Evidence of two species currently under the name of *Eleotris fusca* (Gobioidei: Eleotridae) in the Indian Ocean

by

Marion Isabelle MENNESSON* & Philippe KEITH (1)

Abstract. – The observation of the cephalic free neuromast pattern of the genus *Eleotris* allows to classify the specimens in different groups of species but, as diagnostic characters without overlap are scarce, the morphological identification of the species is difficult. However, genetic analyses, particularly with barcoding (*COI*), facilitate the discrimination between species. In a recent study on the phylogeography of *Eleotris fusca* Bloch & Schneider, 1801 in the Indo-Pacific area, two species have been revealed although they present the same cephalic free neuromast pattern. The first one included specimens mainly from the Pacific Ocean and the second one, specimens from the Indian Ocean. They are separated with a mean pairwise divergence of 5.6% and present 32 diagnostic nucleotide substitutions in the 585 bp of *COI* sequenced. After the examination of all the available types of the synonym of *E. fusca* from the Indian Ocean, we revalidated the name of *Eleotris klunzingerii* Pfeffer, 1893.

Received: 16 Oct. 2016
Accepted: 14 Feb. 2017
Editor: C. Lord

Key words
Eleotridae
Eleotris fusca
Eleotris klunzingerii
Indo-Pacific area
Cryptic species

Résumé. – Mise en évidence de deux espèces confondues sous le nom d'*E. fusca* (Gobioidei : Eleotridae) dans l'océan Indien.

Au sein du genre *Eleotris*, l'observation des patrons de papilles sensorielles céphaliques permet de classer les spécimens dans différents groupes, mais étant donné que les caractères discriminants ne se recouvrant pas sont peu nombreux, l'identification morphologique des espèces est difficile. Cependant, l'apport de la génétique, et notamment du Barcoding (*COI*), facilite la discrimination entre les espèces. Dans une récente étude phylogéographique sur *Eleotris fusca* Bloch & Schneider, 1801 dans la zone Indo-Pacifique, deux espèces ont été mises en évidence bien qu'elles présentent le même patron de papilles sensorielles céphaliques. L'une de ces deux espèces est composée en majorité de spécimens collectés dans l'océan Pacifique alors que la seconde provient de l'océan Indien. Au total, 5,6% de divergence nucléotidique séparent ces deux espèces, soit 32 sites diagnostiques sur les 585 pb séquencées du gène *COI*. Après examen de l'ensemble des types d'*E. fusca* placés en synonymie et natifs de l'océan Indien, nous avons conclu que le nom correspondant à l'espèce cryptique est *Eleotris klunzingerii* Pfeffer, 1893.

In the Indian Ocean area, there are three well-known widespread species of *Eleotris* (Mennesson *et al*., 2016): *Eleotris fusca* Bloch & Schneider, 1801 with a '2.4.6' cephalic free neuromast pattern, *Eleotris acanthopoma* Bleeker, 1853 with a '2.4' pattern and *Eleotris melanosoma* Bleeker, 1853 with a '2.3.4' pattern (see morphomeristics and Fig. 1). These species are euryhaline and found in brackish waters. They are predators and prefer to be close to the riverbank where the current is slow, or in the lentic zones (Keith *et al*., 2010). It is well known that field identification of *Eleotris* species is difficult due to the overlap of meristic characters (Pezold and Cage, 2002), to the difficult observation of the neuromasts, and because all the species are generally brown and look alike.

There are few studies on the taxonomy of the genus *Eleotris* (Pezold and Cage, 2002) and some recent ones, using genetic analyses, found cryptic species (Guimarães-Costa *et al*., 2016; Mennesson *et al*., 2016). A recent phylogeography study of *E. fusca* in the Indo-Pacific area by Mennesson (2016) revealed the presence of a cryptic and endemic species in the Indian Ocean (called *Eleotris* cf. *fusca* in this paper) within the *E. fusca* group. Both have the same cephalic free neuromast pattern. Several species with this neuromast pattern were described in the past in the Indian Ocean and were placed by different authors in synonymy with *E. fusca* (Eschmeyer *et al*., 2016): *Eleotris fornasini* Bianconi, 1857; *Eleotris klunzingerii* Pfeffer, 1893; *Eleotris soaresi* Playfair, 1867; *Eleotris cavifrons* Blyth, 1860; *Eleotris incerta* Blyth, 1860; and *Cheilodipterus culius* Hamilton, 1822.

The aims of this study are to (i) describe the cryptic species found, (ii) compare it with its congeners described in the Indo-Pacific (valid and synonym species), and (iii) assign the correct name to this species.

