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RESEARCH ARTICLE

Synchiropus flavistrigatus, a new species of dragonet from the tropical eastern Atlantic (Teleostei: Callionymidae)RONALD FRICKE¹, FRANCESC ORDINES² & SERGIO RAMÍREZ-AMARO²

Abstract

A new species of dragonet, *Synchiropus flavistrigatus* **sp. n.** from the eastern tropical Atlantic, is described on the basis of 15 specimens. The new species is characterised within the subgenus *Yerutius* Whitley, 1931 by having 8 rays in the second dorsal fin (the last divided at its base), 8 anal-fin rays (the last divided at its base), 20–21 pectoral-fin rays, a single upper unbranched pectoral-fin ray, 1–2 curved dorsal points on the upper margin of the preopercular spine (additional to the main tip), length of first spine of first dorsal fin in male 12.8–15.9% of standard length, in female 14.5–15.4%; caudal-fin length in male 27.7–32.2% of standard length, in female 25.5–27.9%; length of last ray of second dorsal fin in male 18.2–21.6% of standard length; length of last ray of anal fin in male 14.6–17.1% of standard length, in female 13.5–15.1%; second dorsal fin and caudal fin with oblique yellow bars in both sexes; anal fin with a distal dark streak in both sexes. We also provide molecular information, based on two mitochondrial fragments (*COI* and *12s rRNA*), that clearly supports the morphological results confirming that *S. flavistrigatus* **sp. n.** corresponds to a new species, distinct from *S. phaeton* (Günther, 1861). The new species is compared with other species of the subgenus.

Key words: distribution, dragonets, fishes, Guinea-Bissau, new species.

Zusammenfassung

Eine neue Leierfischart, *Synchiropus flavistrigatus* **sp. n.** aus dem tropischen Ostatlantik, wird anhand von 15 Exemplaren beschrieben. Die neue wird innerhalb der Untergattung *Yerutius* Whitley, 1931 durch folgende Merkmale charakterisiert: 8 Strahlen in der zweiten Rückenflosse (der letzte an der Basis geteilt), 8 Strahlen in der Afterflosse (der letzte an der Basis geteilt), 20–21 Brustflossenstrahlen, ein einziger Brustflossenstrahl oben unverzweigt, 1–2 gebogene Spitzen auf der dorsalen Seite des Präoperculardorns (zusätzlich zur Hauptspitze), Länge des ersten Strahls der ersten Rückenflosse beim Männchen 12.8–15.9% der Standardlänge, beim Weibchen 14.5–15.4%; Schwanzflossenlänge beim Männchen 27.7–32.2% der Standardlänge, beim Weibchen 25.5–27.9%; Länge des letzten Strahls der zweiten Rückenflosse beim Männchen 18.2–21.6% der Standardlänge; Länge des letzten Strahls der Afterflosse beim Männchen 14.6–17.1% der Standardlänge, beim Weibchen 13.5–15.1%; zweite Rückenflosse und Schwanzflosse bei beiden Geschlechtern mit gelben Schrägstreifen; Afterflosse bei beiden Geschlechtern distal mit einem dunklen Streifen. Eine molekulare Untersuchung basierend auf zwei mitochondrialen Fragmenten (*COI* und *12s rRNA*) unterstützt die morphologischen Befunde und bestätigt, daß es sich bei *S. flavistrigatus* **sp. n.** um eine neue Art handelt, die sich von *S. phaeton* (Günther, 1861) deutlich unterscheidet. Die neue Art wird mit anderen Arten der Untergattung verglichen.

Introduction

Dragonets of the family Callionymidae (Pisces: Teleostei) are a group of benthic living fishes occurring in the upper 900 metres of all temperate, subtropical and tropical oceans of the world, with a few species found in estuarine and freshwater habitats. They are characterised by a depressed body, a triangular head when seen from above, large eyes situated dorsally on the head, the presence of a preopercular spine bearing additional points and/or serrae, gill opening reduced to a small pore, swimbladder absent, two dorsal fins, the first with thin, flexible spines, the second with soft rays, and jugular pelvic fins

which are separated from each other but each connected with the pectoral-fin base by a membrane.

