruise 19, station HAUL 30, bottom trawl, 18 February 1987; USNM 306452, 3 specimens, 85.7–89.1 mm SL, off Habo, 11°43'42"N, 50°28'48"E, 160 m depth, coll. G. Small, RV *Beinta*, cruise 18, station HAUL 24, prawn trawl, 17 January 1987.

Diagnosis. A species of *Chelidoperca* distinguished from other members of the genus by the following combination of characters: pectoral-fin rays 14 or 15 (modally 15); pored lateral-line scales 42–44 (modally 44); scale rows between lateral line and sixth dorsal-fin spine base 3.5; total gill rakers including all rudiments 20–22 (modally 20); preopercular serrae 28–43; interopercular serrae 2–7; head length 40.6–43.3% (mean 41.9%) SL; postorbital length 22.6–23.6% (mean 23.2%) SL; upper caudal fin lobe expanded posteriorly with well-rounded contour; interorbital scales extending anteriorly well beyond center of orbit; scales on ventral surface of angular extending anteriorly onto dentary; 1 or 2 dark spots on upper lobe of caudal fin; longitudinal row of dark blotches laterally on body.

Description. Characters given in diagnosis not repeated; morphometric and meristic values given in Tables 1–2. Dorsal-fin rays X, 10; anal-fin rays III, 6; pelvic-fin rays I, 5.

Caudal fin truncate, upper lobe rounded, slightly expanded posteriorly; upper lobe with 2 unbranched and 8 branched segmented rays, lower lobe with 2 or 3 unbranched and 7 branched segmented rays, 19 or 20 (modally 20) total segmented rays. Scale rows above lateral line 4; cheek scale rows 6.

Body slightly elongated (Fig. 1A); snout pointed, dorsal profile of snout in lateral view forming angle of *ca.* 40° to horizontal axis of head and body; caudal peduncle relatively long. Orbit large, its dorsal margin included in dorsal contour of head. Mouth large, slightly oblique; posterior margin of maxilla extending beyond vertical through center of eye but not reaching vertical through posterior margin of orbit; maxilla expanded posteriorly, with low lateral ridge diverging posteriorly into two ridges in large specimens; lower jaw slightly protruding beyond upper jaw when mouth closed. Upper jaw with band of *ca.* 5 rows of small, pointed conical teeth, outermost row with 15–18 relatively large canines; cluster of 10–18 enlarged canines on each side of symphysis. Lower jaw with band of 1–3 rows of small, pointed conical teeth, outermost row with 9–18 enlarged canines, innermost row with 22–28 canines (shorter than outermost canines); vomer with blunt, V-shaped band of 2–3 rows of small, pointed conical teeth, and several large canines posteriorly; palatine with relatively long, broad band of 3–4 rows of small, pointed conical teeth (width of band 6.2–8.0% SL). Anterior nostril at middle of snout, with small rounded flap arising from posterior rim; posterior nostril an elliptical opening at anterior border of orbit. Opercle with 2 prominent flat spines, upper spine slightly longer than lower; angle formed by upper and lower spines *ca.* 40°; subopercular serrae 5–19; posttemporal with small bony crest bearing 2–6 spines at beginning of lateral line.

Body with ctenoid scales; lateral line slightly arched over pectoral fin before gradually descending, terminating at caudal-fin base. Uppermost row of body scales along dorsal-fin base always about half size of those in adjacent row (Fig. 2A). Small cycloid scales on caudal- and pectoral-fin bases, not extending onto fins; no scales on dorsal-, anal- and pel-

Table 1. Frequency of meristic values for selected characters recorded from specimens of *Chelidoperca maculicauda* and *C. occipitalis* from the Arabian Sea.

	Pectoral-fin rays ¹			Pored LL scales			SR in longitudinal series				SR below LL												
	14/15	15/15	15/16	42	43	44	43	44	45	46	10	11	12										
<i>C. maculicauda</i>	1	7		1	1	4			3	4	1	4	1										
<i>C. occipitalis</i>	1	3	2	1	2		1	3	1			3											
	Circumpeduncular scales			Pre-dorsal-fin SR				Upper gill rakers ²				Lower gill rakers ²											
	18			19			7	8	9	10	5	6	7	8	11	12	13	14	15				
<i>C. maculicauda</i>	4			3				2	2	1		2	5	1			2	5	1				
<i>C. occipitalis</i>	3			1			1	2	1		1	5			3	2	1						
	Total gill rakers ²							Upper developed gill rakers			Lower developed gill rakers			Total developed gill rakers									
	16	17	18	19	20	21	22	2		3		8		9		10		10		11		12	
<i>C. maculicauda</i>										5		2		1		8				4		4	
<i>C. occipitalis</i>	1	2	2	1				5		1		4		2				3		1		1	

DSB: dorsal-fin spine base, LL: lateral line, SR: scale rows. ¹Both sides, ²Including rudiments.