MATERIALS AND METHODS

Materials

Forty *Eleotris* specimens with the *E. fusca* cephalic free neuromast pattern were sampled in 11 island rivers from the

(1) Muséum national d'Histoire naturelle, UMR 7208 BOREA (MNHN-CNRS-UPMC-IRD-UCBN-UA), CP 026, 57, rue Cuvier, 75231 Paris CEDEX 05, France. [keith@mnhn.fr]
* Corresponding author [mmenness@edu.mnhn.fr]

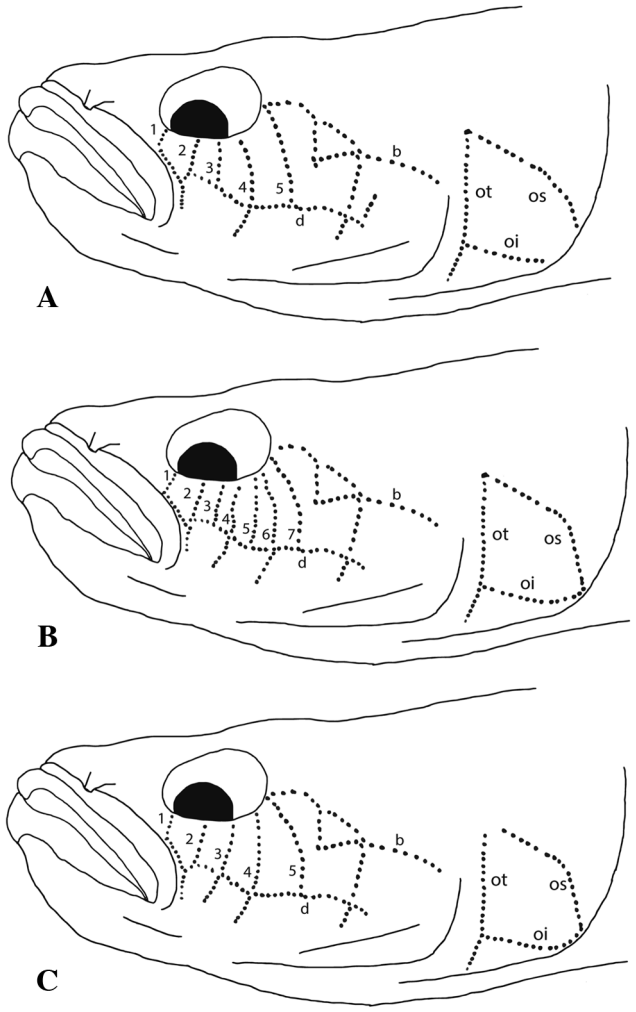

Figure 1. – Schematic illustrations showing main cephalic free neuromast patterns. **A**: *Eleotris acanthopoma* (Holotype, RMNH 25934); **B**: *Eleotris niger* (Syntype, MNHN A.1578) synonym of *E. fusca*; **C**: *Eleotris melanosoma* (Syntype, RMNH 4815).

Indo-Pacific area (Vanuatu, Rarotonga, Moorea, Solomon, Samoa, Reunion, Mayotte, Seychelles, Anjouan, Moheli islands and Madagascar) using a DEKA 3000 electrofishing system (Gerätebau, Marsberg, Germany). They were compared in morphomeristics with three other *Eleotris* species (*E. acanthopoma, E. melanosoma,* and *E. bosetoi*), including type specimens, and deposited in museum collections.

Material examined and comparative material

Eleotris klunzingerii Pfeffer, 1893; ZMH-H412 holotype, 1 male, Zanzibar. MNHN 2016-0089, 1 male, Mayotte, 09 Nov. 2003, Marquet *et al*. coll.; tag 11816. MNHN 2016-0090, 1 male, 2 females, Mayotte, 20 Apr. 2009, Feutry and ARDA coll.; tag 11819, 11820, 11821. MNHN 2016-0091, 1 male, 4 females, Reunion Island, 24 Mar. 2007, Marquet and Zimmermann coll.; 11824, 11826, 11827, 11828, 11829. MNHN 2016-0092, 3 males, 1 female, Reunion Island, ARDA coll.; 12405, 12406, 12407, 12408.

