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# Review of *Ophiocara* (Teleostei: Butidae) from Indo-Pacific Islands

by

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## Key words

*Ophiocara*  
Butidae  
Indo-Pacific

**Abstract.** – *Ophiocara* species from the Indo-Pacific area are reviewed. Three species are recognized using genetic and morphomeristic approaches. The species differ by a high percentage of divergence (around 8%) in partial *COI* gene (446 bp) and by several characters including the number of scales in lateral, transverse backward, zigzag, and predorsal series, and the jaw length.

**Résumé.** – Révision du genre *Ophiocara* (Teleostei : Butidae) de la région indopacifique.

Des collections de spécimens des *Ophiocara* provenant de la région indopacifique ont été étudiées. Trois espèces ont été répertoriées selon des approches génétiques et morpho-méristiques. Elles diffèrent par un fort pourcentage de divergence au niveau du gène *COI* partiel (446 pb) et par plusieurs caractères incluant, principalement, le nombre d'écailles en séries latérale, transverse postérieure, zigzag et prédorsale, et par la longueur de la mâchoire.

## INTRODUCTION

*Ophiocara* Gill, 1863 species are found in insular habitats of the tropical Indian and Pacific oceans. The genus is widely distributed and has been collected in many coastal streams from estuaries to lower parts of rivers, as far as 60 km upstream in the Sepik River in Papua New Guinea (Allen and Coates, 1990), usually in bank vegetation and in shelters over muddy or gravel bottoms where the current is slow, or in the lentic zones below stones or dead wood (Allen and Coates, 1990; Marquet *et al.*, 2003; Keith *et al.*, 2010, 2021). The species are thought to be amphidromous. They spawn in freshwater and, after hatching, larvae drift downstream to the sea where they undergo a planktonic phase during several months (Marquet *et al.*, 2003). After this marine phase, individuals return to rivers to grow and reproduce. In these rivers, *Ophiocara* is a sit-and-wait predator, a carnivorous species, hunting, from hiding places, for small fish, shrimps (Atyidae), prawns (Palaemonidae) and molluscs (Thiaridae) (Allen and Coates, 1990; Nanjo *et al.*, 2008; Gammanpila *et al.*, 2019). Adults are, in most places, targeted as a food resource for human consumption (Englberger *et al.*, 2008) and since a long time. Recently, Bouffandeau *et al.* (2019) have shown that the Lapita's economy (2920-2870 B.P.) in

Vanuatu (Teouma site) was characterised by an intensive and broad-spectrum exploitation of all freshwater resources through particularly the *Ophiocara*.

In their study, Akihito and Meguro (1974) gave the most important characteristics of the genus *Ophiocara* compared to *Giuris* recently reviewed by Keith and Mennesson (2020) and Keith *et al.* (2020): the presence of a process on the inner side of the maxillary; the presence of oculoscapular canal from nasal to post-temporal with the pores A to L except for G, of preopercular canal with the pores M to Q and three supratemporals; 26 (rarely 27) vertebrae; the absence of a short, low longitudinal ridge on frontal; and the first and second pterygiophores of the first dorsal fin are inserted between the third and fourth vertebrae.

According to the authors, one to three valid species are currently assigned to *Ophiocara*: *O. ophicephalus* (Valenciennes, 1837), *O. porocephala* (Valenciennes, 1837) and *O. macrolepidota* (Bloch, 1792) (Kottelat, 2013; Fricke *et al.*, 2021) but a dozen of supposed species belonging to this genus were described in the past, and this has never been reviewed.

The purpose of this paper is to review *Ophiocara* species using, when possible, genetic and morphometric approaches,

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using both the new material collected and MNHN types for genetic purposes.

## METHODS

### Sample collection

The fish used for the study were collected from Indian and Pacific islands streams or studied from various museum collections (see further). Collected specimens were sampled using a DEKA 3000 electrofishing system (Gerätebau, Marsberg, Germany). Following the annex IV of the directive 2010/63/EU, fish were either euthanized using an overdose of clove oil (10%), or a piece of fin was taken while the fish was anaesthetised. In the case of anaesthetization, the fish was then awakened in clear water before it was released. Entire fish or fin clips were stored and preserved in 95% ethanol for molecular analysis.

### Material examined

Types and other specimens were examined from several Museum collections (MNHN: Muséum national d'Histoire naturelle, Paris; RMNH: Rijksmuseum van Natuurlijke Historie, Leiden; ZMB: Zoological Museum of Berlin (Museum für Naturkunde); BMNH: Natural History Museum, London; AMS: Australian Museum of Sydney; NTM: Northern Territory Museum; SAIAB: The South African Institute for Aquatic Biodiversity).

#### Types studied:

*Eleotris madagascariensis*, Valenciennes in Cuvier & Valenciennes, 1837; Madagascar. Syntypes: MNHN-IC-A-2709 (2), A-1683 (1).

*Eleotris ophicephalus* Valenciennes in Cuvier & Valenciennes, 1837; Java, Indonesia. Holotype (unique): MNHN-IC-A-1569.

*Eleotris porocephala* Valenciennes in Cuvier & Valenciennes, 1837; Seychelles and New Ireland Island, Bismarck Archipelago, Papua New Guinea. Syntypes: MNHN-IC-A-1573 (5) Seychelles and MNHN-IC-A-1574 (2) New Ireland.

*Eleotris porocephaloides* Bleeker, 1854; Priaman, Sumatra, Indonesia. Holotype (unique): RMNH 6198.

*Eleotris viridis* Bleeker, 1849; Madura Straits near Surabaya and Kammal, Java, Indonesia. Syntype: RMNH 6197.

*Eleotris cantor* Günther, 1861; Penang, Malaysia. Syntypes: BMNH 1860.3.19.577 and 1860.3.19.581 (2 half skins). ?NMW 22552 (1) Fiji (Kandavu).

*Sciaena macrolepidota* Bloch, 1792; Valparaiso. Holotype (unique): ZMB 2155.

*Agonostoma darwiniense* Macleay, 1878; Port Darwin, Northern Territory, Australia. Syntype: AMS I.14855; not seen, pictures only (courtesy D. Hoese).

*Lindemanella iota* Whitley, 1935; Freshwater creek on Lindeman Island, northern Queensland, Australia. Holotype (unique): AMS IA.6411; not seen, pictures only (courtesy D. Hoese).

*Eleotris limosus* Smith, 1936; Isipingo lagoon, South Africa. Holotype (unique): SAIAB 95; not seen, data from H. Larson.

Several others non-type specimens have been examined and they are listed in table I and in the species parts. In total nearly 90 specimens, including types, were studied for morphomeristic, genetic or both (see further).

### Morphomeristics

All counts and measurements were taken from the left side. Measurements were taken with dial callipers and are expressed to the nearest tenth of a millimetre.

The size is given in standard length (SL). Abbreviation are as follow: P, Pectoral rays; D, Dorsal rays (D1, first dorsal fin; D2, second dorsal fin); A, Anal rays; D1D2, Distance between the posterior part of the base of D1 and the anterior part of the base of D2 (% SL); PDL, Predorsal length (% SL); PAL, Preanal length (% SL); HL, Head length (% SL); JL, Jaw length (% SL); CPL, Caudal peduncle length (% SL); CPM, Caudal peduncle height (% SL); Pect-L, Pectoral fin length (% SL); BDa, Body depth at anus (% SL); BDD1, Body depth at first dorsal fin (% SL); SDFL, Second dorsal fin length (% SL); AFL, Anal fin length (% SL); CFL, Caudal fin length (% SL); O, Eye diameter (% SL); IO, Interorbital length (% SL); SL, Standard length (SL) (mm).

For scales, abbreviations are as follow: LS, scales in lateral series counted from upper pectoral base, or anteriormost scale along lateral midline, to central hypural base; PD, predorsal midline counted from scale directly anterior to first dorsal fin insertion to the anteriormost scale; TRB, transverse series back, refers to scales counted from the first scale anterior to second dorsal fin, in a diagonal manner, posteriorly and ventrally to the anal fin base or ventralmost scale; TRF, transverse series forward refers to scales counted from the first scale anterior to second dorsal fin, in a diagonal manner, anteriorly and ventrally to the centre of belly or ventralmost scale; ZZ, zigzag series, refers to scales on the narrowest region of the caudal peduncle counted from the dorsalmost scale to the ventralmost scale in a zigzag (reversed at every scale) manner. Gill rakers counts are all rakers on the outer face of the first arch.

### Sensory papillae

The head sensory papillae of *Ophiocara* were examined with the aid of a dissecting microscope. They were described by Akihito and Meguro (1974) and Akihito *et al.* (1988) as follow: Seven transverse lines of pit organs from eye downwards on cheek. Three lines from eye upwards. A line from eye forwards below posterior nostril. A longitudinal line

Table I. – Species, specimens and localities sampled.