Table 2. Morphometric ranges, expressed as percentages of standard length, for selected features recorded from specimens of *Chelidoperca maculicauda* and *C. occipitalis* from the Arabian Sea.

Standard length (mm)	<i>C. maculicauda</i> <i>n</i> =8		<i>C. occipitalis</i> <i>n</i> =6	
	85.3–114.2	Mean	65.9–89.9	Mean
Body depth	22.9–27.9	25.4	22.7–27.5	24.2
Body depth at anal-fin origin	21.5–23.3	22.5	20.3–22.9	21.3
Body width	18.1–20.2	19.1	16.5–20.9	18.1
Head length	40.6–43.3	41.9	41.3–43.2	42.2
Head width	12.4–15.2	13.9	11.9–14.1	13.2
Snout length	7.3–8.2	7.7	7.4–9.4	8.4
Orbit diameter	11.7–13.1	12.7	11.5–12.6	11.8
Interorbital width	3.0–3.7	3.4	2.3–2.7	2.5
Internasal width	5.7–6.5	6.0	5.8–6.3	6.0
Upper-jaw length	17.4–18.8	18.2	17.4–19.3	18.3
Lower-jaw length	18.9–20.7	19.4	18.4–20.3	19.4
Maxillary depth	4.8–5.7	5.3	4.3–4.8	4.6
Postorbital length	22.6–23.6	23.2	22.3–23.6	23.0
Suborbital depth	0.9–2.8	1.8	1.3–1.8	1.6
Inter-opercular-spine width	5.1–6.1	5.5	4.4–4.9	4.7
Pre-dorsal-fin length	37.2–39.0	38.3	35.1–39.2	37.6
Pre-anal-fin length	63.5–66.9	65.3	61.2–66.6	63.8
Pre-pelvic-fin length	34.0–38.3	35.7	33.7–36.4	35.3
1st DS length	4.4–6.1	5.4	5.5–6.8	6.0
2nd DS length	8.1–10.5	9.6	9.0–11.0	9.7
3rd DS length	13.8–15.5	14.8	12.7–15.1	13.8
4th DS length	15.4–17.3	16.2	15.3–16.5	16.0
5th DS length	14.2–15.9	15.0	14.5–16.2	15.2
6th DS length	12.5–14.0	13.2	13.0–14.5	13.6
7th DS length	10.4–11.5	11.1	11.1–12.9	11.8
8th DS length	8.2–9.6	9.0	9.3–10.8	9.9
9th DS length	7.7–8.6	8.2	8.4–9.7	9.1
10th DS length	9.8–10.9	10.4	9.8–10.8	10.3
1st D soft ray length	14.6–15.8	15.3	13.3–15.6	14.9
5th D soft ray length	17.2–18.7	18.0	16.3–17.2	16.8
Penultimate D soft ray length	18.6–21.6	19.7	18.1–20.8	19.4
Longest D soft ray length	19.1–21.6	20.0	18.1–20.8	19.4
1st AS length	4.2–5.3	4.8	4.9–5.5	5.1
2nd AS length	6.5–8.4	7.6	8.0–8.9	8.4
3rd AS length	10.3–11.7	10.9	9.5–10.3	9.8
1st A soft ray length	13.2–16.1	15.0	14.0–15.0	14.5
3rd A soft ray length	17.0–19.6	18.1	16.2–16.6	16.4
Penultimate A soft ray length	20.7–23.9	21.9	17.7–19.2	18.3
Longest A soft ray length	20.7–23.9	21.9	17.7–19.2	18.3
P1 length	26.0–28.8	27.5	26.1–26.9	26.5
P2 spine length	14.6–15.7	15.5	12.5–14.0	13.3
Longest P2 soft ray length	26.4–30.1	28.7	25.5–28.2	26.4
Caudal-fin length	23.8–27.8	26.3	26.9–28.1	27.5
Middle caudal-fin length	21.1–26.7	23.8	22.4–24.8	23.9
Caudal-peduncle depth	10.8–11.8	11.2	10.7–12.1	11.6
Caudal-peduncle length	19.0–21.3	20.2	19.6–21.5	20.4
Upper caudal-peduncle length	18.0–21.7	19.0	15.8–16.7	16.4
D base length	43.4–47.3	45.4	43.8–49.9	46.6
A base length	16.9–17.8	17.1	15.8–18.6	17.2
P1 base length	5.8–6.3	6.1	6.1–6.5	6.3

A: anal-fin, D: dorsal fin, LL: lateral line, P1: pectoral fin, P2: pelvic fin, S: spine.