Eleotris fusca Bloch & Schneider, 1801. *Eleotris niger* Quoy & Gaimard, 1824; MNHN A-1578 syntype, male (89 mm SL); Waigeo, Indonesia. *Eleotris vitianus* Sauvage, 1880; MNHN A-1420 syntypes (2 from 4), 2 males (93.3-118 mm SL); Fiji Islands. *Eleotris fornasini* Bianconi, 1857; BMNH 1852.9.13.179 holotype, male (101.8 mm SL); Mozambique. *Eleotris andamensis* Herre, 1939; CAS-SU 37152 paratypes, 2 males (31.7-38.1 mm SL); Andaman Islands. MNHN 2015-0364, 1 male, 1 female (78.2-95.4 mm SL), Samoa, Upolu, 25 Jul. 2008, Keith *et al*. coll.; tags 16023, 16024. MNHN 2015-0365, 2 males, 1 female (45.2-58.2 mm SL), Bali, Tukad Unda, Indonesia, 22 Apr. 2014, Keith *et al*. coll.; tags 12443, 12446, 12447. MNHN 2015-0366, 1 female (58.4 mm SL), Ua Uka, Marquesas, 24 Feb. 2009, Pascal *et al*. coll.; tag 16087. MNHN 2015-0367, 1 male (52.8 mm SL), Kumafa, Papua, 15 Oct. 2010, Keith *et al*. coll.; tag 16015. MNHN 2015-0368, 1 male (32.7 mm SL), Tireloach, Palau, 28 Feb. 2011, Keith *et al*. coll.; tag 16017. MNHN 2015-0369, 1 male (32.7 mm SL), Pohnpei, 14 Mar. 2012, Keith *et al*. coll.; tag 16019. MNHN 2015-0370, 1 male (64.8 mm SL), Lokapava, Choiseul, Solomon, 21 Oct. 2014, Keith *et al*. coll.; tag 13531. MNHN 2015-0371, 1 female (33.8 mm SL), Maewo, Vanuatu, 12 Nov. 2007, Keith *et al*. coll.; tag 16124. MNHN 2015-0372, 1 female (47.3 mm SL), Moorea, French Polynesia, Jun. 2007, Sasal *et al*. coll.; tag 16097. MNHN 2015-0373, 1 female (55.7 mm SL), Rurutu, French Polynesia, Jun. 2001, Keith *et al*. coll.; tag 16094. MNHN 2015-0374, 1 female (62 mm SL), Tubuai, French Polynesia, Jul. 2007, Sasal *et al*. coll.; tag 16086. MNHN 2015-0375, 1 male (71 mm SL), Alegre, Philippines, 5 Feb. 2014, Gaulke *et al*. coll.; tag 12450. MNHN 2015-0376, 1 female (42.6 mm SL), Samoa, Upolu, Palilua River, 24 Jul. 2008, Keith *et al*. coll.; tag 16020. MNHN 2015-0377, 1 male (47 mm SL), Papua, 26 Oct. 2008, Keith *et al*. coll.; tag 16018. MNHN 2015-0378, 1 female (42.6 mm SL), Vanuatu, Epi, Buavinai, 27 Nov. 2014, Mennesson *et al*. coll.; tag 13526. MNHN 2015-0383, juvenile (21.45 mm SL), New Caledonia, Wan Pwé On, 2 Feb. 2013, Taillebois *et al*. coll.; tag L-207. MNHN 2016-0024, 1 male (71.1 mm SL), Moorea, French Polynesia, Jul. 2007, Sasal *et al*. coll.; tag 11777.

Eleotris melanosoma Bleeker, 1853. RMNH 4815 syntype, male (62.4 mm SL); Wahai, Sumatra, Indonesia. *E. soaresi* Playfair, 1867. BMNH 1856.3.18.26-27 syntypes, 2 males (70.1 mm and 101.1 mm SL); Mozambique, Africa. MNHN 2016-0030, male (49.9 mm SL), Vage River, Kolobangara, Solomon, 10 Nov. 2015, Keith *et al*. coll.; tag 12397. MNHN 2016-0031, 1 male (52.9 mm SL), Vanga River, Kolobangara, Solomon, 1 Nov. 2015, Keith *et al*. coll.; tag 12487. MNHN 2016-0032, juvenile (32.8 mm SL), Zamba River, Kolobangara, Solomon, 10 Nov. 2015, Keith *et al*. coll.; tag L-229.

Eleotris bosetoi Mennesson, Keith, Ebner & Gerbeaux, 2016. MNHN 2015-0382 holotype, female (101.6 mm SL), Zamba River, Kolobangara Island, Solomon Islands; 10 Nov. 2015; Keith, Lord, Boseto and Marquet coll.; tag 13558. *Paratypes*: MNHN 2015-0380, female (70 mm SL), Lokasereke River, Choiseul Island,

Solomon Islands; 13 Oct. 2014; Keith, Marquet, Gerbeaux, Boseto and Ebner coll.; tag 13529. MNHN 2015-0379, female (77.6 mm SL), Pisuku River, Choiseul Island, Solomon Islands; 10 Oct. 2014; Keith, Marquet, Gerbeaux, Boseto and Ebner coll.; tag 13528. MNHN 2016-0001, male (49.4 mm SL), Vanga River, Kolobangara Island, Solomon Islands; 18 Nov. 2015; Keith, Lord, Boseto and Marquet coll.; tag 12491.

Eleotris acanthopoma Bleeker, 1853. RMNH 25934 holotype, male (85.7 mm SL); Sumatra, Indonesia. MNHN 2016-0025, 1 male (48.9 mm SL), Moorea, French Polynesia, Jun. 2007, Salsa *et al*. coll.; tag 16098. MNHN 2016-0026, 1 male (44.9 mm SL), Rarotonga, Jul. 2010, Keith *et al*. coll.; tag 16005. MNHN 2016-0027, 1 male (47.8 mm SL), Gaua, Kaska River, Vanuatu, 5 Nov. 2014, Mennesson *et al*. coll.; tag 13546.