MNHN number	Tag number	Species	Archipelago	Island	River	Date	Collectors	COI 446 bp	COI 199 bp	COI 106 bp	COI 110 bp
MNHN-IC-A-1573	1	Syntype <i>Eleotris porocephala</i>	Seychelles	–	–	1825-1826	Dussumier			X	
MNHN-IC-A-1573	2	Syntype <i>E. porocephala</i>	Seychelles	–	–	1825-1827	Dussumier				
MNHN-IC-A-1573	3	Syntype <i>E. porocephala</i>	Seychelles	–	–	1825-1828	Dussumier				
MNHN-IC-A-1573	4	Syntype <i>E. porocephala</i>	Seychelles	–	–	1825-1829	Dussumier				
MNHN-IC-A-1573	5	Syntype <i>E. porocephala</i>	Seychelles	–	–	1825-1830	Dussumier				
MNHN-IC-A-2709	1	Syntype <i>Eleotris madagascariensis</i>	Madagascar	Madagascar	–	–	Goudot	X	X	X	
MNHN-IC-A-2709	2	Syntype <i>Eleotris madagascariensis</i>	Madagascar	Madagascar	–	–	Goudot				
RMNH 6198	–	Holotype <i>Eleotris porocephaloides</i>	Indonesia	Sumatra	Priaman	–	Bleeker				
SALAB 95	–	Holotype <i>Eleotris limosus</i>	South Africa	–	Isipingo lagoon	–	–				
MNHN-IC-1960-0223	–	<i>Ophiocara porocephala</i>	Madagascar	Madagascar	Ivolina	–	Kiener			X	
MNHN-IC-2020-0177	12653	<i>Ophiocara porocephala</i>	Madagascar	Madagascar	st5 Antalaviana	May 2010	Diamsoi	X	X	X	
MNHN-IC-2020-0178	14511	<i>Ophiocara porocephala</i>	Comoros	Mayotte	st 26 Dombéni	12 Aug. 2019	Valade et al.	X	X	X	
MNHN-IC-2020-0178	14512	<i>Ophiocara porocephala</i>	Comoros	Mayotte	st 26 Dombéni	12 Aug. 2019	Valade et al.	X	X	X	
MNHN-IC-2020-0178	14513	<i>Ophiocara porocephala</i>	Comoros	Mayotte	st 26 Dombéni	12 Aug. 2019	Valade et al.	X	X	X	
MNHN-IC-2020-0178	14514	<i>Ophiocara porocephala</i>	Comoros	Mayotte	st 26 Dombéni	12 Aug. 2019	Valade et al.	X	X	X	
MNHN-IC-2020-0178	14515	<i>Ophiocara porocephala</i>	Comoros	Mayotte	st 26 Dombéni	12 Aug. 2019	Valade et al.	X	X	X	
MNHN-IC-2020-0178	14516	<i>Ophiocara porocephala</i>	Comoros	Mayotte	st 26 Dombéni	12 Aug. 2019	Valade et al.	X	X	X	
uncatalogued	B121	<i>Ophiocara porocephala</i>	Comoros	Mayotte	st 26 Dombéni	12 Aug. 2019	Valade et al.	X	X	X	
MNHN-IC-2020-0480	12531	<i>Ophiocara porocephala</i>	Comoros	Mayotte	Tahiti plage	16 May 2006	Keith & Arda	X	X	X	
MNHN-IC-2020-0480	12532	<i>Ophiocara porocephala</i>	Comoros	Mayotte	Tahiti plage	16 May 2006	Keith & Arda	X	X	X	
MNHN-IC-2020-0480	12534	<i>Ophiocara porocephala</i>	Comoros	Mayotte	Tahiti plage	16 May 2006	Keith & Arda	X	X	X	
uncatalogued	12655	<i>Ophiocara porocephala</i>	Comoros	Mayotte	Tahiti plage	16 May 2006	Keith & Arda	X	X	X	
MNHN-IC-2006-0607	–	<i>Ophiocara porocephala</i>	Comoros	Mohéli	Mjauatché	31 Oct. 2005	Keith & Marquet				
MNHN-IC-2020-0179	Ophiocara4 12589	<i>Ophiocara porocephala</i>	Comores	Mohéli	Mjauatché	31 Oct. 2005	Keith & Marquet	X	X	X	
–	Ophio-adul1	<i>Ophiocara porocephala</i>	Seychelles	Mahé	Gorre	02 Feb. 2020	Mennesson, Keith & Henriette	X	X		
–	Ophio-adul2	<i>Ophiocara porocephala</i>	Seychelles	Mahé	Dauban river	13 Feb. 2020	Mennesson, Keith & Henriette	X	X		
–	Ophio-juv1	<i>Ophiocara porocephala</i>	Seychelles	Mahé	Dauban river	13 Feb. 2020	Mennesson, Keith & Henriette	X	X		
–	Ophio-juv2	<i>Ophiocara porocephala</i>	Seychelles	Mahé	Dauban river	13 Feb. 2020	Mennesson, Keith & Henriette	X	X		
–	12659-1	<i>Ophiocara porocephala</i>	Seychelles	Mahé	Dauban river	13 Feb. 2020	Mennesson, Keith & Henriette	X	X		
–	12659-2	<i>Ophiocara porocephala</i>	Seychelles	Mahé	Dauban river	13 Feb. 2020	Mennesson, Keith & Henriette	X	X		
–	12660-1	<i>Ophiocara porocephala</i>	Seychelles	Mahé	Dauban river	13 Feb. 2020	Mennesson, Keith & Henriette	X	X		
–	12660-2	<i>Ophiocara porocephala</i>	Seychelles	Mahé	Dauban river	13 Feb. 2020	Mennesson, Keith & Henriette	X	X		
–	SALAB645-07	<i>Ophiocara porocephala</i>	Seychelles	Mahé	near Pont Connal	5 Oct. 05	see BOLD	X	X	X	
–	SALAB650-07	<i>Ophiocara porocephala</i>	Seychelles	Mahé	near Pont Connal	5 Oct. 05	see BOLD	X	X	X	
MNHN-IC-2020-0180	12733	<i>Ophiocara porocephala</i>	Seychelles	Praslin	Anse petite court	23 Feb. 2020	Mennesson, Keith & Henriette	X	X	X	
–	Ophio-01	<i>Ophiocara porocephala</i>	Seychelles	Praslin	Anse petite cours	23 Feb. 2020	Mennesson, Keith & Henriette	X	X		
–	Ophio-02	<i>Ophiocara porocephala</i>	Seychelles	Praslin	Anse petite cours	23 Feb. 2020	Mennesson, Keith & Henriette	X	X		

Table I. – Continued.

MNHN number	Tag number	Species	Archipelago	Island	River	Date	Collectors	COI 446 bp	COI 199 bp	COI 106 bp	COI 110 bp
–	Ophio-03	<i>Ophiocara porocephala</i>	Seychelles	Praslin	Anse petite cours	23-févr-2020	Mennesson, Keith & Henriette	X	X		X
MNHN-IC-2020-0181	12523	<i>Ophiocara porocephala</i>	Seychelles	Praslin	N. Découverte	08 Oct. 2003	Keith & Arda				
MNHN-IC-2020-0181	12524	<i>Ophiocara porocephala</i>	Seychelles	Praslin	N. Découverte	08 Oct. 2003	Keith & Arda				
MNHN-IC-A-1574	1	Syntype <i>Eleotris porocephala</i>	Papua New Guinea	New Ireland	–	1826-1829	Quoy & Gaimard				X
MNHN-IC-A-1574	2	Syntype <i>Eleotris porocephala</i>	Papua New Guinea	New Ireland	–	1826-1829	Quoy & Gaimard				
MNHN-IC-A-1549	–	Holotype <i>Eleotris ophicephalus</i>	Indonesia	Java	–	–	Kuhl & van Hasselt				
RMNH 6197	–	Syntype <i>Eleotris viridis</i>	Indonesia	Java	Madura Straits near Surabaya and Kammal	–	Bleeker				
AMS I.14855	–	Syntype <i>Agonostoma darwiniense</i>	Australia	Lindeman Island	Port Darwin, Northern Territory	–	–				
AMS IA.6411	–	Holotype <i>Lindemanella iota</i>	Australia	Lindeman Island	Northern Queensland, Australia	–	–				
NSW 22552	–	Supposed syntype of <i>E. cantoris</i>	Fiji	Kandavu	–	1869	Eduard Gräffe (de)				
MNHN-IC-2000-1269	–	<i>Ophiocara ophicephalus</i>	New Caledonia	Grande Terre	–	1999	Marquet				
MNHN-IC-2001-2910	–	<i>Ophiocara ophicephalus</i>	New Caledonia	Grande Terre	–	1999	Marquet				
–	12651	<i>Ophiocara ophicephalus</i>	New Caledonia	Grande Terre	Tibarama	16 Jan. 2010	Keith <i>et al.</i>		X	X	X
–	Ophiocara1	<i>Ophiocara ophicephalus</i>	New Caledonia	Grande Terre	Tibarama	16 Jan. 2010	Keith <i>et al.</i>	X	X	X	X
–	Ophiocara2	<i>Ophiocara ophicephalus</i>	New Caledonia	Grande Terre	Tibarama	16 Jan. 2010	Keith <i>et al.</i>	X	X	X	X
–	Ophiocara3	<i>Ophiocara ophicephalus</i>	New Caledonia	Grande Terre	Tibarama	16 Jan. 2010	Keith <i>et al.</i>	X	X	X	X
–	without tag	<i>Ophiocara ophicephalus</i>	Solomon	Kolobangara	–	Nov. 2015	Keith <i>et al.</i>	X	X	X	X
MNHN-IC-2020-0182	17579	<i>Ophiocara ophicephalus</i>	Solomon	Choiseul	Bilata	19 Oct. 2019	Keith, Boseto, Lord & Causse	X	X		
MNHN-IC-2020-0182	17584	<i>Ophiocara ophicephalus</i>	Solomon	Choiseul	Bilata	19 Oct. 2019	Keith, Boseto, Lord & Causse	X	X		X
MNHN-IC-2020-0183	17596	<i>Ophiocara ophicephalus</i>	Solomon	Choiseul	Tukutu	19 Oct. 2019	Keith, Boseto, Lord & Causse	X	X		X
MNHN-IC-2020-0184	17562	<i>Ophiocara ophicephalus</i>	Solomon	Choiseul	Simbe	20 Oct. 2019	Keith, Boseto, Lord & Causse	X	X		
MNHN-IC-2020-0478	17538	<i>Ophiocara ophicephalus</i>	Solomon	Isabel	Kupikolo, Rapa	23 Oct. 2019	Keith, Boseto, Lord & Causse	X	X		X
MNHN-IC-2020-0479	17840	<i>Ophiocara ophicephalus</i>	Solomon	Isabel	Kolopakissa	25 Oct. 2019	Keith, Boseto, Lord & Causse	X	X		X
MNHN-IC-2020-0185	12537	<i>Ophiocara ophicephalus</i>	Vanuatu	Santo	Venoui	15 Jul. 2005	Keith & Marquet		X	X	X
–	12552-1	<i>Ophiocara ophicephalus</i>	Vanuatu	Santo	–	Jul. 2005	Keith & Marquet	X	X	X	X
–	12552-2	<i>Ophiocara ophicephalus</i>	Vanuatu	Santo	–	Jul. 2005	Keith & Marquet	X	X	X	X
MNHN-IC-2020-0475	6843	<i>Ophiocara ophicephalus</i>	Palau	Babelthaupt	Small	02 Mar. 2011	Keith <i>et al.</i>	X	X		X
–	12656	<i>Ophiocara ophicephalus</i>	Palau	Babelthaupt	Kirelauch	28 Feb. 2011	Keith <i>et al.</i>	X	X	X	X
MNHN-IC-2020-0476	5246	<i>Ophiocara ophicephalus</i>	Micronesia	Pohnpei	Petroglyphs	14 Mar. 2012	Keith <i>et al.</i>	X	X	X	X
MNHN-IC-2020-0476	5247	<i>Ophiocara ophicephalus</i>	Micronesia	Pohnpei	Petroglyphs	14 Mar. 2012	Keith <i>et al.</i>	X	X	X	X
MNHN-IC-2020-0476	5248	<i>Ophiocara ophicephalus</i>	Micronesia	Pohnpei	Petroglyphs	14 Mar. 2012	Keith <i>et al.</i>	X	X	X	X

Table I. – Continued.