The Indo-Pacific species of the family were revised by FRICKE (1983a), who distinguished 126 valid species from the area. FRICKE (2002), in a checklist of the callionymid fishes of the world, listed a total of 182 valid species in 10 genera. Subsequently, 16 additional species and one new genus were described [*Callionymus kanakorum* Fricke, 2006 and *Protogrammus antipodum* Fricke, 2006 from New Caledonia (FRICKE 2006), the genus *Tonlesapia* with *Tonlesapia tsukawakii* Motomura & Mukai, 2006 from Cambodia (MOTOMURA & MUKAI 2006), *T. amnica* Ng & Rainboth, 2011 from Vietnam (NG & RAINBOTH

2011), *Synchiropus tudorjonesi* Allen & Erdmann, 2012 from Papua, Indonesia (ALLEN & ERDMANN 2012), *Callionymus profundus* Fricke & Golani, 2013 from the northern Red Sea (FRICKE & GOLANI 2013), *Callionymus madangensis* Fricke, 2014 from Papua New Guinea (FRICKE 2014), *Diplogrammus paucispinis* Fricke & Bogorodsky in Fricke, Bogorodsky & Mal, 2014 from the eastern Red Sea (FRICKE et al. 2014a), *Callionymus omanensis* Fricke, Jawad & Al-Mamry, 2014 from the northwestern Indian Ocean (FRICKE et al. 2014b), *Protogrammus alboranensis* Fricke, Ordines, Farias & García-Ruiz, 2016 from the southwestern Mediterranean Sea (FARIAS et al. 2016), *Callionymus alisae* Fricke, 2016 from New Ireland (FRICKE 2016a), *Callionymus petersi* Fricke, 2016 from New Ireland (FRICKE 2016b), *Synchiropus novaehiberniensis* Fricke, 2016 from New Ireland (FRICKE 2016c), *Synchiropus sycorax* Tea & Gill, 2016 from the Philippines (TEA & GILL 2016), *Callionymus boucheti* Fricke, 2017 from New Ireland (FRICKE 2017), *Callionymus vietnamensis* Fricke & Vo, 2018 from Vietnam (FRICKE & VO 2018)]; *Synchiropus apricus* (McCulloch, 1926) was removed from the synonymy of *Synchiropus phasis* (Günther, 1880) by GOMON & YEARSLEY (2008), and *Eleutherochir mccaddeni* Fowler, 1941 was removed from the synonymy of *E. opercularis* (Valenciennes in Cuvier & Valenciennes, 1837) by YOSHIGOU et al. (2006), bringing the worldwide total to 201 species in the family (FRICKE et al. 2022a).

The genus *Yerutius* Whitley, 1931 was originally described by WHITLEY (1931: 115) based on *Callionymus apricus* McCulloch, 1926 as the type species (by original designation). The type species was synonymised with *Synchiropus phasis* (Günther, 1880) by FRICKE (1983a: 572; 2002: 63), but removed from synonymy and resurrected by GOMON & YEARSLEY (2008) (see above). Species of *Yerutius* were classified by NAKABO (1982) in the genus *Foetorepus* Whitley, 1931.

FRICKE (1981: 26) defined the subgenus *Synchiropus* (*Yerutius*) within the genus *Synchiropus* Gill, 1859, which equalled part of the genus *Foetorepus* (not Whitley, 1931) of NAKABO (1982), and included two species, *S. phasis* (Günther, 1880) (FRICKE 1981) from southern Australia and New Zealand and *S. atrilabiatus* (Garman, 1899) from the eastern Pacific. FRICKE (2002: 102) distinguished seven species in this subgenus, also including *Synchiropus agassizii* (Goode & Bean, 1888) from the western Atlantic, *S. dagmarae* Fricke, 1985 from the southwestern Atlantic, *S. goodenbeani* (Nakabo & Hartel, 1999) from the northwestern Atlantic, *S. phaeton* (Günther, 1861) from the northeastern Atlantic and Mediterranean and *S. valdiviae* (Trunov, 1981) from Walvis Ridge, southeastern Atlantic.

Species of the complex live on deep soft bottoms; they usually do not bury in the substrate but are well camouflaged due to their cryptic colouration. Callionymid fishes typically occur in harem groups, with one male control-

ling a larger home range and living together with several females. Spawning usually takes place around dusk; the courting pair ascends and releases the eggs well above the ground, following a complex courtship behaviour where the spreading of the first dorsal fin or flashing blue 'lights' (iridescent blue spots) are frequent motor patterns. The eggs and larvae are pelagic; during transition into juveniles they shift to a benthic lifestyle (FRICKE et al. 2014b).

In a revision of the *Synchiropus agassizii* species complex, FRICKE (1985: 247) noted that the tropical West African form of *S. phaeton* seemed different and might be based on a different taxon, but that its formal recognition and description would have needed more material. During the cruise BISSAU 2019 in November/December 2019, several specimens of this new species were collected, as well as two additional specimens collected in Angola by Research Vessel "Dr. Fridtjof Nansen" in 2003; the new species is described, and the subgeneric complex reviewed, in the present paper.