DNA analysis

A total of 19 *Eleotris* tissue samples collected in the Indo-Pacific area and held in the Muséum national d'Histoire naturelle (MNHN) (Tab. I) were used for genetic analyses. They included *E. fusca, E.* cf. *fusca, E. melanosoma* and *E. acanthopoma* as well as the types of *E. fornasini* (BMNH 1852.9.13.179) and *E. bosetoi* (MNHN 2015-0380, tag 13529; MNHN 2015-0379, tag 13528; MNHN 2016-0001, tag 12491). For DNA extraction we used Macherey and Nagel NucleoSpin® Tissue kits following the manufacturer's instructions on an Eppendorf EpMotion 5075. A mitochondrial fragment of the *COI* gene (585 bp) was amplified using the specific fish primers TelF1 5'TCGACTAATCAYAAAGAYATYGGCAC3' and TelR1 5'ACTTCTGGGTGNCCAAARAATCARAA3' (Dettai *et al*., 2011). DNA amplification was performed by PCR in a final 20 μL volume containing 5% DMSO, 1 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, 54°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. For the outgroup, we included a sequence of *Hypseleotris agilis* (JN021219) from GenBank.

Data processing and sequence assembly were done in Geneious 9.0.5 (http://www.geneious.com, Kearse *et al*., 2012). All the *COI* sequences were aligned with Muscle Alignment. The phylogenetic analysis was performed using Bayesian inference (MrBayes 3.2; Ronquist *et al*., 2012) with the model HKY + G computed by jModelTest 2.1.1 (Guindon and Gascuel, 2003; Darriba *et al*., 2012). Four independent analyses were run for 10 million generations, sampling every 200 generations. Ten percent of the trees were discarded as burn-in, after having checked that it was sufficient for convergence. After checking convergence had been reached, the trees and parameters resulting from the four analyses were pooled and combined in a consensus. Intra- and inter- specific distances (*p*-distances) were obtained with the Muscle algorithm in Geneious.

Table I. – Details of tissue samples of *Eleotris* specimens used for the DNA analysis. *: *E. fornasini*.

Countries	Islands	*E.* cf. *fusca* (*E. klunzingerii*)	*E. bosetoi*	*E. fusca*	*E. acanthopoma*	*E. melanosoma*
Society Islands	Moorea			MNHN 2016-0024	MNHN 2016-0025	
Cook Islands	Rarotonga				MNHN 2016-0026	
Vanuatu	Maewo				MNHN 2016-0027	
–	Epi			MNHN 2015-0378		
New Caledonia	Grande Terre					
Samoa	Upolu			MNHN 2015-0364		
Salomon	Choiseul		MNHN 2015-0380			
			MNHN 2015-0379			
–	Kolobangara					MNHN 2016-0030
			MNHN 2016-0001			MNHN 2016-0031
						MNHN 2016-0032
Mozambique	–			*BMNH 1852.9.13.179		
Mascarene Islands	Reunion	MNHN 2016-0091				
Seychelles Islands	Silhouette	MNHN ICTI 6638				
Mayotte Island	Mayotte	MNHN 2016-0090				
Comoros Islands	Anjouan	MNHN ICTI 6639				
–	Moheli	MNHN ICTI 6640				
Madagascar	Madagascar	MNHN ICTI 6641				
	Total	N = 6	N = 3	N = 4	N = 3	N = 3

Morphomeristics

Methods follow Keith *et al*. (2012). Measurements of specimens were taken with a dial calliper to the nearest tenth of a millimetre. All counts were taken from the right side. The size is given as standard length (SL). Abbreviations for institutions and collections cited follow http://www.asih.org/resources/standard-symbolic-codes-institutional-resource-collections-herpetology-ichthyology.

Scale and fin ray counts are reported as: A, anal fin elements (includes flexible spine and segmented rays); D, dorsal fins (D1, first dorsal fin spines; D2, second dorsal fin elements); P, pectoral fin rays; C, caudal fin rays (only branched rays are reported); LS, scales in lateral series counted from upper pectora1 fin base, or anteriormost scale along lateral midline, to central hypural base; PD, predorsal midline scales counted from scale directly anterior to first dorsal fin