MNHN number	Tag number	Species	Archipelago	Island	River	Date	Collectors	COI 446 bp	COI 199 bp	COI 106 bp	COI 110 bp
MNHN-IC-2020-0476	5249	<i>Ophiocara ophicephalus</i>	Micronesia	Pohnpei	Petoglyphs	14 Mar. 2012	Keith <i>et al.</i>	X	X		X
MNHN-IC-2020-0476	12528	<i>Ophiocara ophicephalus</i>	Micronesia	Pohnpei	Petoglyphs	14 Mar. 2012	Keith <i>et al.</i>	X	X		X
	12529	<i>Ophiocara ophicephalus</i>	Micronesia	Pohnpei	Petoglyphs	14 Mar. 2012	Keith <i>et al.</i>				X
	MH085797	<i>Ophiocara ophicephalus</i>	Indonesia	Bali	see GeneBank	see GeneBank	see GeneBank	X	X	X	X
	JN021238	<i>Ophiocara ophicephalus</i>	Philippines	–	see GeneBank	see GeneBank	see GeneBank	X	X	X	X
	JN021237	<i>Ophiocara ophicephalus</i>	Philippines	–	see GeneBank	see GeneBank	see GeneBank	X	X	X	X
	JN021236	<i>Ophiocara ophicephalus</i>	Philippines	–	see GeneBank	see GeneBank	see GeneBank	X	X	X	X
	JN021235	<i>Ophiocara ophicephalus</i>	Philippines	–	see GeneBank	see GeneBank	see GeneBank	X	X	X	X
NTM A 02873	94	<i>Ophiocara ophicephalus</i>	Australia	–	Coastal FNO, Holloways Lake	–	–	X	X		X
NTM S.17970-002 (NTM A 04457)	95	<i>Ophiocara ophicephalus</i>	Australia	Australia, NT	Darwin Harbour, Drain on Tiger Brennan Drive	–	–	X	X		
	GOBY131-07	<i>Ophiocara ophicephalus</i>	Australia	Australia, NT	see BOLD	see BOLD	see BOLD	X	X	X	X
	KP194840	<i>Ophiocara ophicephalus</i>	Australia	Australia, QL	see GeneBank	see GeneBank	see GeneBank	X	X	X	X
	KP194189	<i>Ophiocara ophicephalus</i>	Australia	Australia, QL	see GeneBank	see GeneBank	see GeneBank	X	X	X	X
BMNH 1860.3.19.577	–	<i>Syntype Eleotris cantoris</i>	Malaysia	Penang	–	–	Cantor				
BMNH 1860.3.19.581	–	<i>Syntype Eleotris cantoris</i>	Malaysia	Penang	–	–	Cantor				
	KY849537	<i>Ophiocara cantoris</i>	Malaysia	–	see GeneBank	see GeneBank	see GeneBank	X	X	X	
MNHN-IC-A1329	–	<i>Ophiocara cantoris</i>	Cambodge	–	–	Mar. 1961	see GeneBank				
MNHN-IC-1963-0597	–	<i>Ophiocara cantoris</i>	Vietnam	–	–	1876	diAubenton & Fily Harmand				
NTM S.17453-002 (NTM A 01791)	93	<i>Ophiocara cantoris</i>	Singapour	Singapour	Observatory Pulau Urbin	16 Oct. 2012	Larson & Party		X		

above posterior nostril. A transverse line between anterior and posterior nostrils. Clusters of pit organs before first transverse line on cheek. Two longitudinal lines on cheek. A longitudinal line from pore behind eye to a little over one pore above uppermost pore on preopercle. Three short transverse lines before lowest pore on opercle extending as a line of clusters of pit organs on lower jaw. Another line along with it on the outer side. On symphysis of lower jaw, a longitudinal line on each side. A transverse line between uppermost pore on preopercle and one pore above it. A transverse line with a longitudinal branch on opercle. An oblique line on posterior part of opercle (Fig. 1).

### DNA extraction and amplification of partial cytochrome oxidase I gene (*COI*)

The present study is based on specimens collected between 1826 and 2020 (Tab. I). For the oldest the DNA was difficult to extract and amplify. As a consequence, two extraction protocols and three couples of primers were used. For recent collected specimens, total DNA was extracted using Macherey & Nagel NucleoSpin® Tissue kits following the manufacturer's instructions on an Eppendorf EpMotion 5075 whereas a QIAamp DNA Mini Kit was used for the other specimens.

The DNA of 48 specimens of *Ophiocara* (Tab. I), and of a specimen of *Giuris aporocephalus* from Papua New Guinea used as outgroup, were amplified for the barcoding fragment of the *COI* gene (446 bp). This fragment was amplified with the specific fish primers TelF1 and TelR1 (Dettai *et al.*, 2011). But as the amplification was not efficient for all samples, these primers were modified to better grip on the barcoding fragment (this study): TelF1-O 5' ACCAT-AAAGACATTGGCACCCTTTATC3' and TelR1-O 5' ACTTCRGGGTGCCCAAAGAATCAGAA3'. DNA amplification was performed by PCR in a final 20 µL volume containing 5% DMSO, 1 µL of BSA, 0.8 µL of dNTP 6.6 µM, 0.15 µL of Qiagen Taq DNA polymerase, using 2 µL of the buffer provided by the manufacturer, and 0.4 µL of each of the two primers at 10 pM; 1.2 µL of DNA extract was added. After denaturation for 2 min at 94°C, the PCR was run for 55 cycles of (25s, 94°C; 25s, 52°C; 55s, 72°C) on a Bio-Rad C1000 Touch Thermal Cycler. Successful PCRs were selected on ethidium-bromide stained agarose gels. Sanger sequencing was performed in both directions by a commercial company (Eurofins; <http://www.eurofins.fr>) using the same primers.

As we had difficulties to amplify the three specimens from NTM (Australia) (Tab. I), specific primers were made. The primers O-94F 5' CCAGACAT-



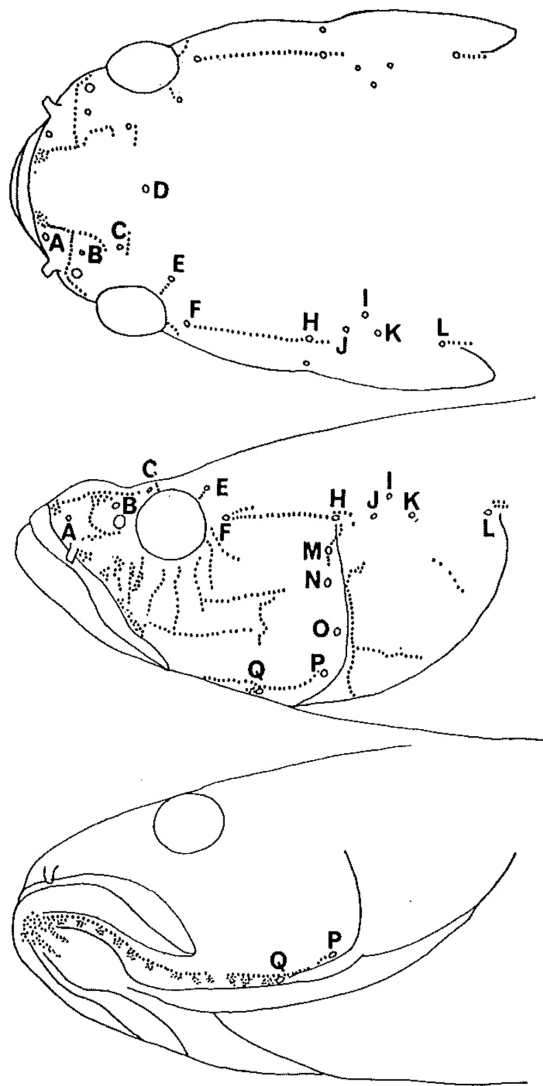


Figure 1. – Head sensory papillae of *Ophiocara* from Akihito and Meguro (1974).

GGCATTCCCTCGAAT3' and O-317 5'TTATATTAAG-GATTGTTGTGATGA3' permitted to amplify 199 bp of the *COI* gene.

The DNA of the several syntypes of *Eleotris porocephala* Valenciennes, 1837 (MNHN-IC-A-1573 from Seychelles and MNHN-IC-A-1574 from New Ireland) and of *Eleotris madagascariensis* Valenciennes, 1837 (MNHN-IC-A-2709 from Madagascar) was sequenced using shotgun-sequencing libraries with a NEBNext® Ultra™ II DNA Library Prep Kit for Illumina®. Shotgun libraries were then sequenced on Illumina HiSeq sequencers following manufacturer instructions.

#### *COI* gene analysis

Data processing and sequence assembly were done in Geneious 11.1.2 (<http://www.geneious.com>, Kearse *et al.*,

2012). Partial *COI* sequences were aligned with Muscle Alignment.

A first phylogenetic tree was performed on the 446 bp alignment using Bayesian inference (MrBayes v.3.2; Ronquist *et al.*, 2012). Three models, corresponding to the three-codon positions, computed in PartitionFinder (Lanfear *et al.*, 2012) (1<sup>st</sup> position, K80 model; 2<sup>nd</sup> position, F81 model; 3<sup>rd</sup> position, HKY+G model) were run for 10 million generations, sampling every 200 generations with two independent runs to access convergence. Run convergence was checked using TRACER v.1.6.0 (Rambaut and Drummond, 2007). Trees were summarised using the 50% majority rule method after discarding the first 25% of the sample as burnin and visualised using FigTree v.1.4.2 (Rambaut, 2007). The sequence of *Giuris aporocephalus* (Eleotridae) was included as outgroup and 11 sequences of *Ophiocara* from BOLD ([www.barcodinglife.org](http://www.barcodinglife.org)) and Genbank were added (Tab. I). The percentage of divergence between sequences was calculated with Geneious 11.1.2 software (Suppl. data).

As we had only 199 bp for the three specimens from NTM (Australia), a neighbor-joining (NJ) tree with Kimura2 parameter model was built to perform hierarchical placement to identify the short sequences on MEGA version X (Kumar *et al.*, 2018; Stecher *et al.*, 2020). The robustness of cluster nodes was estimated by the bootstrap method with 1000 replicates.

A map to reference was used to find *COI* fragments in the shotgun libraries from complete *COI* genes of *Ophiocara* species (pers. data); the consensus was checked manually (assembly success, coverage assessment, BLAST searches; Altschul *et al.*, 1997) in Geneious.

With *COI* fragments obtained from syntypes specimens (106, 110 and 654 bp), two neighbor-joining (NJ) trees with Kimura2 parameter model were built to perform hierarchical placement to identify the short sequences (*i.e.* *Eleotris porocephala* MNHN-IC-A-1573 from Seychelles and MNHN-IC-A-1574 from New Ireland; *Eleotris madagascariensis* MNHN-IC-A-2709 from Madagascar) on MEGA version X. The robustness of cluster nodes was estimated by the bootstrap method with 1000 replicates.

## RESULTS

#### DNA Barcode analysis

Four trees are given depending of the number and position of the *COI* gene base pairs obtained (*i.e.* 446, 199, 110 and 106 bp). Pairwise distances are given only for the Bayesian tree (446 bp) (Suppl. data).

The first phylogenetic tree based on 446 bp (Fig. 2) presents 3 clades: the clade A is composed of a specimen collected in Malaysia and separated by 8.5% of divergence (d) with the clades B and C; the clade B is composed of speci-