Fig. 1. Preserved specimens of (A) *Chelidoperca maculicauda*, USNM 306446, one of two specimens, 103.9 mm SL, off Somalia, Gulf of Aden, and (B) *C. occipitalis*, USNM 389094, one of five specimens, 89.1 mm SL, off Oman, Gulf of Oman.

Fig. 2. Semi-schematic illustrations illustrating differences in scale rows between lateral line and dorsal-fin base in (A) *Chelidoperca maculicauda*, USNM 306452, one of three specimens, 87.0 mm SL, and (B) *C. occipitalis*, USNM 389097, 89.9 mm SL. Shaded scales counted as 0.5. Closed and open arrowheads indicate the dorsal-fin origin and pored lateral-line scale, respectively. Bars equal 3 mm.

vic-fin bases; no scales on dorsal- and anal-fin membranes. Head generally with ctenoid scales (absent on snout and maxilla); scales on preopercle, interopercle, subopercle, and opercle also ctenoid; interorbital region and ventral surface of lower jaw with cycloid scales.

Interorbital canals with numerous small pores running along outer margin of interorbital region, diverging outward anteriorly, and reaching to vertical through posterior nostril; interorbital canal pores in 2 irregular bilateral rows (*i.e.*, *ca.* 2 rows on each side; Fig. 3A). Ventral surface of lower jaw with 4 single or double sensory pores on each side: anterior-most pore simple, situated to side of mandibular symphysis, followed by 2 pairs of adjacent minute pores on dentary and then by slit-like posteriormost pores situated anteriorly on angular.

Dorsal-fin origin above pectoral-fin base, fourth spine

longest, ninth spine shortest; all soft rays branched, subequal in length, eighth or ninth longest. Anal-fin origin below base of second dorsal-fin soft ray, third spine longest; all soft rays branched, fifth longest. Pectoral fin with uppermost three rays unbranched, remaining rays branched, eighth to tenth longest, posterior tip of fin reaching vertical through anal-fin origin. Pelvic-fin origin below pectoral-fin base; spine covered with skin; all soft rays branched, second longest, expanded distally, its tip reaching anus when depressed but not reaching anal-fin origin.

Color of preserved specimens. Head, body, and fins generally pale brown, body with longitudinal mid-lateral row of about 5 indistinct dark, elongate blotches from behind opercle to caudal-fin base (Fig. 1A). Dorsal-fin spines dusky; membrane of spinous portion dusky basally, small dark blotch distally on membrane between last spine and

Fig. 3. Semi-schematic illustrations of dorsal views of head (A, C) and ventral views of lower jaw (B, D) showing squamation differences in (A–B) *Chelidoperca maculicauda*, USNM 306446, one of two specimens, 103.9 mm SL and (C–D) *C. occipitalis*, USNM 389094, one of five specimens, 84.5 mm SL. AN and PN indicate the anterior and posterior nostrils, respectively. Bars equal 3 mm.

Fig. 4. Distributional map of *Chelidoperca maculicauda* (squares) and *C. occipitalis* (circles). Open and closed symbols indicate previously reported and new records, respectively. Note: Psomadakis *et al.* (2015) recorded *C. occipitalis* from the Pakistan coast.

first soft ray, this spot much smaller than spot on caudal-fin upper lobe; tip of first soft ray with minute dark blotch. Caudal fin with 4 or 5 rows of transverse narrow dark bands and inner row of numerous small semi-translucent spots; small dark spot (sometimes with additional minute dark spot) on upper lobe. Other fins without markings. Fresh coloration described by Bineesh *et al.* (2013).

Distribution. The species has been recorded from off Kollam, Kerala coast, southwestern India (type locality;

Bineesh *et al.* 2013, 2015), and off Somalia, Gulf of Aden (this study), in the Arabian Sea (Fig. 4).

Identification. The present specimens are identical with *C. maculicauda*, having the diagnostic features of the species recognized by Bineesh *et al.* (2013) and additional characters recognized in this study (see below). *Chelidoperca maculicauda* is characterized by 15 (rarely 14) pectoral-fin rays (vs. 16 or 17 in *C. hirundinacea*), 42–46 pored lateral-line scales (vs. 34 or 35 in *C. stella*), 3.5 scale rows between

Fig. 5. Relationships of head length (A), postorbital length (B), snout length (C), and longest pelvic-fin soft ray length (D) (all as % of standard length) to standard length (mm) in *Chelidoperca hirundinacea* (diamonds), *C. lecroi* (crosses), *C. occipitalis* (circles), *C. maculicauda* (squares), *C. margaritifera* (circles with cross), *C. pleurospilus* (downward-pointing triangles), *C. santosi* (star), and *C. stella* (upward-pointing triangles), showing interspecific differences (A–B) and growth-related changes within the species (C–D). Open symbols indicate the type series of *C. occipitalis* (circles), the holotype of *C. maculicauda*, and a non-type specimen reported by Bineesh *et al.* (2014: table 2) (squares).