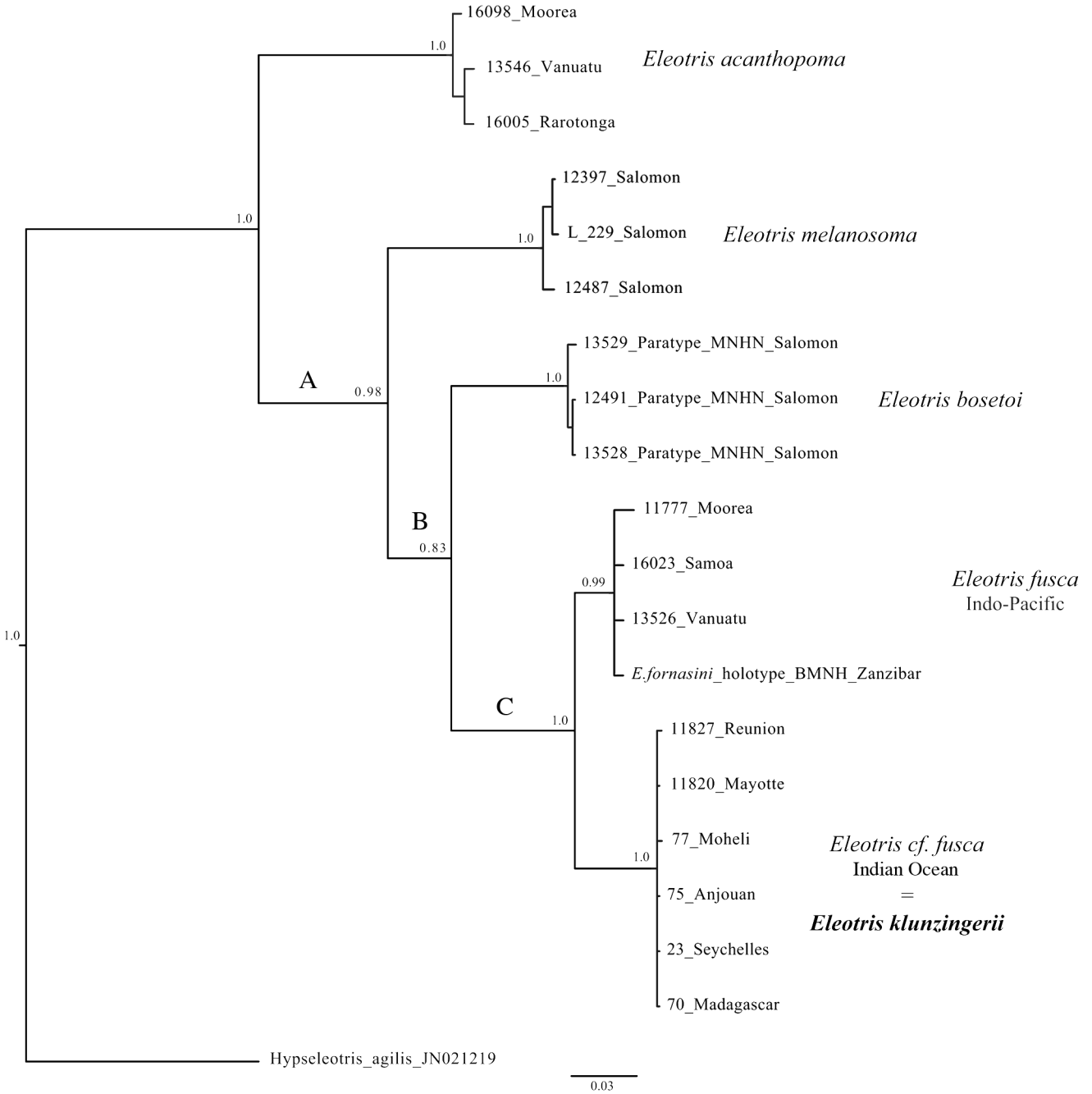

Figure 2. – Bayesian tree of the cytochrome c oxidase subunit (*COI*) for sequenced specimens of *Eleotris*. Numbers on the nodes represent posterior probabilities.

Table II. – List of the 32 diagnostic nucleotide substitutions found in the 585 bp of the cytochrome c oxidase subunit (*COI*) between *E. fusca* and *E. klunzingerii* and compared to the other *Eleotris* species.

Nucleotide position	6	9	21	45	84	105	135	147	150	153	166	174	231	255	258	273	300	306	316	354	363	376	397	435	438	456	462	483	507	540	546	549
E. acanthopoma	A	G	A	A	T	T	G	C	T	C	T	C	A	T	C	T	A	A	C	T	C	C	C	G	G	A	A	T	A	T	A	G
E. melanosoma	G	A	A	A	C	T	A	T	T	C	T	T	A	C	T	C	A	T	C	C	T	C	T	G	A	A	A	T	A	C	A	G
E. bosetoi	A	A	A	A	C	C	A	T	T	C	T	C	A	C	C	C	A	C	C	T	C	C	T	A	A	A	A	C	G	T	G	A
E. fusca	**A**	**G**	**A**	**G**	**C**	**C**	**G**	**T**	**T**	**C**	**T**	**C**	**A**	**C**	**C**	**G**	**A**	**C**	**T**	**C**	**T**	**T**	**T**	**G**	**G**	**G**	**A**	**T**	**A**	**T**	**G**	**C**
E. klunzingerii	**G**	**A**	**G**	**A**	**T**	**T**	**A**	**C**	**C**	**A**	**C**	**T**	**G**	**T**	**T**	**A**	**G**	**T**	**C**	**T**	**C**	**C**	**C**	**A**	**A**	**A**	**G**	**C**	**G**	**C**	**A**	**G**
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

insertion to the anteriormost scale; TRB, transverse series backward, refers to scales counted from the first scale anterior to second dorsal fin origin, 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 origin, in a diagonal manner, anteriorly and ventrally to the centre of abdomen 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 (alternating) manner.