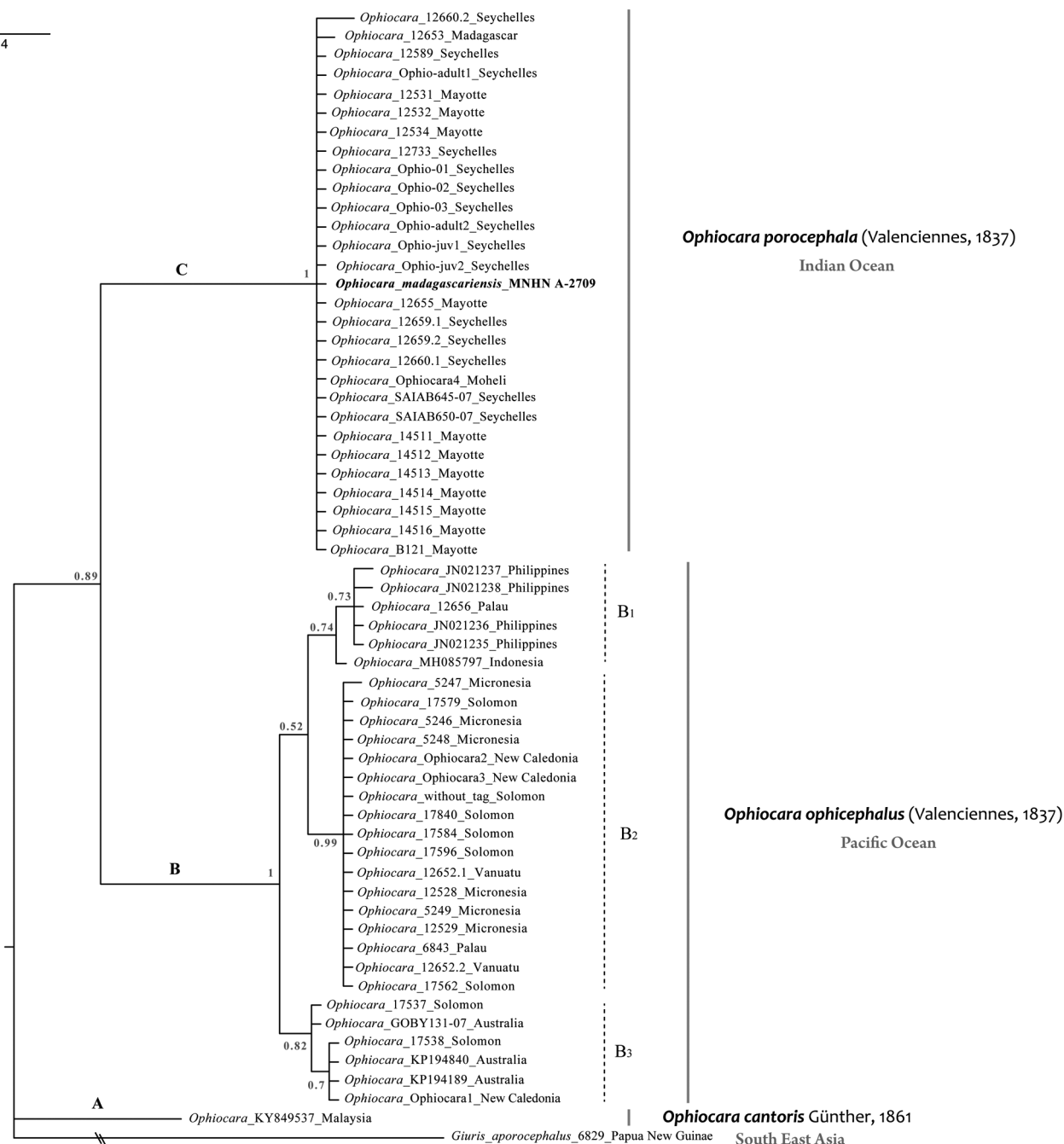


Figure 2. – Bayesian tree of the cytochrome c oxidase subunit (COI; 446 bp) for sequenced specimens of *Ophiocara*. Numbers at each node represent posterior probabilities.

mens collected in the Pacific Ocean (Philippines, Micronesia, Vanuatu, Solomon Is., New Caledonia, Australia etc.) with three lineages separated by 1.2%, 1.4% and 1.6% of divergence (respectively B<sub>2</sub> vs B<sub>3</sub>, B<sub>1</sub> vs B<sub>2</sub> and B<sub>1</sub> vs B<sub>3</sub>); this clade B diverges from 8.2% with clade C which is composed of specimens collected in the Indian Ocean (Comoros, Seychelles, Mayotte, Madagascar). This last clade also includes one syntype of *Eleotris madagascariensis* Valenci-

ennes, 1837 (MNHN-IC-A-2709).

The three NJ distance trees (Fig. 3A-C) with short length of the COI gene (respectively 199, 110 and 106 bp) provide a good discrimination of the syntypes specimens sequenced and those from NTM. Indeed, the two specimens collected in Australia (NTM A04457 and A02873) are in clade B and, the one sampled in Singapore (NTM A01791) is in clade A (199pb, Fig. 3A). With the two other NJ distance trees



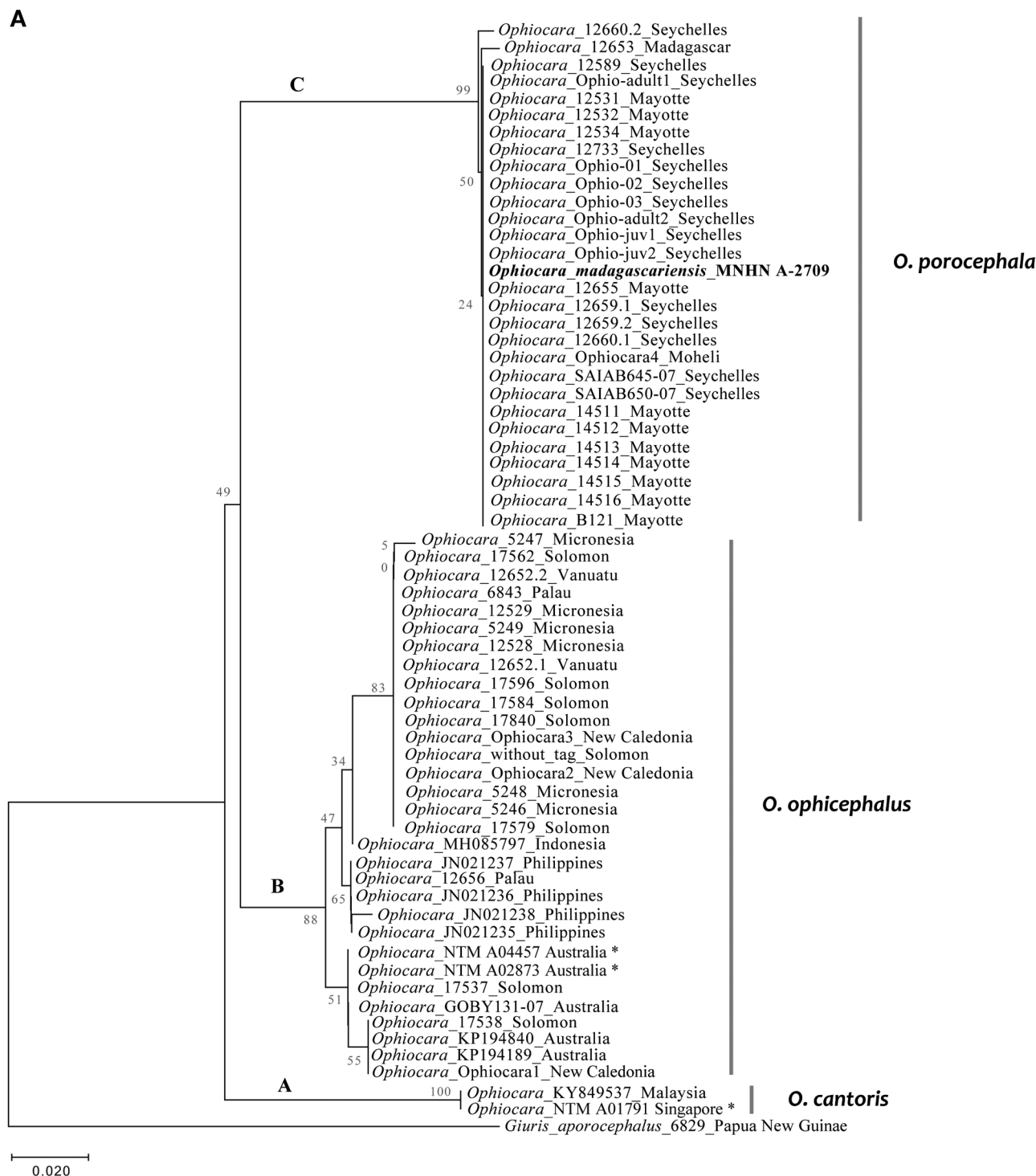


Figure 3. – Barcoding NJ K2P trees of the cytochrome c oxidase subunit for sequenced specimens of *Ophiocara* including three syntypes from MNHN collection; *Eleotris porocephala* Valenciennes, 1837 from New Ireland (Papua New Guinea) (MNHN-IC-A-1574) and from Seychelles (MNHN-IC-A-1573), and *E. madagascariensis* Valenciennes, 1837 (MNHN-IC-A-2709). Numbers at each node represent bootstrap values. For all trees, MNHN syntypes are in bold. In tree (A) [199 bp], the three specimens from the Museum & Art Gallery of the Northern Territory (NTM, Australia) are highlighted with a star; Tree (B) [110 bp]; Tree (C) [106 bp].

(110 bp, Fig. 3B and 106 bp, Fig. 3C), we were able to place types in the trees. A syntype of *Eleotris porocephala* Valenciennes, 1837 from New Ireland (PNG) (MNHN-A-1574) is included in clade B [Pacific Ocean] (Fig. 3B) whereas a syn-

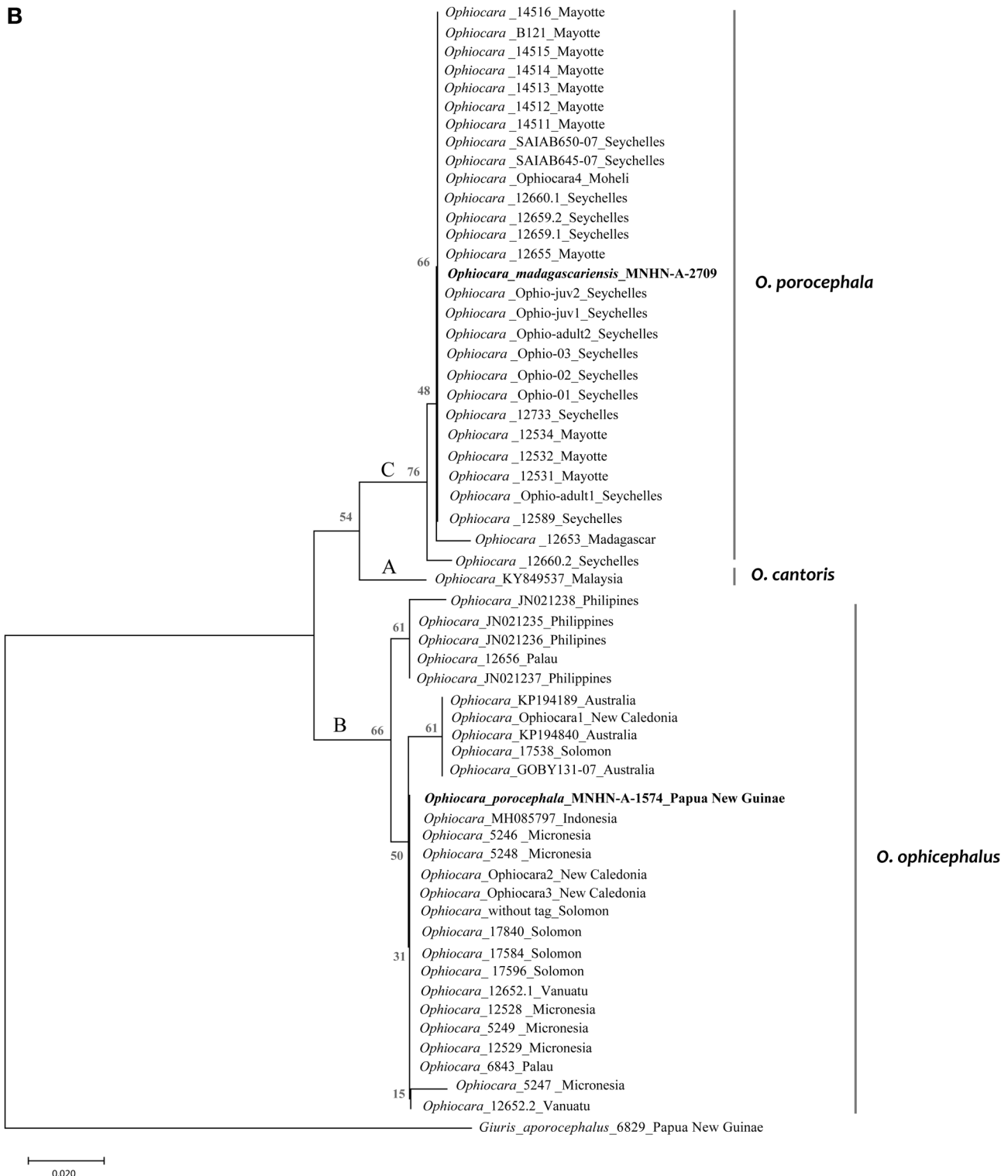


Figure 3. – Continued.

type of *E. porocephala* from Seychelles (MNHN-A-1573) is included in clade C [Indian Ocean] (Fig. 3C) with the syn-type of *E. madagascariensis* (MNHN-A-2709).