the lateral line and sixth dorsal-fin spine base (vs. 2.5 in *C. investigatoris*, *C. margaritifera*, *C. occipitalis*, and *C. stella*) and 20–22 total gill rakers including rudiments [vs. 16 or 17 in *C. lecroi*, 16–19 in *C. occipitalis* [19–21 in Bineesh *et al.* (2014) as discussed in the following Remarks], 16–19 in *C. pleurospilus*, and 17–19 in *C. stella*] (Bineesh *et al.* 2014; Williams and Carpenter 2015; Matsunuma and Motomura 2016; this study). Bineesh *et al.* (2013) stated that *C. maculicauda* can be distinguished from *C. pleurospilus* by gill raker number [3+9 vs. 5–6+11–12 in the latter (Akazaki 1972)]; however, the counts for *C. maculicauda* in Bineesh *et al.* (2013) were for developed gill rakers only, while Akazaki's (1972) counts may have included rudiments. The total numbers of gill rakers including rudiments observed in comparative specimens of *C. pleurospilus* for the present study (5–6 + 11–13) agree those of Akazaki (1972), rather than with a count of developed gill rakers only (2–3+8–9), supporting this contention. Additionally, *C. maculicauda* was originally diagnosed as having X, 10 dorsal-fin rays and III, 6 anal-fin rays (Bineesh *et al.* 2013). As all currently known species of *Chelidoperca* possess the same dorsal- and anal-fin ray counts (Senou 2013; Bineesh *et al.* 2014; Williams and Carpenter 2015; Matsunuma and Motomura 2016; this study), these counts are useful only for the generic diagnosis.

Regarding morphometric proportions, *C. maculicauda*

has greater postorbital 22.6–23.6% SL [23.7–24.7% SL in Bineesh *et al.* (2013)] and head lengths 40.6–43.3% SL [40.3–42.6% SL in Bineesh *et al.* (2013)], compared with congeners (17.4–20.9 and 34.2–40.0% SL, respectively), with the exception of *C. investigatoris* (24.9–28.5 and 41.9–48.7% SL, respectively) and *C. occipitalis* (22.3–24.9 and 41.3–44.7% SL, respectively) (Bineesh *et al.* 2014; Williams and Carpenter 2015; this study; Fig. 5A–B). Although Bineesh *et al.* (2014) considered *C. maculicauda* to be distinguishable from *C. pleurospilus* by body depth (22.8–24.3% SL vs. 22.7–23.1% SL in the latter) and from *C. occipitalis* by eye diameter (10.8–11.6% SL vs. 9.1–10.6% SL in the latter), the ranges of body depth measurements clearly overlap and no clear differences in the above characters were observed between species pairs in the present study (see also Table 2). *Chelidoperca maculicauda* was also originally diagnosed by several other morphometrics, including the lengths of the fourth dorsal-fin spine, longest dorsal-fin soft ray, first and second anal-fin spines, and pelvic fin, but Bineesh *et al.* (2013) did not detail interspecific differences for these characters. Accordingly, these morphometric features are excluded from the diagnosis of *C. maculicauda* presented here. Furthermore, although Bineesh *et al.* (2013) stated in their diagnosis of the species that the head length of *C. maculicauda* is 3.16–3.54 times the length of the second anal-fin

Fig. 6. Relationships of numbers of preopercular serrae (A) and interopercular serrae (B) to standard length (mm) in *Chelidoperca hirundinacea* (diamonds), *C. lecromi* (crosses), *C. maculicauda* (squares), *C. margaritifera* (circles with cross), *C. occipitalis* (circles), *C. pleurospilus* (downward-pointing triangles), *C. santosi* (stars), and *C. stella* (upward-pointing triangles).

spine, the statement appears erroneous, since a recalculation of the measurements for the type series (Bineesh *et al.* 2013: table 1) yields a head length of *ca.* 5.5–6.6 times the spine length.