Eleotris species are mainly distinguished by the superficial neuromast patterns of the head (Akihito, 1967). Cephalic neuromast distribution patterns were examined and illustrated with the aid of a dissecting microscope and camera lucida. Cephalic neuromast patterns are described using terminology developed by Sanzo (1911) with modifications employed by Miller and Wongrat (1991) and Pezold and Cage (2002). Transverse opercular rows are labelled *ot*. Upper and lower longitudinal rows on the operculum are labelled *os* and *oi*, respectively. Transverse suborbital rows are designated with Arabic numbers and major horizontal rows on the cheek are indicated with the letters *b* and *d*.

To simplify references to the particular transverse suborbital rows crossing row *d*, a formula of row numbers separated by periods is used (see Pezold and Cage, 2002). For example, if rows 2, 4 and 6 cross row *d*, this condition is represented by the formula '2.4.6'.

The main cephalic neuromast patterns of the three most common *Eleotris* in Indian Ocean are presented with schematic drawings in figure 1. For this figure, we used a syntype of *E. melanosoma* (RMNH 4815), the holotype of *E. acanthopoma* (RMNH 25934) and as there is no type known for *E. fusca*, we used a syntype of *Eleotris niger* (MNHN A-1578), which is a synonym of *E. fusca*.

RESULTS AND DISCUSSION

Genetics

The phylogenetic tree-based on the *COI* gene (585 bp), among the *Eleotris* sampled, supported species-level differentiation (Fig. 2). *E. acanthopoma* is separated, with a 14% mean pairwise divergence, from the clade A that included the four congeneric species, *E. melanosoma*, *E. bosetoi*, *E. fusca* and the *Eleotris* first considered as *E. fusca* from the Indian Ocean and called here *E.* cf. *fusca*. A 12% mean pairwise divergence is observed between *E. melanosoma* and the clade B. *E. bosetoi* is separated with a 10% mean pairwise divergence from the *E. fusca* and *E.* cf. *fusca* (Clade C) and, these two sister species are separated from each other by a mean pairwise divergence of 5.6%, although they were in the past considered by the scientific community as the same species (Hoese, 1986). The type of *E. fornasini* Bianconi, 1857 is included in the *E. fusca* clade and is thus a synonym of this species.

So, the genetic analysis revealed five distinct species: *E. acanthopoma, E. melanosoma E. bosetoi, E. fusca* and *E.* cf. *fusca*. The latter is only found in the Indian Ocean and is characterised by 32 fixed nucleotide substitutions compared to its sister species *E. fusca* (Tab. II).

Morphomeristic comparison

E. fusca and *E.* cf. *fusca* have the same opercular row patterns and the same '2.4.6' cephalic neuromast pattern (Fig. 1). Although they are clearly genetically different, the morphomeristic characters overlap (Tab. III) but there are generally more transverse scales in forward series (TRF) in *E. cf. fusca* (males: 18-30 *vs*. 13-22; females: 22-28 *vs*. 13-25).

Revalidation of *Eleotris klunzingerii* Pfeffer, 1893

Among species placed in synonymy with *E. fusca* (Eschmeyer *et al.*, 2016), there are no types known for *E. cavifrons* Blyth, 1860, *E. incerta* Blyth, 1860 and *Cheilodipterus culius* Hamilton, 1822. So, we follow Kottelat (2013) who placed them as synonyms of *E. fusca*. After examination of the *E. soaresi* syntype, we concluded

Table III. – Morphometric values for *E. fusca* and *E. cf. fusca* expressed to the nearest whole percent of standard length. Indo-P: Indo-Pacific.

			Lateral series (Lse)														
			53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
Eleotris cf. *fusca*	Indian	male						1	4	1	–	1	–	–	–	1	
		female				1	–	–	1	–	2	1	–	1			
Eleotris fusca	Indo-P	male	1	–	1	5	2	1	1	–	–	1	–	–	–	–	2
		female	1	–	1	–	–	–	1	2	2	1	1	2			

			Predorsal midline series (PD)																								
			30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Eleotris cf. *fusca*	Indian	male										1	1	–	–	–	–	–	–	–	–	–	2				
		female																				1					
Eleotris fusca	Indo-P	male					1	–	–	1	–	1	3	2	–	1	–	–	–	1							
		female	1	–	–	–	–	1	–	–	–	–	–	–	–	1	1	–	–	–	–	–	1	–	–	–	1

			Transverse backward series (TRB)									Zigzag series (ZZ)					
			13	14	15	16	17	18	19	20	21	12	13	14	15	16	17
Eleotris cf. *fusca*	Indian	male				1	1	1	4	–	1	2	1	1	1	1	2
		female				1	1	1	2	1			2	2	1	1	
Eleotris fusca	Indo-P	male			4	2	5	3				4	1	3	3	2	1
		female	1	–	–	–	5	–	3	1	1	2	2	3	3	1	

			Transverse forward series (TRF)																	
			13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Eleotris cf. *fusca*	Indian	male						1	–	1	–	1	–	1	1	1	1	–	–	1
		female										1	–	–	2	1	1	1		
Eleotris fusca	Indo-P	male	1	2	1	2	–	3	3	–	2	1								
		female	1	–	1	1	2	1	–	1	–	–	1	2	1					