To conclude, according to our four trees, 3 clades were identified and the main results are that (i) three candidate species of *Ophiocara* are in our studied samples (Clades A, B,

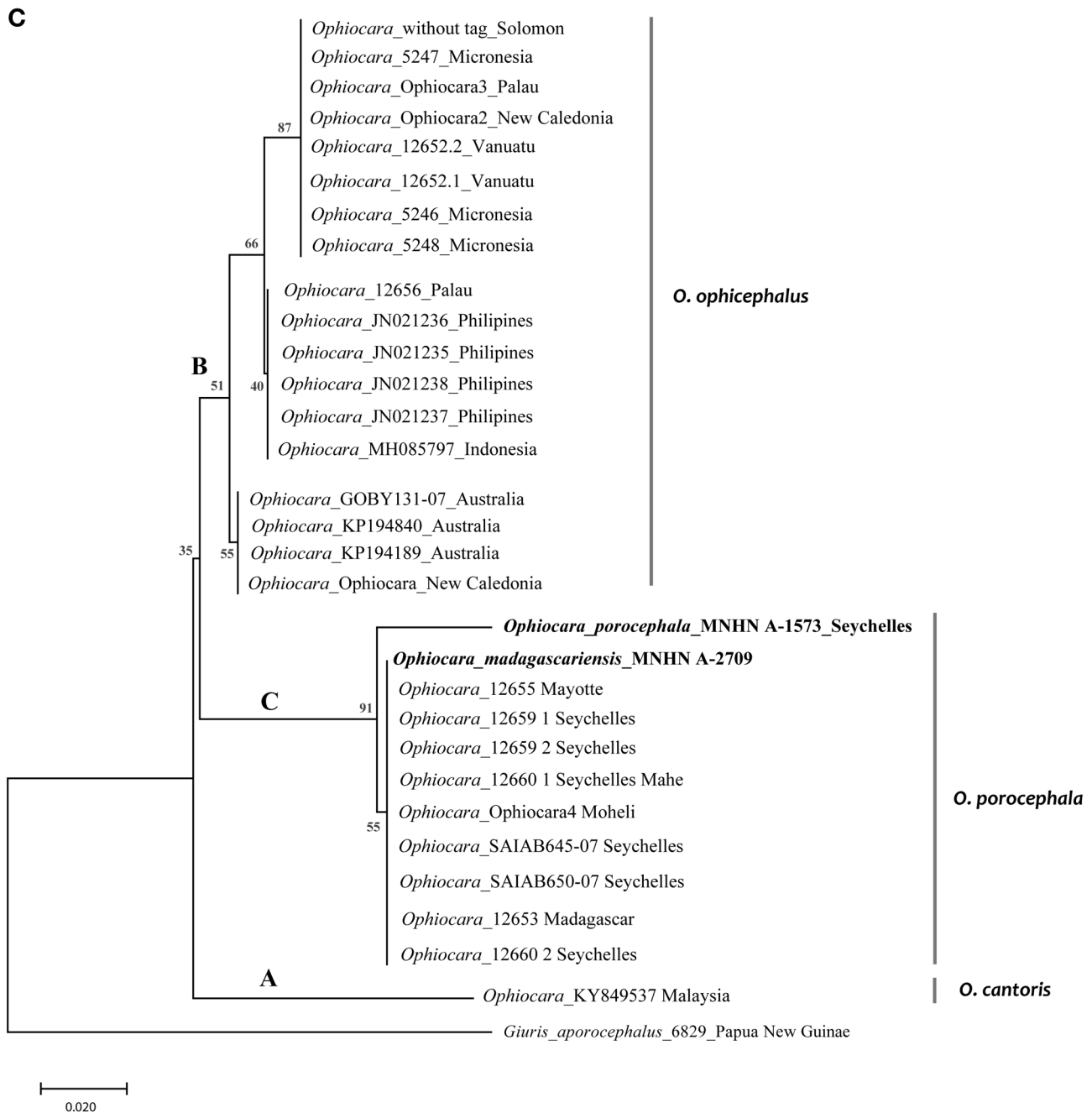


Figure 3. – Continued.

C), (ii) the syntype of *Eleotris porocephala* sequenced from New Ireland Island (Papua New Guinea) (clade B) is not in the same clade than the syntype sequenced from Seychelles (clade C), and (iii) the sequenced syntype of *E. madagascariensis* is in the same clade than the sequenced syntype of *E. porocephala* from Seychelles (clade C).

### Morphomeristics

After examination and measurement of the nearly 90 studied specimens (including type specimens), the morphological and meristic data showed that 3 species were represented in our samples, each corresponding to our 3 genetic clades: one in the Indian Ocean, two in the Pacific Ocean (see below, discussion, tables II-III, Suppl. data and Figs 2-3). The species differ by several characters including

Table II. – Selected scale counts in *Ophiocara*.

	Lateral series							
	32	33	34	35	36	37	38	39
<i>O. porocephala</i>				3	9	5		
<i>O. ophicephalus</i>	3	6	6	1				
<i>O. cantoris</i>						2	2	1

	Transverse backward			Transverse forward				
	11	12	13	16	17	18	19	20
<i>O. porocephala</i>		9	8	5	7	5		
<i>O. ophicephalus</i>	10	6		6	6	1	3	
<i>O. cantoris</i>	1	2	2			3	1	1

	Zigzag series			Predorsal series						
	8	9	10	21	22	23	24	25	26	27
<i>O. porocephala</i>	1	11	5	2	6	6	3			
<i>O. ophicephalus</i>	11	5			2	13	1			
<i>O. cantoris</i>	3	2						2	2	1

the number of scales in lateral, transverse backward, zigzag, and predorsal series.

## DISCUSSION

Valenciennes (1837) described, in the same volume (v. 12) of *Histoire naturelle des Poissons*, *E. porocephala* (p. 237), *E. ophicephalus* (p. 239) and *E. madagascariensis* (p. 240). The first two names were in frequent usage until Koumans (1953) who treated *ophicephalus* as a synonym of *porocephala* and that has been subsequently followed. Many authors have considered that these three names referred to the same species and used *Ophiocara porocephala* (Valenciennes, 1837) as the valid name. Nevertheless, Kottelat (2013) considered that Günther (1861) was the first reviser treating *porocephala* as a synonym of *ophicephalus* and he gave precedence to *ophicephalus*.

Our genetic and morphomeristic results show that three species of *Ophiocara* exist in the Indo-Pacific area, two in the Pacific Ocean (clades A, B) and one in the Indian Ocean (clade C). For the species the most largely distributed in the Pacific (clade B in our trees), after the examination of the holotype, we retain the name of *O. ophicephalus* (Valenciennes, 1837). It was collected on the Pacific side of Java by Kuhl and van Hasselt. They arrived at Batavia (now Jakarta) in December 1820, and set about investigating and collecting the fauna and flora of Batavia, Buitenzorg (now Bogor) and neighbouring areas (Roberts, 1993).

For the species found in Indian Ocean (clade C), we retain the name of *O. porocephala* (Valenciennes, 1837). As in the syntypes series of *E. porocephala* two species are

Table III. – Selected morphometrics in *Ophiocara* expressed to the nearest whole percent of standard length.

	Jaw length				Predorsal length							
	14	15	16	17	42	43	44	45	46	47	48	
<i>O. porocephala</i>	5	9	3		2	1	3	7	4			
<i>O. ophicephalus</i>			10	6			3	2	4	3	4	
<i>O. cantoris</i>	1	2	1			2	–	1	2			

	Body depth at anus							Caudal peduncle depth				
	19	20	21	22	23	24	25	13	14	15	16	17
<i>O. porocephala</i>	1	2	2	4	2	3	1		1	4	9	3
<i>O. ophicephalus</i>		1	6	5	1	2	1			8	6	2
<i>O. cantoris</i>	1	–	1	1	1	1		2	1	1	1	

represented (Clades B and C), to avoid confusion, according to ICZN (1999: art. 74.1) we here designate a lectotype (MNHN-IC-2020-0477; see further) taken among the syntypes MNHN-IC-A-1573 from Seychelles Islands (included in the clade C), which become the unique type locality of the species. The remaining specimens (4) of MNHN-IC-A-1573 become paralectotypes (ICZN (1999); art. 74.1.3). According to the trees (Figs 2, 3B) and confirmed by the measurements (Tabs II-III), the other syntypes of *O. porocephala* (MNHN-IC-A-1574) from New Ireland (Papua New Guinea) are not this species but *O. ophicephalus* (Valenciennes, 1837) (clade B).

A syntype (from MNHN-IC-A-2709) of *O. madagascariensis* (Valenciennes, 1837), from Madagascar, is included in the Indian Ocean clade (Clade C, Fig. 2) with one of the syntype of *O. porocephala* from Seychelles; *O. madagascariensis* is thus considered as a synonym of *O. porocephala*. According to Kottelat (2013), Smith (1958) gave precedence to *porocephala*.

It is noted here, after examination of the syntype MNHN-IC-A-1683 of *O. madagascariensis*, that this specimen is not *Ophiocara* but *Eleotris*.

For the last species of *Ophiocara* (Clade A) from Singapore and Malaysia, after examination of the BMNH syntypes of *Ophiocara cantoris* (Günther, 1861) (BMNH 1860.3.19.577 and 1860.3.19.581), we consider that the specimens belong to this species. Günther (1861) indicated that the species was based on *Eleotris porocephala* of Cantor from Malaysia, and also of Bleeker (1854) from Amboina. Under ICZN (1999: Article 72.4.1) the specimens from Amboina are also syntypes, but we don't found any information on the RMNH specimens or even if they exist, if so they are probably not labelled as types. Günther also lists other localities, but it is not clear what the basis was, and, according to our results, the species present in Amboina should be *a priori* another species, *i.e.* *O. ophicephalus*. The specimen NMW 22552 (Fig. 4) from the Naturhistorisches Museum of Vienna is also mentioned by Fricke *et al.* (2021) as possibly





Figure 4. – *Ophiocara ophicephalus*, NMW 22552, Fiji; 179 mm SL (Photo NMW, A. Palandacic).

a syntype as well. It was a leg of the Godeffroy Museum to Vienna Museum and it is labelled as collected in Fiji (Kandavu) in 1869 by Eduard de Gräffe<sup>1</sup>. Considering the date of collection (8 years after the description by Günther) and the locality (Fiji), we do not consider this specimen as one of the Günther types and, according to our genetic results and measurements, the species from Fiji is another species, *i.e.* *O. ophicephalus*. For these reasons, to avoid confusion, according to ICZN (1999: art. 74.1) we here designate a lectotype (BMNH 1860.3.19.577; see further) taken among the BMNH syntypes from Malaysia, which becomes the unique type locality of the species.