The number of serrae on some head bones is also useful for identifying species of *Chelidoperca* (Akazaki 1972; Matsunuma and Motomura 2016). *Chelidoperca maculicauda* is distinguished from *C. margaritifera* by its moderate number of preopercular serrae (28–43 in the present 85.3–114.2 mm SL specimens and 40–46 in the 153.4–160.7 mm SL type specimens reported by Bineesh *et al.* (2013)], compared with 45–60 serrae in 80–90 mm SL specimens of the latter species (Fig. 6A). Further interspecific comparisons based on specimens of >80 mm SL revealed *C. maculicauda* to have fewer interopercular serrae 2–7, compared with 6 or more in most congeners (data not available for *C. investigatoris* and limited to two examples of *C. lecromi*) (Williams and Carpenter 2015; Matsunuma and Motomura 2016; this study; Fig. 6B). Although Bineesh *et al.* (2013) stated that *C. maculicauda* differs from *C. pleurospilus* in having more preopercular serrae, the trend though apparent a clear-cut separation of the two species was not observed (Fig. 6A).

The extent of squamation in the interorbital region and on the ventral surface of the lower jaw is also helpful for species identification in *Chelidoperca* (Akazaki 1972; Matsunuma and Motomura 2016; this study). *Chelidoperca maculicauda* is characterized by interorbital scales that extend anteriorly beyond the mid-orbit and reach the anterior margin of the orbit in dorsal view (*vs.* just reaching to a position above mid-orbit in *C. margaritifera*, *C. occipitalis*, *C. pleurospilus*, *C. santosi*, and *C. stella*), and by scales on the ventral surface of the angular that extend anteriorly onto the posterior part of the dentary (anterior to the posteriormost mandible pore) (*vs.* only the angular being scaly in *C. occipitalis* and *C. pleurospilus*) (Bineesh *et al.* 2013, 2014; Williams

and Carpenter 2015; Matsunuma and Motomura 2016; this study; Fig. 3).

As noted by Bineesh *et al.* (2013), *C. maculicauda* possesses unique caudal fin markings: 1 or 2 dark spots (grey in fresh condition; Bineesh *et al.* 2013) on the upper lobe and several rows of numerous small, semi-translucent spots (bluish-white in fresh condition; Bineesh *et al.* 2013), while congeners lack this combination of markings (Bineesh *et al.* 2014; Williams and Carpenter 2015; Matsunuma and Motomura 2016; this study). *Chelidoperca maculicauda* is also distinguished from its congeners in having the upper caudal fin lobe expanded posteriorly with a well-rounded contour, in contrast to a truncated fin with the upper lobe elongated and pointed in other species (Alcock 1894: pl. X, fig. 10; Bineesh *et al.* 2013, 2014; Williams and Carpenter 2015; Matsunuma and Motomura 2016; this study).

Remarks. Several differences in meristic and morphometric characters were found between the present specimens and the original description of *C. maculicauda*. Bineesh *et al.* (2013) stated that *C. maculicauda* possesses 2.5 or 3 scale rows between the lateral line and the tenth dorsal-fin spine base, compared with 3.5 rows observed during the present study (Fig. 2A). It is likely that Bineesh *et al.* (2013) overlooked or misidentified the dorsal-most row of small scales above the lateral line. Other minor differences in counts between the present specimens and those available to Bineesh *et al.* (2013), including the numbers of total developed gill rakers (2+9–10 in the former *vs.* 3+9 in the latter) and pored lateral-line scales (42–44 *vs.* 42), can be attributed to an inadequate sample size.

The present specimens also differ from those of Bineesh *et al.* (2013) in having a slightly shorter snout (7.3–8.2% SL *vs.* 8.6–8.8% SL in the latter) and relatively longer fin rays, including the fourth dorsal-fin spine (15.4–17.3% SL *vs.* 14.2–14.6% SL), first anal-fin soft ray (13.2–16.1% SL *vs.*

12.0–13.3% SL), longest pectoral-fin ray (26.0–28.8% SL vs. 24.5–25.5% SL), longest pelvic-fin soft ray (26.4–30.1% SL vs. 21.7–24.9), and caudal-fin (23.8–27.8% SL vs. 22.5–24.8% SL). However, an analysis of those measurements (expressed as percentages of SL) indicated the occurrence of growth-related changes in some body proportions. In particular, the snout length tends to increase proportionally with growth (Fig. 5C) in *C. maculicauda*, whereas lengths of the dorsal-fin spines, first anal-fin soft ray, longest pelvic-fin soft ray and caudal fin all decrease proportionally with growth (Fig. 5D).

Among congeners, similar ontogenetic trends were also recognized in this study in the examined samples of *C. hirundinacea*, *C. margaritifera*, *C. occipitalis*, and *C. pleurospilus*. No growth-related changes were recognized in pectoral-fin length, either in *C. maculicauda* or the same congeners. Accordingly, the morphometric differences between the present specimens and those of Bineesh *et al.* (2013) are regarded as either size-related ontogenetic changes or individual variation. Although the present specimens also differ from those of Bineesh *et al.* (2013) in having a slightly narrower interorbital width (3.0–3.7% SL vs. 4.6–4.8% SL in the latter), this is likely due to different measuring techniques. Interorbital width in the present study is the “least bony width” whereas that of Bineesh *et al.* (2013) may represent the fleshy width.