Material and methods

The data of the holotype are given first, followed by those of the paratypes in brackets. Methods follow FRICKE (1983a); fin-ray counts follow FRICKE (1983b); osteological nomenclature follows NAKABO (1983). The starting point for length measurements is the middle of the upper lip. The standard length (measured from the tip of the upper lip to the middle of the urohyal/caudal fin base) is abbreviated SL. The predorsal (1) length is measured from the middle of the upper lip to the base of the first spine of the first dorsal fin; the predorsal (2) length correspondingly to the base of the first ray of the second dorsal fin. The last ray of the second dorsal and anal fins is always divided at its base; counts in the key include this divided ray as one. In identification keys, males and females are keyed out separately only if there are significant differences between male and female morphology and colouration, and if females of two different species are more similar to each other than to the males of the same species. In callionymid fishes, sexes are easily externally distinguished by the presence of an enlarged urogenital papilla in the male (small or absent in the female).

Species classification is based on FRICKE (2002). Nomenclature follows FRICKE et al. (2022b). References and journals follow FRICKE (2022) and FRICKE & ESCHMEYER (2022a), respectively.

Molecular analyses: A piece of the right pectoral fin was removed from fresh specimens and preserved in 96% ethanol. A total of three samples of *Synchiropus flavistrigatus* sp. n. were used for molecular analyses. In addition, three samples of *S. phaeton* were also analysed, which were collected from bottom trawl sampling carried out at a mean depth of 357 m during the MEDITS_ES05_20 survey around the Balearic Islands (39°17'0.6"N 2°25'47.2"E), western Mediterranean, in June 2020.

DNA was extracted from this tissue using the DNeasy Blood and Tissue Extraction kit (Qiagen, West Sussex, UK). Polymerase chain reaction (PCR) was used to amplify two partial mitochondrial genes: cytochrome c Oxidase subunit I (*COI*; DNA barcode) with primers FF2d/FR1d (IVANOVA et al. 2007) and the *12s rRNA* with primers 12SL1091/12SH1478 (KOCHER

et al. 1989). PCR was performed in a 25 µl volume: 17.7 µl ddH₂O, 2.5 µl Mangobuffer (Bioline), 1 µl dNTPs, 1.75 µl MgCl₂, 0.5 µl of each primer (each 10 pmol), 0.05 µl TAQ (Bioline) and 1 µl DNA. The PCR thermal profile used for both mitochondrial genes was: initial stage at 96 °C for 5 min; then 35 cycles at 94 °C for 60 seconds, 50/54 °C for 60 seconds and 72 °C for 60 seconds, followed by a final extension at 72 °C for 10 min. PCR products were purified using the QIAquick PCR Purification Kit (QIAGEN). Both heavy and light strands were sequenced on an ABI 3130 sequencer (Applied Biosystems).

Sequences were imported into BioEdit 7.0.5.2. (HALL 1999) and checked for quality and accuracy with nucleotide base assignment. Multiple sequence alignments (MSA) were obtained with ClustalW (THOMPSON et al. 1994). The DNA sequences obtained were deposited in the GenBank database (<http://www.ncbi.nlm.nih.gov/genbank/>) under the following numbers: ON391145-ON391150 for *COI* and ON398520-ON398525 for *12s rRNA*.

Additionally, GenBank was searched for all species belonging to the genus *Synchiropus*, considering at least the same resulting length of the two sequenced mitochondrial fragments.

The genetic distance (*p*-distance) and number of base differences between pairs of sequences of each mitochondrial fragment were calculated with MEGA v.7.1 (TAMURA et al. 2013). The sequences were also used to reconstruct the phylogenetic relationships of the new species with the rest of the species included here. To do so, phylogenetic trees based on Maximum Likelihood (ML) were reconstructed. The optimal substitution model of molecular evolution for *COI* was the Hasegawa-Kishino-Yano model with invariable sites and gamma distribution (HKY+G+I; HASEGAWA et al. 1985), while for the *12s rRNA* fragment Kimura 2-parameter was used (KIMURA 1980). These models were selected following the Akaike Information Criterion (AIC) using MEGA. ML trees were also performed with MEGA and assessed by non-parametric bootstrapping (1000 replicates). The species *Callionymus enneactis* Bleeker, 1879 (GenBank ID for complete mitochondrial genome AP012316; SONG et al. 2014) was included as an outgroup for both phylogenetic trees.