Finally, the examination of the holotype of *Sciaena macrolepidota* Bloch, 1792 (ZMB 2155) supposed from Valparaiso, leads to us to conclude that it is not an *Ophiocara* as stated by Fricke *et al.* (2021) but a *Dormitator* (Fig. 5).

The main characteristics of the 3 species are given below as a map given their distribution (Fig. 6).

***Ophiocara ophicephalus* (Valenciennes, 1837)**  
(Figs 2-3, 6-7; Tabs II-III)

*Eleotris viridis* Bleeker, 1849; Madura Straits near Surabaya and Kammal, Java, Indonesia, Bleeker coll.; syntype: RMNH 6197.

*Agonostoma darwiniense* Macleay, 1878; Port Darwin, Northern Territory, Australia; syntype: AMS I.14855.

<sup>1</sup> The Godeffroy Museum was a private natural history museum in Hamburg, founded in 1861 and dispersed in 1878. Most of its collections were taken over by other natural history museums in Germany. In 1860, Johan Cesar IV Godeffroy who wanted to create his museum, invited a young Swiss doctor, Eduard de Gräffe (1833-1919), to come and help him create his museum and participate in the collection of specimens in the Pacific. Gräffe participated for ten years in this enterprise and travelled, alone or accompanied by other collectors, to Australia, Samoa, Tahiti, Fiji, Tonga.

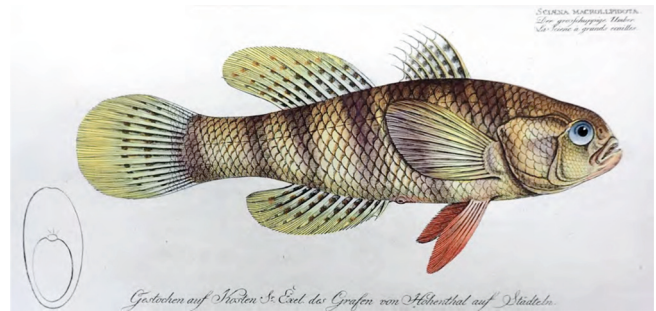


Figure 5. – *Sciaena macrolepidota*, drawing from Bloch (1797).

*Lindemanella iota* Whitley, 1935; Freshwater creek on Lindeman Island, northern Queensland, Australia; holotype (unique): AMS IA.6411.

*Eleotris kuak* Montrouzier, 1857; Woodlark Island, Papua New Guinea; MGHNL (lost).

**Material examined**

*Holotype* (unique). – MNHN-IC-A-1569 (113 mm SL) Java, Indonesia.

*Others*. – MNHN-IC-A-1574, syntypes of *Eleotris porocephala* Val. in Cuvier & Valenciennes, 1837; 2 males (134-164 mm SL), New Ireland Island, Bismarck Archipelago, Quoy & Gaimard coll. RMNH 6197, syntype of *Eleotris viridis* Bleeker, 1849; Madura Straits near Surabaya and Kammal, Java, Indonesia. AMS I.14855, syntype of *Agonostoma darwiniense* Macleay, 1878; 106 mm SL, Port Darwin, Northern Territory, Australia. AMS IA.6411, holotype (unique) of *Lindemanella iota* Whitley, 1935; juvenile (165 mm SL), Freshwater creek on Lindeman Island, northern Queensland, Australia. MNHN-IC-2000-1269, female (109 mm SL), New Caledonia, 1999, Marquet coll. MNHN-IC-2001-2910, female (87 mm SL), New Caledonia, 1999, Marquet coll. MNHN-IC-2020-0182, 1 female, 1 juvenile (52.3-78.3 mm SL), Bilata, Choiseul, Solomon Is., 19 Oct. 2019, Keith, Boseto, Lord & Causse coll.; tags 17579, 17584. MNHN-IC-2020-0183, male (84.3 mm SL), Tukutu, Choiseul, Solomon Is., 19 Oct. 2019, tag 17596. MNHN-IC-2020-0184, male (94 mm SL), Simbe, Choiseul, Solomon Is., 20 Oct. 2019; tag 17562. MNHN-IC-2020-0185, female (77 mm SL), Venoui, Santo, Vanuatu, 15 July 2005, Keith & Marquet coll.; tag 12537. MNHN-IC-2020-0475, juvenile (51 mm SL), small river, Palau, 02 March 2011, Keith *et al.* coll.; tag 6843. MNHN-IC-2020-0476, 1 male, 2 females (of 6) (68.7-82.6 mm SL), Petroglyphs, Pohnpei, Micronesia, 14 March 2012, Keith *et al.* coll.; tags 5246, 5247, 12528.

**Diagnosis**

The species usually has 32-34 lateral scales, 22-24 predorsal scales, 8-9 zigzag scales and the jaw length is 16-17% SL.

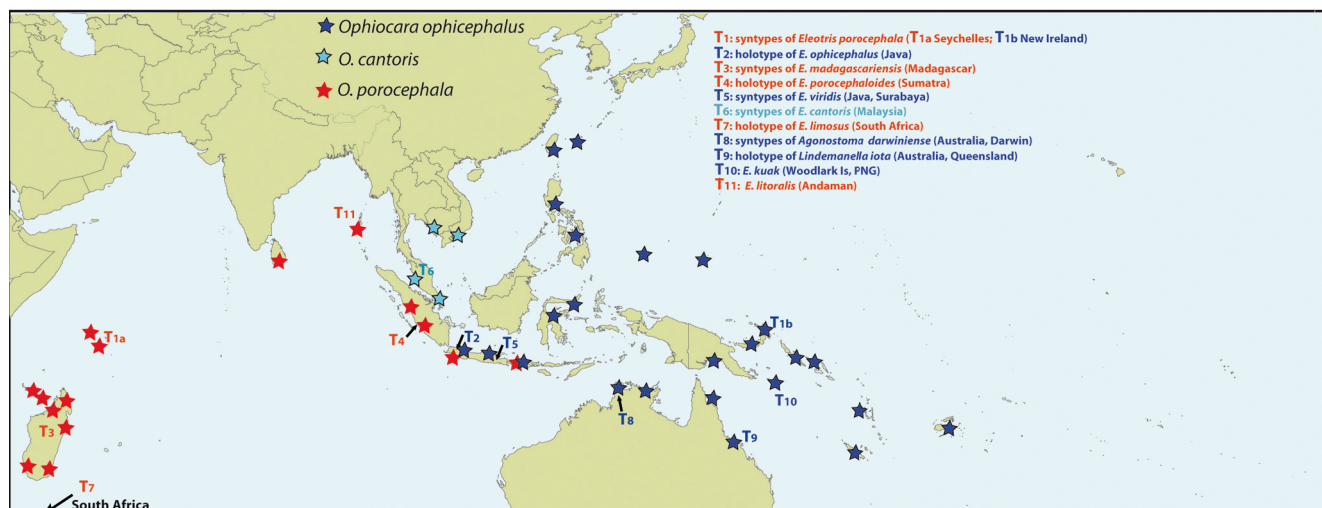


Figure 6. – Distribution of *Ophiocara* species.

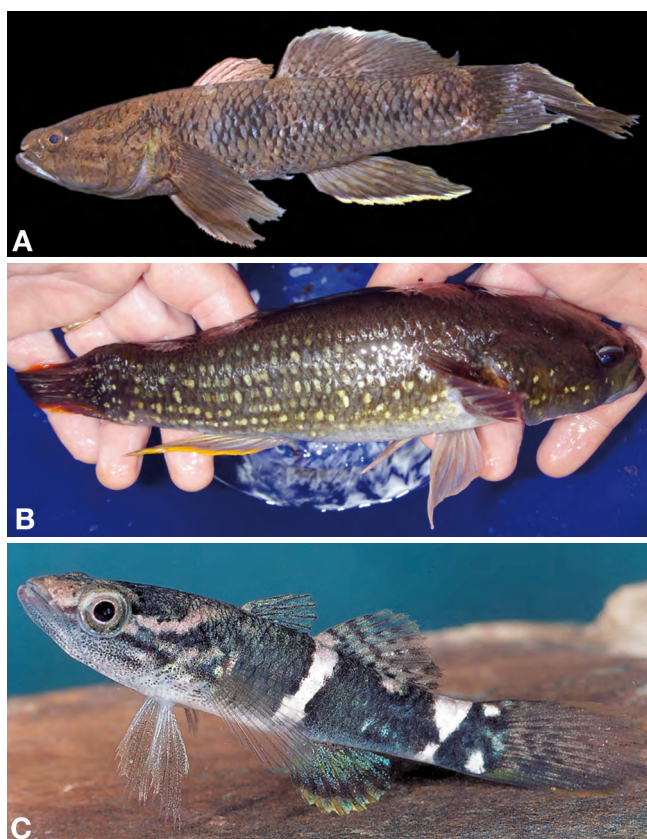


Figure 7. – **A:** *Ophiocara ophicephalus*, male, New Caledonia (Photo N. Charpin); **B:** *Ophiocara ophicephalus*, male, 'silver dotted pattern', New Caledonia (Photo L. Taillebois); **C:** *Ophiocara ophicephalus*, juvenile, New Caledonia (Photo E. Vigneux).

### Description

The scale counts are given in table II and selected morphometrics in table III.

The body is more ovoid than elongated. The body depth

at anus is 20-24% SL, at first dorsal fin 22-26% SL, and the caudal peduncle depth is 15-16% SL. Predorsal length 44-48% SL and preanal length 63-69% SL. Size: up to 26 cm SL.

The head 37-39% SL is depressed, the snout is convex. The anterior nostrils are long, reaching lower margin of upper lip. The mouth and jaw length 16-17% SL are large with inwardly curved teeth set on both jaws and larger on outer row of upper jaw. Posterior end of maxillary extending below 1/2 or 2/3 of posterior margin of eye. Eye diameter 6-8% SL and interorbital length 11-13% SL.

Dorsal fins VI-I,8 with no filamentous rays. The first dorsal fin is with second, third and fourth rays longer. Anal fin I,7 directly opposite to the second dorsal fin. The caudal fin is with 14-15 branched rays and its posterior margin is rounded. Pelvic fins separate, I,5. Pectoral fins 15, with the posterior margin pointed. Lateral scales usually 32-34 (1 specimen with 35), with ctenoid scales on flanks and caudal peduncle. Cycloid scales from snout to top of head and anterior part of D1, on operculum, on base of pectoral fins and on belly extending to anus. Scales of top of head and back bigger than those of belly. Scales in transverse back series 11-12, in transverse forward 16-19, in predorsal usually 23 (1 specimen with 22 and 1 with 24) and in zigzag usually 8 (4 specimens with 9). Usually 26 vertebrae. Gill opening extending beyond the posterior end of urohyal. Gill rakers 11-13.

Cephalic sensory pore system as described by Akihito and Meguro (1974) and Akihito (1986), with oculoscapular canal nasal to post-temporal with the pores A to L except for G; preopercular canal long with the pores M to Q; oculoscapular canal grooves on nasal, frontal, pterotic and post-temporal; inner side of oculoscapular canal on frontal walled continuously from C to F; preopercular canal groove long.



Head sensory papillae as described by Akihito and Meguro (1974) and Akihito *et al.* (1988).

Males with a rounded/elongated urogenital papilla with distal tip rounded. The females have rectangular or chalice-shaped bulbous urogenital papilla with crenulated outer edges around distal opening.