Chelidoperca maculicauda was originally described by Bineesh *et al.* (2013) on the basis of three specimens collected off Kollam, southwest coast of India. Since no specimen-based records of the species have been reported since, the present specimens from the Gulf of Aden represent the first records of the species from that region (Fig. 4).

***Chelidoperca occipitalis* Kotthaus, 1973**
(Figs 1B, 2B, 3C–D, 4–6; Tables 1–2)

Chelidoperca occipitalis Kotthaus 1973: 30, fig. 299 (type locality: southwest of Socotra Island, Yemen, Arabian Sea, 11°33.9'N, 52°54'E to 11°38'N, 52°52'E, *Meteor* station 102; Wilkens and Dohse 1993: 417 (type catalog of ZMH); Manilo and Bogorodsky 2003: S104 (Arabian Sea; listed); Bineesh *et al.* 2014: 119, figs 4–6 (Kollam, west coast of India; redescription); Bineesh *et al.* 2015: 104 (Kollam and Mangaluru, west coast of India; molecular phylogenetic analysis); Psomadakis *et al.* 2015: 195, pl. XII, fig. 99 (Pakistan; short description).

Chelidoperca investigatoris (not of Alcock 1890): Said Koya 2010: 15, unnumbered fig. (Calicut, west coast of India; listed).

Examined specimens. Six specimens, 65.9–89.9 mm SL: **OMAN:** USNM 389094, 5 specimens, 65.9–89.1 mm SL, Gulf of Oman (23°33'N, 58°23'E), 106 m depth, RV *Anton Bruun*, International Indian Ocean Expedition, cruise 4B, station 269B, 3 December 1963. **INDIA:** USNM 389097, 89.9 mm SL, off India (22°14'N, 67°42'E), 104–108 m depth, RV *Anton Bruun*, International Indian Ocean Expedition, cruise 4B, station 220 A, 18 November 1963.

Diagnosis. A species of *Chelidoperca* distinguished from other members of the genus by the following combination of characters: pectoral-fin rays 14–16 (modally 15); pored lateral-line scales 42 or 43; scale rows between lateral line and sixth dorsal-fin base 2.5; preopercular serrae 19–33; head length 41.3–43.2% (mean 42.2%) SL; postorbital length 22.3–23.6% (mean 23.0%) SL; interorbital scales just reaching forward to point above center of orbit; scales on ventral surface of lower jaw restricted to angular, not extending anteriorly onto dentary; upper margin of caudal fin with numerous short, dark bands (reddish when fresh); dark longitudinal dashed stripe present mid-laterally on side of body.

Description. Characters given in diagnosis not repeated. Morphometric and meristic values given in Tables 1–2. Dorsal-fin rays X, 10; anal-fin rays III, 6; pelvic-fin rays I, 5. Caudal fin truncate, upper lobe with elongate, pointed tip; upper lobe with 3 unbranched and 7 or 8 branched segmented rays, lower lobe with 2 or 3 unbranched and 7 branched segmented rays, 19–21 (modally 20) total segmented rays. Scale rows above lateral line 3; cheek scale rows 6.

Body slightly elongated (Fig. 1B); snout pointed, dorsal profile of snout in lateral view forming angle of ca. 40° to horizontal axis of head and body; caudal peduncle relatively long. Orbit large, its dorsal margin included in dorsal contour of head. Mouth large, slightly oblique; posterior margin of maxilla extending beyond vertical through center of eye but not reaching to vertical through posterior margin of orbit; maxilla slightly expanded posteriorly, lateral ridge undeveloped; lower jaw slightly protruding beyond upper jaw when mouth closed. Upper jaw with band of ca. 6 rows of small, pointed conical teeth, outermost row with 20–26 relatively large canines; cluster of 15–17 enlarged canines on each side of symphysis. Lower jaw with band of 2–4 irregular rows of small, pointed conical teeth, outermost row with 10–12 enlarged canines, innermost row with 20–25 canines (shorter than outer canines); vomer with blunt, V-shaped band of 1 or 2 rows of small, pointed conical teeth, and several large canines posteriorly; palatine with relatively long, narrow band of ca. 2 rows of small, pointed conical teeth (width of band 5.7–6.5% SL). Anterior nostril on middle of snout, with small, rounded flap arising from posterior rim; posterior nostril an elliptical opening at anterior border of orbit. Opercle with 2 flat, prominent spines, upper spine clearly longer than lower, angle between them ca. 30°; interopercular serrae 3–9; subopercular serrae 10–19; post-temporal with small bony crest bearing 1–3 spines at beginning of lateral line.