Materials: Materials of the new species and comparative materials are listed below. Abbreviations of museum collections (see below) follow FRICKE & ESCHMEYER (2022b). Type specimens are deposited in the Colección de Fauna Marina, Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, Málaga, Spain (CFM-IEOMA), the Hebrew University of Jerusalem, Israel (HUJ), and Staatliches Museum für Naturkunde Stuttgart, Germany (SMNS).

Comparative material [subgenus *Synchiropus* (*Yerutius*): ***Synchiropus agassizii***: MCZ 86660 (holotype of *Callionymus agassizii* Goode & Bean, 1888 and *Callionymus himantophorus* Goode & Bean, 1896), Barbados; ROM 36864 (1), Barbados; ROM 36865 (1), Barbados; ROM 3686 (1), Barbados; USNM 188529 (8), Honduras. ***Synchiropus atrilabiatus***: CAS-SU 25249 (1 syntype of *Callionymus atrilabiatus* Garman, 1899), Panama, Panama Bay; CAS-SU 5746 (holotype of *Callionymus garthi* Seale, 1940), Colombia, Port Utria; USNM 144258 (holotype of *Synchiropus talarae* Hildebrand & Barton, 1949), Peru, Talara; CAS 44015 (1), Costa Rica, Golfo de Nicoya; CAS 44026 (1), Costa Rica, Golfo de Nicoya; CAS 44114 (32), Costa Rica, Quepos; CAS 44124 (46), Costa Rica, Quepos; CAS 44136 (2), Costa Rica, Golfo de Nicoya; CAS 46429 (1), Panama, Hannibal Bank; CAS 46947 (2), Costa Rica, Cabo Blanco; CAS-SU 19393 (32), Mexico, Baja California Sur, Gorda Banks; CAS-SU 25249 (1), Panama; CAS-SU 46428 (21), Mexico, Baja California Sur, Gorda Banks; CAS-SU 46430 (1), Mexico, Baja California Sur, Gorda Banks; CAS-

SU 46431 (2), Mexico, Baja California Sur, Gorda Banks; GCR 10682-1329 (1), Panama; LACM 20681-1 (1), Ecuador, Galapagos Islands; LACM 32269-4 (2), Costa Rica, Cocos Island; LACM 32556-1 (7) Costa Rica, Isla de Cano; SIO 68-55 (3), Mexico, Baja California Sur; ZMUC P64158 (2), Panama, Gulf of Panama. ***Synchiropus dagmarae***: USNM 188521 (holotype), Venezuela, off mouth of Orinoco River; USNM 256454 (10 paratypes), Venezuela, off mouth of Orinoco River; ISH 1088/6 (1), Uruguay, off east coast; ISH 1775/68 (1), Brazil, off Rio Grande do Sul; ISH 1983/68 (3), Brazil, off Rio de Janeiro; NSMT-P 22380 (2), Suriname; NSMT-P 22381 (1), Suriname; NSMT-P 22382 (3), Suriname; NSMT-P 22383 (2), Suriname; NSMT-P 22384 (1), Suriname; NSMT-P 22385 (2), Suriname; NSMT-P 22386 (1), Suriname; NSMT-P 22387 (30), Suriname; NSMT-P 22391 (13), Suriname; SMNS 9068 (3), Suriname; SMNS 9069 (1), Suriname. ***Synchiropus goodenbeani***: MCZ 95955 (holotype of *Synchiropus goodenbeani*), USA, New York, Long Island; BMNH 1933.10.12.85 (1 paratype of *Synchiropus goodenbeani*, USA, Florida, Dry Tortugas; MCZ 38492 (1 paratype of *Synchiropus goodenbeani*), USA, mid-Atlantic Bight; USNM 44607 (1 paratype of *Callionymus himantophorus* Goode & Bean, 1896), USA, off Florida, Gulf of Mexico; SMNS 8465 (1), USA, New York. ***Synchiropus phaeton***: NMW 58817 (1 syntype of *Callionymus phaeton* Günther, 1861), Italy, Rome; BMNH 1952.5.26.11 (1), Italy, Elba; BMNH 1972.1.10.66-71 (6), Morocco, off Casablanca; BMNH 1978.1.17.62 (1), Tunisia; HUJ 8036 (1), Israel; HUJ 8075 (1), Italy, Lampedusa; HUJ 8077 (3), Israel, Hadera; HUJ 8078 (2), Israel; HUJ 8079 (11), Cyprus; HUJ 8087 (1), Israel; HUJ 8092 (5), Israel; HUJ 8095 (1), Malta; HUJ 8387 (1), Cyprus; HUJ 9134 (5), Malta; HUJ 15041 (4), Israel; HUJ 16432 (1), Israel; HUJ 17110 (1), Israel; HUJ 17607 (1), Israel; HUJ 18650 (1), Israel; HUJ 20683 (1), Spain, Balearic Islands; HUJ 20698 (1), Spain, Balearic Islands, Mallorca; HUJ 20813 (2), Spain, Balearic Islands, Menorca; MSNG 43609 (4), Italy, San Remo; NMW 77229 (1), Italy, Gulf of Genoa; NMW 77230 (1), France, Nice; SMNS 15282 (1), France, Banyuls-sur-Mer. ***Synchiropus phasis***: BMNH 1879.5.14.564 (holotype of *Callionymus phasis* Günther, 1880), Australia, New South Wales, Eden; AMS E.5714 (2), Australia, Victoria, Gippsland; AMS I.18794-001 (10), Australia, New South Wales, Wollongong; AMS I.18795-007 (2), Australia, New South Wales, Wollongong; BMNH 1937.9.21.28 (1), Australia, Tasmania; LACM 11516-5 (1), Australia, Victoria, off Bairnsdale; NMW 58774 (1), Australia, South Australia; Gulf of Saint Vincent. ***Synchiropus valdiviae***: ZISP 45303 (1 paratype of *Callionymus valdiviae* Trunov, 1981), southeastern Atlantic, Valdivia Bank.