### Colour in preservation

Background of body brown on the back. The flanks are brownish with some greyish patches. Belly greyish. Top of head brownish, as lateral parts; with sometimes 2 or 3 dark brown stripes radiating from the eye to the cheeks and operculum. The first and second dorsal fins are greyish with 4-5 rows of aligned dark spots along rays. The pelvic, pectoral and anal fins are greyish and without spots.

### Colour in life

*Adults.* – Most common pattern similar for male and female. Usually, background of body brownish to greyish with dark brown or black on the back. Two light whitish or light brown vertical bands on the flanks, sometimes not very visible. The first one from the anterior part of the second dorsal fin to the anterior part of the anal fin, the second one around the caudal peduncle. Two white or light brown spots on hypural base. Top of head brownish, with several whitish or light brown parts between eyes and on nose. Lateral parts brown with 3 dark brown stripes radiating from the eye to the cheeks and operculum. Isthmus and belly dark grey to brown. Bigger specimens mostly brown (Fig. 7A), without any white bands or white spots on the flanks, head or hypural base (white marks less marked on old specimens). The first and second dorsal fins are greyish or light brown with 4-5 rows of aligned dark spots along rays. The pelvic, pectoral and anal fins are grey or light brown. The anal and caudal fins have a light yellow distal part.

A second pattern occurs sometimes in males with a background of body entirely dark grey and covered with numerous small silver or bluish spots, including the caudal fin (named here 'silver or golden dotted pattern'; found in New Caledonia, Palau, Papua New Guinea, Solomon Is. and Vanuatu). The belly is whitish or light grey. The anal, pelvic and caudal fins are grey with a yellowish band at the distal part. The pectoral fins are translucent to grey (Fig. 7B).

*Juveniles.* – Background of body greyish to black on the back. Flanks greyish to black. Two flashy white vertical continuous bands on the flanks, the first one from the anterior part of the second dorsal fin and the medium part of belly, the second one around the caudal peduncle. 2-3 white spots at hypural base. Top of head brownish, with whitish parts between eyes and on nose. Lateral part greyish with 3 dark brown stripes and a white one radiating from the eye to the cheeks and operculum. Isthmus and belly whitish to greyish. The first and second dorsal fins are greyish with 4-5 rows of

aligned dark spots along rays. The pelvic, pectoral and anal fins are translucent. The anal and caudal fins have a light yellow distal part (Fig. 7C).

### Ecology

The species occurs mainly in the vegetation or under rocks in the lower parts of rivers, from tidal influence to 20 m high in altitude, with sandy, muddy or gravel bottoms. In Australia, its distribution is typically confined to short coastal systems but it does penetrate a moderate distance upstream (Pusey *et al.*, 2017). It is carnivorous and feeds on crustaceans, molluscs and fish (Allen and Coates 1990; Marquet *et al.*, 2003; Nanjo *et al.*, 2008; Keith *et al.*, 2010).

### Distribution

*Ophiocara ophicephalus* is known from the Pacific Ocean from Ryukyu Islands, Taiwan Philippines and Micronesia in the north-west to Indonesia, Papua New Guinea, Solomon Islands, Australia, where it has a patchy northern distribution, New Caledonia, Vanuatu and Fiji Is. in the south-east (Fig. 6).

### Comparison

*Ophiocara ophicephalus* differs from the other species sequenced by having a significant percentage of divergence in *COI* gene (8.2%) (Suppl. data). Moreover, it differs from *O. porocephala* by a combination of characters including fewer scales in lateral series (32-34 vs 35-37), transverse backward series (11-12 vs 12-13) and zigzag series (usually 8 vs usually 9-10), and a greater jaw length (16-17 vs 14-16% SL). The 'silver dotted pattern' (Fig. 7B), known for this species, is unknown for *O. porocephala* and the juveniles have usually fewer vertical interrupted white bands (usually 1) on the flanks than *O. porocephala* (usually 3). *O. ophicephalus* differs from *O. cantoris* by fewer scales in lateral series (32-34 vs 37-39) and predorsal series (22-24 vs 25-27).

### *Ophiocara porocephala* (Valenciennes, 1837)

(Figs 2-3, 6, 8; Tabs II-III)

*Eleotris madagascariensis*, Valenciennes in Cuvier & Valenciennes, 1837, Madagascar, Goudot coll.; syntypes: MNHN-IC-A-2709 (2).

*Eleotris porocephaloides* Bleeker, 1854, Priaman, Sumatra, Indonesia, Bleeker coll.; holotype (unique): RMNH 6198.

*Eleotris limosus* Smith, 1936, Isipingo lagoon, South Africa; holotype (unique): SAIAB 95.

*Eleotris litoralis* Day, 1876, Andaman Islands, east of Bay of Bengal; Holotype (unique): ZSI 111 (lost) [Considered by Kottelat (2013) to be a synonym of *O. ophicephalus*. As the type locality is Andaman, the species should be

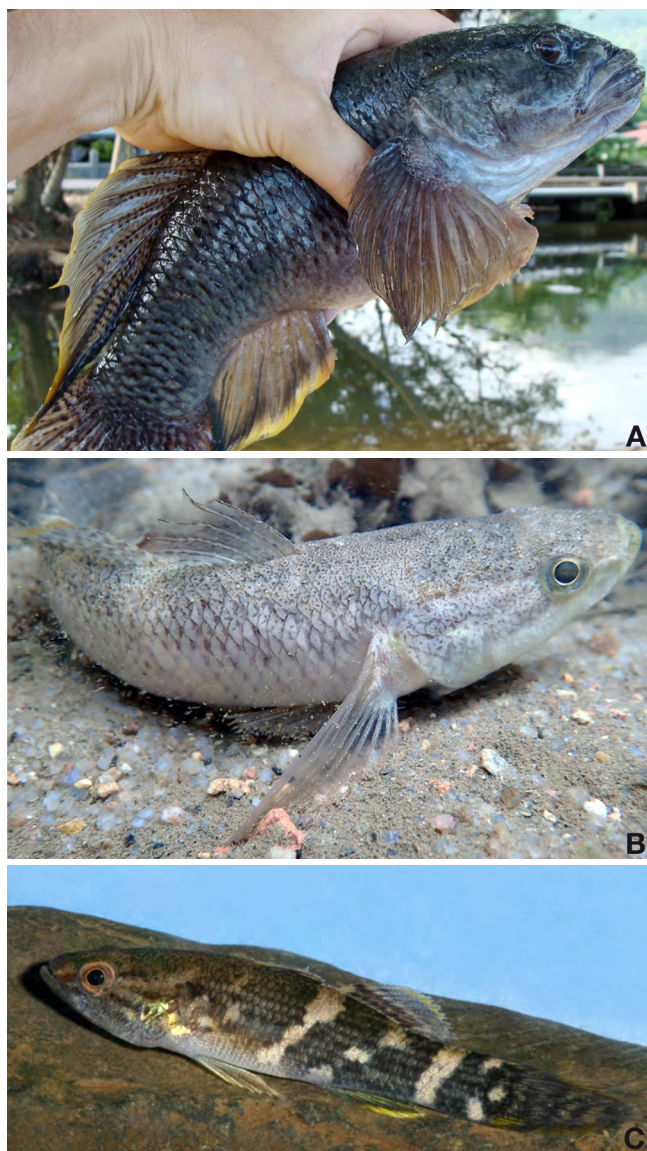


Figure 8. – **A:** *Ophiocara porocephala*, male, Seychelles (Photo J.F. Perrin); **B:** *Ophiocara porocephala*, in vivo, Mahé, Seychelles (Photo P. Keith); **C:** *Ophiocara porocephala*, juvenile, Mayotte, Comoros (Photo P. Keith).

*O. porocephala*, which is distributed in Indian Ocean].

NB: *Eleotris scintillans* Blyth, 1860 from Andaman is generally considered to be a synonym of *Ophiocara ophicephalus* (Kottelat, 2013), but Day (1869) mentioned on the Blyth specimen ‘small scales... and a black ocellus on the upper part of the caudal fin’, and he added later (Day, 1876) that the specimen has 42 lateral scales. These data suggest that *E. scintillans* is probably not an *Ophiocara* but could be an *Incara* (D. Hoese, pers. comm.), which is very similar to *Ophiocara*, but has smaller (and more) scales than *Ophiocara* (never more than 39 LS in *Ophiocara*). We list here this species as *incertae sedis*.

### Material examined

As in the syntypes series of *E. porocephala*, two species are represented (see Clade B and C of our trees) to avoid confusion, according to ICZN (1999: art. 74.1) we here designate a lectotype among the 5 syntypes MNHN-IC-A-1573 from Seychelles Islands, which become the unique type locality of the species.

*Lectotype*. – MNHN-IC-2020-0477, male, 98 mm SL; Seychelles Islands, Dussumier coll. (extracted from MNHN-IC-A-1573).

*Paralectotypes*. – MNHN-IC-A-1573 (4), 93–110 mm SL; Seychelles Islands, Dussumier coll.

*Others*. – MNHN-IC-A-2709, syntypes of *Eleotris madagascariensis*, Val. in Cuvier & Valenciennes, 1837; 2 females (195–203 mm SL), Madagascar, Goudot coll. SAIAB 95, holotype (unique), of *Eleotris limosus* Smith, 1936; 198 mm SL, Isipingo lagoon, South Africa; not seen, data from D. Hoese. RMNH 6198, holotype (unique) of *Eleotris porocephalooides* Bleeker, 1854; Priaman, Sumatra, Indonesia, Bleeker coll. MNHN-IC-1960-0223, female (198 mm SL), Ivolina, Madagascar, Kiener coll. MNHN-IC-2020-0177, male (127.4 mm SL), Antalaviana, Madagascar, May 2010, Diamsoi coll.; tag 12653. MNHN-IC-2020-0178, 1 male, 2 females (70–130 mm SL), Dembéné, st 026, Mayotte, Comoros, 12 Aug. 2019, Valade *et al.* coll.; tags 14512, 14513, 14514. MNHN-IC-2020-0480, Tahiti plage, Mayotte, Comoros, 16 May 2006, Keith & Arda coll.; tags 12531, 12532, 12534. MNHN-IC-2006-0603, female (117 mm SL), Mjawatché, Mohéli, Comoros, 31 Oct. 2005, Keith & Marquet coll. MNHN-IC-2020-0179, female (66 mm SL), Gorre, Mahé, Seychelles, 2 Feb. 2020, Mennesson, Keith & Henriette coll.; tag 12589. MNHN-IC-2020-0180, male (60 mm SL), Anse petite court, Praslin, Seychelles, 23 Feb. 2020, Mennesson, Keith & Henriette coll.; tag 12733. MNHN-IC-2020-0181, 2 males (of 8) (69–93 mm SL), Nouvelle-Découverte, Praslin, Seychelles, 8 Oct. 2003, Keith & Arda coll.; tags 12523, 12524.

### Diagnosis

The species usually has 35–37 lateral scales, 21–24 predorsal scales, 9–10 zigzag scales and the jaw length is 14–16% SL.

### Description

Below, the lectotype counts are given first, followed in brackets, if different, by the other specimens counts. The scale counts are given in table II and selected morphometrics in table III.

The body is more ovoid than elongated. The body depth at anus is 22 (19–26% SL), at first dorsal fin 21 (20–26% SL), and the caudal peduncle depth is 17 (14–17% SL). Predorsal length 44 (42–46% SL) and preanal length 68 (61–69% SL). Size: up to 27 cm SL.