Body with ctenoid scales; lateral line slightly arched over pectoral fin before gradually descending, terminating at caudal-fin base. Uppermost row of body scales along dorsal-fin base always about half size of those in adjacent row. Small cycloid scales on caudal- and pectoral-fin bases, not extending onto fins; no scales on dorsal-, anal- and pelvic-fin bases. Row of small cycloid scales on each membrane between first and fourth dorsal-fin soft rays and membrane between third anal-fin spine and first anal-fin soft ray. Head generally with ctenoid scales but scales absent on snout and

maxilla; scales on preopercle, interopercle, subopercle, and opercle ctenoid; interorbital region and ventral surface of lower jaw with cycloid scales.

Interorbital canals with numerous small pores running along outer margin of interorbital region, diverging outward anteriorly, and reaching to area between anterior and posterior nostrils; interorbital canal pores in *ca.* 2 irregular bilateral rows (*i.e.*, *ca.* 2 rows on each side; Fig. 2B). Ventral surface of lower jaw with 4 sets of sensory pores on each side; anteriormost pore simple, situated to side of mandibular symphysis, followed by 2 pairs of adjacent minute pores on dentary and then by more posterior complex of 2 or 3 minute pores situated anteriorly on angular.

Dorsal-fin origin above pectoral-fin base, fourth spine longest, ninth spine shortest; all soft rays branched, subequal in length, ninth longest. Anal-fin origin below base of second dorsal-fin soft ray, third spine longest; all soft rays branched, fifth longest. Pectoral fin with uppermost one or two rays unbranched, remaining rays branched, ninth longest, posterior tip of fin reaching vertical through anal-fin origin. Pelvic-fin origin below pectoral-fin base; spine covered with skin; all soft rays branched, second longest, expanded distally, its tip just reaching anus when depressed.

Color of preserved specimens. Head, body, and fins uniformly pale brown; mid-lateral body with narrow dashed dark stripe extending from posterior tip of gill cover to caudal-fin base. Upper part of spinous portion of dorsal fin dusky; soft-rayed portion with 2 or 3 longitudinal rows of small dark spots; 2 or 3 laterally elongate dark blotches on anteriormost part of soft-rayed portion. Upper margin of caudal fin with *ca.* 5–7 indistinct short, dark bands. No other markings on fins.

Distribution. *Chelidoperca occipitalis* has been recorded from many localities along the Arabian Sea coast, including the west coast of India, Pakistan, the Gulf of Oman, and off Socotra Island near the mouth of the Gulf of Aden (Kotthaus 1973; Bineesh *et al.* 2014; Psomadakis *et al.* 2015; this study; Fig. 3).

Identification. The present specimens generally agree with the descriptions of *C. occipitalis* given by Kotthaus (1973) and Bineesh *et al.* (2014). *Chelidoperca occipitalis* is characterized by usually having 15 pectoral-fin rays (*vs.* usually 16 in *C. hirundinacea*), 42 or 43 pored lateral-line scales (*vs.* 34 or 35 in *C. stella*), and 2.5 scale rows between the lateral line and the sixth dorsal-fin spine base (*vs.* 3.5 in *C. hirundinacea*, *C. lecromi*, *C. pleurospilus*, and *C. maculicauda*). Moreover, *C. occipitalis* is distinguished from *C. margaritifera* by having a moderate number (19–33) of preopercular serrae (*vs.* 27–60 in the latter) (Fig. 6A).

In term of morphometric proportions, *C. occipitalis* can be distinguished from *C. hirundinacea*, *C. lecromi*, *C. margaritifera*, *C. pleurospilus*, *C. santosi*, and *C. stella* by its relatively longer head (41.3–43.2% SL *vs.* 34.2–40.0% SL in the latter species) and greater postorbital length (22.3–23.6% SL *vs.* 17.4–20.9% SL). It is further distinguished from these species as well as *C. maculicauda* by its relatively shorter upper caudal-peduncle length (15.8–16.7% SL *vs.* 17.6–22.5% SL) (Williams and Carpenter 2015; Matsunuma and

Motomura 2016; this study). Although Bineesh *et al.* (2014) stated that *C. occipitalis* differs from *C. pleurospilus* in having an interorbital width that is exceeded 10.3–14.6 times by the head length (*vs.* <10.95 times in the latter species), no clear difference in this character was found between examples of the two species examined in this study (2.3–2.7% SL in the former *vs.* 2.1–2.9% SL in the latter).