			Second dorsal length (%SDL)														
			20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Eleotris cf. *fusca*	Indian	male						1	1	–	1	2	–	3			
		female						1	2	3							
Eleotris fusca	Indo-P	male	1	–	2	–	–	2	1	1	–	2	4	1	1	–	1
		female			1	–	1	3	–	3	1	–	1				

			Anal fin length (%AL)								Jaw length (%JL)							
			23	24	25	26	27	28	29	30	6	7	8	9	10	11	12	13
Eleotris cf. *fusca*	Indian	male			2	1	2	1	1	1		1	–	–	1	4	2	
		female			1	3	2							1	2	2	1	
Eleotris fusca	Indo-P	male	2	1	2	2	1	1	5	1		1	–	1	2	4	5	2
		female	1	4	2	2	–	2			1	–	1	1	2	3	3	

with the '2.3.4' pattern observed that it is a synonym of *E. melanosoma* and not of *E. fusca*. With the permission of the BMNH, the DNA of *E. fornasini* holotype (BMNH 1852.9.13.179)* has been extracted and used to amplify the *COI* gene (585 bp) revealing its synonymy to *E. fusca*

* The status of BMNH 1852.9.13.179 is uncertain. It is cited in Eschmeyer *et al*. (2011) as a syntype of *Eleotris mauritiana*. But it is labelled as the holotype of *E. fornasini* in Kottelat, 2013.

Table III. – Continued.

			Caudal fin length (%CL)																	
			21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
Eleotris cf. *fusca*	Indian	male					1	–	–	1	–	2	2	–	–	2					
		female							1	1	1	1	1	–	1						
Eleotris fusca	Indo-P	male	1	–	–	1	–	1	2	1	1	–	2	4	2						
		female						1	1	–	2	1	1	–	1	1	1	–	1	–	1

			Caudal peduncle depth (%CPD)							Head length (%HL)							
			11	12	13	14	15	16	17	30	31	32	33	34	35	36	37
Eleotris cf. *fusca*	Indian	male			2	1	3	2		1	2	2	1	2			
		female			4	–	2				3	–	–	2	1		
Eleotris fusca	Indo-P	male	2	–	1	1	5	2	1		1	4	5	4	1		
		female		2	2	7	2				1	2	4	1	1	1	1

			Body depth at second dorsal fin origin in males (%BDM)								
			17	18	19	20	21	22	23	24	25
Eleotris cf. *fusca*	Indian	male			1	2	–	2	2	–	1
Eleotris fusca	Indo-P	male	1	1	2	3	4	1	–	2	

			Predorsal length (%PDL)												
			39	40	41	42	43	44	45	46	47	48	49	50	51
Eleotris cf. *fusca*	Indian	male			1	–	–	3	1	–	1	1	–	–	1
		female	1	–	–	1	1	1	1	–	–	1			
Eleotris fusca	Indo-P	male			1	–	–	3	3	–	5	1	2		
		female			1	–	2	1	2	3	–	–	2		

			Preanal length (%PAL)											
			61	62	63	64	65	66	67	68	69	70	71	72
Eleotris cf. *fusca*	Indian	male			1	1	1	1	–	1	2	1		
		female							1	1	2	2		
Eleotris fusca	Indo-P	male			2	1	5	2	1	1	–	1	1	1
		female	1	–	–	2	2	2	–	–	3	1		

(Pacific area) (Fig. 2).

Finally, after examination of the *E. klunzingerii* type, we concluded that this species is valid and is the right name for *E.* cf. *fusca* cited by Mennesson (2016) and used here.

Distribution

E. klunzingerii Pfeffer, 1893 is currently known only in the Indian Ocean (Zanzibar, Reunion, Mayotte).

Acknowledgments. – The study was conducted in the context of M.I. Mennesson PhD and supported by the UMR BOREA (7208), the French Ichthyological Society (SFI) and the MNHN. For the Seychelles, we would like to thank the UNDP and particularly E. Henriette, B. Santerre and their team. Thanks to R. Fanchette, Ministry of Environment and Energy, Wildlife, Trade and Conservation section, for agreeing to the transfer of material. For the Comoros, we would particularly like to thank Yahaya Ibrahim (CNDRS). For Madagascar, we are grateful to J. Aride from Madagascar National Parks (MNP-ANGAP), to the Manager of Masoala National Parc at Maroantsetra, and to the DIAMSOI team. For Reunion and Mayotte, we thank the Environment Office, the Agriculture Office, and ARDA. For the Solomon Islands, we would like to acknowledge the customary landowners, villages and tribes, ESSI and the Solomon Islands' Government for the support and facilitation of the legal process. For Vanuatu, we would like to acknowledge the Department of Environmental Protection and Conservation (DEPC) and D. Kalfatak for providing us the research permit. For Samoa, we acknowledge the Samoan Ministry of Natural Resources Environment and Meteorology and Conservation International. For the Cook Islands, we would like to thank the Office of the Prime Minister of the Cook Islands in Rarotonga. For French Polynesia, we especially want to thank the Research Delegation (especially J.Y. Meyer), and the Environment Delegation. For New Caledonia,