The head 37 (33-39% SL) is depressed, the snout is convex. The anterior nostrils are long, reaching lower margin of upper lip. The mouth and jaw length 15 (14-16% SL) are large with inwardly curved teeth set on both jaws and larger on outer row of upper jaw. Posterior end of maxillary extending below 1/2 or 2/3 of posterior margin of eye. Eye diameter 6 (6-8% SL) and interorbital length 13 (11-14% SL). Usually 26 vertebrae. Gill opening extending beyond the posterior end of urohyal. Gill rakers 12-13.

Dorsal fins VI-I, 8 with no filamentous rays. The first dorsal fin is with second, third and fourth rays longer. Anal fin I, 7 directly opposite to the second dorsal fin. The caudal fin is with 14-15 branched rays and its posterior margin is rounded. Pelvic fins separate, I, 5. Pectoral fins 15, with the posterior margin rounded. Lateral scales 35 (35-37), with ctenoid scales on flanks and caudal peduncle. Cycloid scales from snout to top of head and anterior part of D1, on operculum, on base of pectoral fins and on belly extending to anus. Scales of top of head and back bigger than those of belly. Scales in transverse back series 13 (12-13), in transverse forward 17 (16-18), in predorsal 22 (21-24) and in zigzag usually 9 (9-10) (1 specimen with 8).

Cephalic sensory pore system as described by Akihito and Meguro (1974) and Akihito (1986) with oculoscapular canal nasal to post-temporal with the pores A to L except for G; preopercular canal long with the pores M to Q; oculoscapular canal grooves on nasal, frontal, pterotic and post-temporal; inner side of oculoscapular canal on frontal walled continuously from C to F; preopercular canal groove long. Head sensory papillae as described by Akihito and Meguro (1974) and Akihito *et al.* (1988).

Males with a rounded/elongated urogenital papilla with distal tip rounded. The females have rectangular or chalice-shaped bulbous urogenital papilla with crenulated outer edges around distal opening.

### Colour in preservation

Background of body brown on the back. The flanks are brownish with some greyish patches. Belly greyish. Top of head brownish, as lateral parts; with sometimes 2 or 3 dark brown stripes radiating from the eye to the cheeks and operculum. The first and second dorsal fins are greyish with several rows of aligned dark spots along rays. The pelvic, pectoral and anal fins are greyish and without spots.

### Colour in life

*Adults.* – Most common pattern similar for male and female. Background of body dark grey to black on the back. Flanks greyish to black. Four to five light brown or whitish interrupted bands on the flanks, sometimes not very visible. The first one (if exists) below the first dorsal fin, the second one from the anterior part of the second dorsal fin to the medium part of belly, the third one from the poste-

rior part of the second dorsal fin to the anterior part of the anal fin, the fourth around the caudal peduncle, and the fifth at the hypural base. Top of head brownish, with sometimes whitish parts between eyes and on nose. Lateral part brown with 3 dark brown stripes and sometimes a white one radiating from the eye to the cheeks and operculum. Isthmus and belly greyish. Bigger specimens mostly dark grey (Fig. 8A), without any white bands or white spots on the flanks, head or hypural base (white marks less marked on old specimens). The first and second dorsal fins are greyish with several rows of aligned dark spots along rays. The pelvic, pectoral and anal fins are grey. The anal and caudal fins have a light yellow distal part (Fig. 8A, B).

*Juveniles.* – Background of body greyish to black on the back. Flanks greyish to black. Five vertical white bands on the flanks, two well marked flashy continuous bands; the first one, from the anterior part of the second dorsal fin to the medium part of belly, the second one, around the caudal peduncle; and three interrupted bands, the first one below the first dorsal fin, the second one from the posterior part of the second dorsal fin to the anterior part of the anal fin, and the third one with three white spots on hypural base. Top of head brownish, with whitish parts between eyes and on nose. Lateral part greyish with 3 dark brown stripes and two greyish radiating from the eye to the cheeks and operculum. A gold spot on operculum. Isthmus and belly whitish to greyish. The first and second dorsal fins are greyish with 4-5 rows of dark aligned spots along rays. The pelvic, pectoral and anal fins are translucent. The anal and caudal fins have a light yellow distal part (Fig. 8C).

### Ecology

The species occurs mainly in the vegetation or under stones, roots or under leaf litter in the lower parts of rivers and ponds, from tidal influence to 15 m high in altitude, with sandy, muddy or gravel bottoms. It is carnivorous and feeds on crustaceans, molluscs and fish. It is particularly abundant in Seychelles Islands where it dominates the fish communities in rivers and ponds (Keith *et al.*, 2006).

### Distribution

*Ophiocara porocephala* is known from the Indian Ocean from South Africa and Mozambique to Madagascar, Comoros, Seychelles, Andaman Islands and Indian Ocean coast of Sunda Islands and Sumatra (Indonesia) (Fig. 6).

### Comparison

*Ophiocara porocephala* differs from the other species sequenced by having a significant percentage of divergence in *COI* gene (8.2%) (Suppl. data). Moreover, it differs from *O. ophicephalus* by a combination of characters including more scales in lateral series (35-37 vs 32-34), transverse backward series (12-13 vs 11-12) and in zigzag series (usu-



ally 9-10 vs usually 8), and a smaller jaw length (14-16 vs 16-17% SL). The 'silver dotted pattern' (Fig. 7B), known for *O. ophicephalus*, is unknown for *O. porocephala*, and the juveniles have usually more vertical interrupted white bands (3) on the flanks than *O. ophicephalus* (1). *O. porocephala* differs from *O. cantoris* by fewer scales in lateral series (35-37 vs 37-39), transverse forward series (16-18 vs 18-20) and predorsal series (21-24 vs 25-27).

***Ophiocara cantoris* (Günther, 1861)**

(Figs 2-3, 6, 9-10; Tabs II-III)

**Material examined**

As there are confusions on the syntypes series of this species (see our previous discussion), according to ICZN (1999: art. 74.1) we here designate a lectotype among the BMNH syntypes.

*Lectotype*. – BMNH 1860.3.19.577 (98 mm SL; half skin), Penang, Malaysia.

*Paralectotype*. – BMNH 1860.3.19.581 (110 mm SL; half skin), Penang, Malaysia.

*Others*. – *Ophiocara* sp, NTM S.17453-002, male (63 mm SL), Creek off Observatory, Pulau Ubin, Singapore, 16 Oct. 2012, Larson & Party coll. MNHN-IC-A-1329, male (107.6 mm SL), Vietnam, 1876, Harmand coll. MNHN-IC-1963-0597, male (90 mm SL), Cambodia, March 1961, d'Aubenton & Fily coll.

**Diagnosis**

The species usually has 37-39 lateral scales, 25-27 predorsal scales, 8-9 zigzag scales and the jaw length is 14-16% SL.

**Description**

Below, the lectotype counts are given first, followed in brackets, if different, by the other specimens counts. The scale counts are given in table II and selected morphometrics in table III.

The body is more ovoid than elongated. The body depth at anus is 21 (19-24)% SL, at first dorsal fin 23 (21-26)% SL, and the caudal peduncle depth is 13 (13-16)% SL. Predorsal length 43 (43-46)% SL and preanal length 64 (64-69)% SL.

The head 33 (32-37)% SL is depressed, the snout is convex. The anterior nostrils are long, reaching lower margin of upper lip. The mouth and jaw length 15 (14-16)% SL are large with inwardly curved teeth set on both jaws and larger on outer row of upper jaw. Posterior end of maxillary extending below 1/2 or 2/3 of posterior margin of eye. Eye diameter 6 (6-8)% SL.

Dorsal fins VI-I, 8 with no filamentous rays. The first dorsal fin is with second, third and fourth rays longer. Anal fin I, 7 directly opposite to the second dorsal fin. The cau-



Figure 9. – *Ophiocara cantoris*, lectotype BMNH 1860.3.19.577 (above; 98 mm SL) and paralectotype BMNH 1860.3.19.581 (below; 110 mm SL) (Photo BMNH, N. Martin).



Figure 10. – *Ophiocara cantoris*, NTM S.17453-002, Singapore; 63 mm SL (Photo NTM, M. Hammer).

dal fin is with 15-branched rays and its posterior margin is rounded. Pelvic fins separate, I, 5. Pectoral fins 15, with the posterior margin rounded. Lateral scales 38 (37-39), with ctenoid scales on flanks and caudal peduncle. Cycloid scales from snout to top of head and anterior part of D1, on operculum, on base of pectoral fins and on belly extending to anus. Scales of top of head and back bigger than those of belly. Scales in transverse back series 13 (11-13), in transverse forward 18 (18-20), in predorsal usually 25 (25-27) and in zigzag 8 (8-9). Gill opening extending beyond the posterior end of urohyal.

Cephalic sensory pore system as described by Akihito and Meguro (1974) and Akihito (1986), with oculoscapular canal nasal to post-temporal with the pores A to L except for G; preopercular canal long with the pores M to Q; oculoscapular canal grooves on nasal, frontal, pterotic and post-temporal; inner side of oculoscapular canal on frontal walled continuously from C to F; preopercular canal groove long. Head sensory papillae as described by Akihito and Meguro (1974) and Akihito *et al.* (1988).

Males with a rounded/elongated urogenital papilla with distal tip rounded.

**Colour in preservation**

Background of body brown on the back and head. The flanks are brownish with some patches light brown (Fig. 10).

Belly beige. Lateral parts of head light brown. Two beige vertical continuous bands on the flanks, the first one from the anterior part of the second dorsal fin and the medium part of belly, the second one around the caudal peduncle. Several beige spots at hypural base and between the second dorsal and the anal fin. The first and second dorsal fins are brown with 4-5 rows of aligned white spots along rays. The pelvic, pectoral and anal fins are grey and without spots. Caudal fin brown to grey with several whitish dots.

### Colour in life

Unknown

NB: In their book *A Guide to Gobies of Singapore* Larson and Lim (2005) gave live pictures of *Ophiocara* living there but they gave 33-37 lateral scales for the specimens examined and this covers both the lateral scales data of *O. ophicephalus* (32-35) and *O. cantoris* (37-39). According to the known distribution of both species, it is possible that these 2 species live in sympatry in Singapore. Thus, the pictures of the book showing a 'silver dotted pattern' for the adult (as Fig. 7B), and a juvenile with 2 transverse vertical bands (as Fig. 7C) could refer to one or the other species, and unfortunately not necessarily to *O. cantoris*.

### Ecology

With the doubt cited in the above note, Larson and Lim (2005) mentioned that in Singapore *Ophiocara* is 'common in mangrove creeks, prawn ponds and canals in estuarine areas hiding along the stream bank edges among mangrove roots or under logs and leaf litter'.

## DISTRIBUTION

*Ophiocara cantoris* is known from Malaysia, Singapore, Vietnam and Cambodia (Fig. 6).

### Comparison

*Ophiocara cantoris* differs from the other species sequenced by having a significant percentage of divergence in *COI* gene (8.5%) (Suppl. data). Moreover, it differs from *O. porocephala* and *O. ophicephalus* by a combination of characters including more scales in lateral series (37-39 vs 35-37 and 32-34, respectively) and predorsal series (25-27 vs 21-24 and 22-24, respectively).

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The supplementary data are available on our website: <https://sfi-Cybium/2021/45/2> – <https://doi.org/10.26028/cybium/2021-452-003>