Furthermore, whereas the interorbital scales of *C. occipitalis* just reach a vertical through the center of the eye, but they extend anteriorly well beyond this point in *C. hirundinacea*, *C. investigatoris*, *C. lecromi*, and *C. maculicauda* (Bineesh *et al.* 2014; this study; Fig. 3C). Moreover, *C. occipitalis* possesses scales only on the ventral surface of the angular, but the scaled area extends anteriorly onto the dentary in *C. hirundinacea*, *C. maculicauda*, and *C. stella* (Fig. 3D).

Chelidoperca occipitalis is characterized by a dark longitudinal dashed stripe situated mid-laterally on the body; in congeners a dark stripe occurs only in *C. investigatoris* and *C. pleurospilus* (Bineesh *et al.* 2014; Williams and Carpenter 2015; Matsunuma and Motomura 2016; this study). Preserved specimens of *C. occipitalis* are also characterized by the following combination of markings: upper margin of caudal fin with *ca.* 5–7 short dark bands (reddish when fresh; Bineesh *et al.* 2014: fig. 5), and membrane between last spine and first soft ray of dorsal fin with 2 or 3 dark blotches (red when fresh) (Bineesh *et al.* 2013, 2014; Williams and Carpenter 2015; Matsunuma and Motomura 2016; this study). *Chelidoperca occipitalis* is further characterized by the presence of a silvery streak along the posteroventral margin of the orbit when fresh (Bineesh *et al.* 2014: fig. 5; Psomadakis *et al.* 2015: pl. XII, fig. 99), a characteristic shared only with *C. lecromi* among known congeners (Bineesh *et al.* 2013, 2014; Williams and Carpenter 2015; Matsunuma and Motomura 2016; this study).

Remarks. The redescription of *C. occipitalis* given by Bineesh *et al.* (2014) based on the holotype and 14 non-type specimens included several inconsistencies, with the description stating “gill rakers 3+5–8+4” and “lateral-line scales 44”, and the accompanying Table 3 listing “total number of gill rakers 19–21” and “total number of tubed lateral-line scales 43 or 44”. In addition, the diagnosis of *C. occipitalis* stated that there are 14 circumpeduncular scales whereas the description said 13 or 14. The specimens examined here possess 18 or 19 circumpeduncular scales. In addition, although Bineesh *et al.* (2014) stated that *C. occipitalis* lacks vomerine teeth, the holotype of *C. occipitalis* was originally described by Kotthaus (1973) as having vomerine teeth. All species of *Chelidoperca* possess a vomerine teeth patch (Bineesh *et al.* 2013, 2014; Williams and Carpenter 2015; Matsunuma and Motomura 2016; this study).

Several differences in morphometric range were recognized between the present specimens and Bineesh *et al.* (2014), including the lengths of the snout (7.4–9.4% SL in the former *vs.* 8.9–10.9% SL in the latter), fourth dorsal-fin spine (15.3–16.5% SL *vs.* 12.7–15.9% SL), and longest pelvic-fin soft ray (25.5–28.2% SL *vs.* 22.3–23.9% SL). However, these differences may be due to ontogenetic changes within the species, as was demonstrated above for *C. maculicauda*

(Fig. 5C–D).

Although Bineesh *et al.* (2014) stated that *C. occipitalis* had also been recorded from Veraval (northwestern India), and from Pakistan, these two records were based solely on personal communications. Psomadakis *et al.* (2015) subsequently recorded the species from Pakistan, supported by a color photograph of a collected specimen. A record of *C. investigatoris* from Calicut, southwestern India, accompanied by a figure (Said Koya 2010) is identifiable as *C. occipitalis*, because it clearly has several reddish bands on the upper margin of the caudal fin. The present specimens of *C. occipitalis* from the Gulf of Oman, representing the first records of the species from that Gulf, indicate a wide distribution of the species in the Arabian Sea.

Comparative material. The following specimens examined in this study were listed in detail in Matsunuma and Motomura (2016): *Chelidoperca hirundinacea* (15 specimens, 48.5–144.3 mm SL), *Chelidoperca lecromi* (2 specimens, 111.8–125.3 mm SL), *Chelidoperca margaritifera* (13 specimens, 45.1–90.2 mm SL), *Chelidoperca pleurospilus* (13 specimens, 57.9–122.4 mm SL), and *Chelidoperca santosi* (1 specimen, 81.6 mm SL). Additional material included *C. margaritifera* (8 specimens, 65.4–87.3 mm SL): UPVMI 1169, 84.3 mm SL, UPVMI 1170, 87.3 mm SL, UPVMI 1171, 87.0 mm SL, UPVMI 1172, 86.8 mm SL, UPVMI 1173, 78.1 mm SL, UPVMI 1174, 77.6 mm SL, UPVMI 1175, 75.7 mm SL, UPVMI 1176, 65.4 mm SL, off Antique, Panay Island, Philippines, 30 July 2014.

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