we would like to thank J.J. Cassa, from the North Province. For the loan of specimens, we thank: D. Catania (CAS), R. de Ruiter (RMNH), S. Dorow, H. Zetzsche, T.J. Alpermann and F. Krupp (SMF), S. Morrison and G.R. Allen (WAM), R. Vonk and H. Praagman (ZMA), R. Hadiaty (MZB), S. Merker (SMNS), I. Eidus (ZMH), T. Heath and J. Maclaine (BMNH), L. Parenti, J. Williams, L. Palmer and S. Raredon (USNM), P. Pruvost, R. Causse, Z. Gabsi, C. Ferrara, M. Hautecœur (MNHN). Finally, we would like to thank the "Service de systématique moléculaire" of the MNHN (CNRS UMS 2700) for the laboratory access and the assistance provided.

REFERENCES

AKIHITO, 1967. - On four species of the gobiid fishes of the genus *Eleotris* found in Japan. *Jpn. J. Ichthyol.*, 14: 135-166.

DARRIBA D., TABOADA G.L., DOALLO R. & POSADA D., 2012. - jModelTest 2: more models, new heuristics and parallel computing. *Nat. Methods*, 9(8): 772.

DETTAI A., LAUTREDOU A.C., BONILLO C., GOIMBAULT E., BUSSON F., CAUSSE R., COULOUX A., CRUAUD C., DUHAMEL G. & DENYS G., 2011. - The Actinopterygian diversity of the Ceamarc cruises: barcoding and molecular taxonomy as a multi-level tool for new findings. *Deep Sea Res. Pt II: Trop. Stud. Oceanogr.*, 58: 250-263.

ESCHMEYER W.N., FRICKE R. & VAN DER LAAN R. (eds), 2011. - Catalog of Fishes. (http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp).

GUIMARÃES-COSTA A., VALLINOTO M., GIARRIZZO T., PEZOLD F., SCHEINDER H. & SAMPAIO I., 2016. - Molecular evidence of two new species of *Eleotris* (Gobiiformes: Eleotridae) in the western Atlantic. *Mol. Phylogenet. Evol.*, 98: 52-56.

GUINDON S. & GASCUEL O., 2003. - A simple, fast and accurate method to estimate large phylogenies by maximum-likelihood. *Syst. Biol.*, 52: 696-704.

HOESE D.F., 1986. - Families Gobiidae, Eleotridae and Kraemeriidae. *In*: Smith's Sea Fishes (Smith M.M & Heemstra P.C., eds), pp. 774-811. Berlin, Heidelberg, New York: Springer Verlag.

KEARSE M., MOIR R., WILSON A. *et al.* [14 authors], 2012. - Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. *Bioinformatics*, *28*: 1647-1649.

KEITH P., MARQUET G., LORD C., KALFATAK D. & VIGNEUX E., 2010. - Poissons et Crustacés d'Eau douce du Vanuatu. 253 p. Paris: Société Française d'Ichtyologie.

KEITH P., HADIATY R.K. & LORD C., 2012. - A new species of *Belobranchus* (Teleostei: Gobioidei: Eleotridae) from Indonesia. *Cybium*, 36(3): 479-484.

KOTTELAT M., 2013. - The fishes of the inland waters of southeast Asia, a catalogue and core bibiography of the fishes known to occur in freshwaters, mangroves and estuaries. *Raffles Bull. Zool.*, 27(Suppl.): 1-663.

MENNESSON M.I., 2016. - Taxonomie, phylogénie et dispersion du genre *Eleotris* (Teleostei: Gobioidei: Eleotridae) dans l'Indo-pacifique. PhD dissertation, Muséum national d'Histoire naturelle, Paris.

MENNESSON M.I., KEITH P., EBNER B.C. & GERBEAUX P., 2016. - *Eleotris bosetoi* (Teleostei: Gobioidei: Eleotridae), a new species of freshwater fish from the Solomon Islands. *Pac. Sci.*, 4: 495-507.

MILLER P.J. & WONGRAT P., 1991. - The innervation of head neuromast rows in eleotridine gobies (Teleostei: Gobioidei). *J. Zool.,* 225: 27-42.

PEZOLD F. & CAGE B., 2002. - A review of the spinycheek sleepers, genus *Eleotris* (Teleostei: Eleotridae), of the western hemisphere, with comparison to the West African species. *Tulane Stud. Zool. Bot.*, 31: 19-63.

RONQUIST F., TESLENKO M., VAN DER MARK P. *et al.* [10 authors], 2012. - MrBayes 3.2: Efficient Bayesian Phylogenetic Inference and Model Choice across a Large Model Space. *Syst. Biol.*, 61: 1-4.

SANZO L., 1911. - Distribuzione delle papille cutanee (organiciatiforme) e suo val ore sistematico nei gobi. *Mitt. Zool. Stn. Neapel*, 20: 249-328.