Taxonomy

Synchiropus flavistrigatus sp. n.

Guinea dragonet
(Figs. 1–2)

<https://zoobank.org/NomenclaturalActs/407554D8-48F1-47C6-827D-DBDE40EC6855>

Synchiropus sp.: FRICKE 2016d: 2824 (eastern Atlantic: Guinea-Bissau south to Angola).

Type material

Holotype: SMNS 27157, 111.7 mm SL, male, eastern Atlantic Ocean, Guinea-Bissau, 230 km southwest of Bissau, 10°26'06"N

17°06'39.6"W–10°25'15.6"N 17°06'25.2"W, 222–222 m depth, R/V Vizconde de Eza, Cruise BISSAU 1219, St. 68, 4 Dec. 2019, 08:45–09:15 h.

Paratypes: HUI 21166, 2 males (90.4–95.0 mm SL), same data as holotype. SMNS 26362, 2 specimens, Angola, 20 km W of Ambriz, 115 km NNW Luanda, 7°50'S 12°55'E, R/V Dr. Fridtjof Nansen, 2003. SMNS 27158, 2 males (91.1–95.6 mm SL) and 2 females (80.6–94.7 mm SL), same data as the holotype. SMNS 27297, 2 females (86.6–110.8 mm SL) and 3 males (89.0–110.3 mm SL), eastern Atlantic Ocean, Guinea-Bissau, 213 km southwest of Bissau, 10°08'20.4"N 16°25'55.2"W–10°07'40.8"N 16°25'15.6"W, 183–178 m depth, R/V Vizconde de Eza, Cruise BISSAU 1219, St. 47, 29 Nov. 2019, 14:47–15:17 h. CFM-IEOMA 7442, 1 female (88.5 mm SL), same data as SMNS 27297; CFM-IEOMA 7443, 1 male (96.8 mm SL), same data as SMNS 27297.

Other material: IFAN 53-1247, 1 specimen, Equatorial Guinea, 11 Mar. 1953. IRSN 13716, 3 males (108.1–117.1 mm SL), Gabon, 0°S 8°58'E, 45 miles north-northeast of Port Gentil, 250–300 m depth, 11 Mar. 1949.

Diagnosis

A species of the subgenus *Synchiropus* (*Yerutius*) with 8 rays in the second dorsal fin, the last divided at its base, 8 anal-fin rays (the last divided at its base), 20–21 pectoral-fin rays, a single upper unbranched pectoral-fin ray, 1–2 curved dorsal points on the upper margin of the preopercular spine (additional to the main tip), length of first spine of first dorsal fin in male 12.8–15.9% of standard length, in female 14.5–15.4%; caudal-fin length in male 27.7–32.2% of standard length, in female 25.5–27.9%; length of last ray of second dorsal fin in male 18.2–21.6% of standard length; length of last ray of anal fin in male 14.6–17.1% of standard length, in female 13.5–15.1%; second dorsal fin and caudal fin with oblique yellow bars in both sexes; anal fin with a distal dark streak in both sexes.

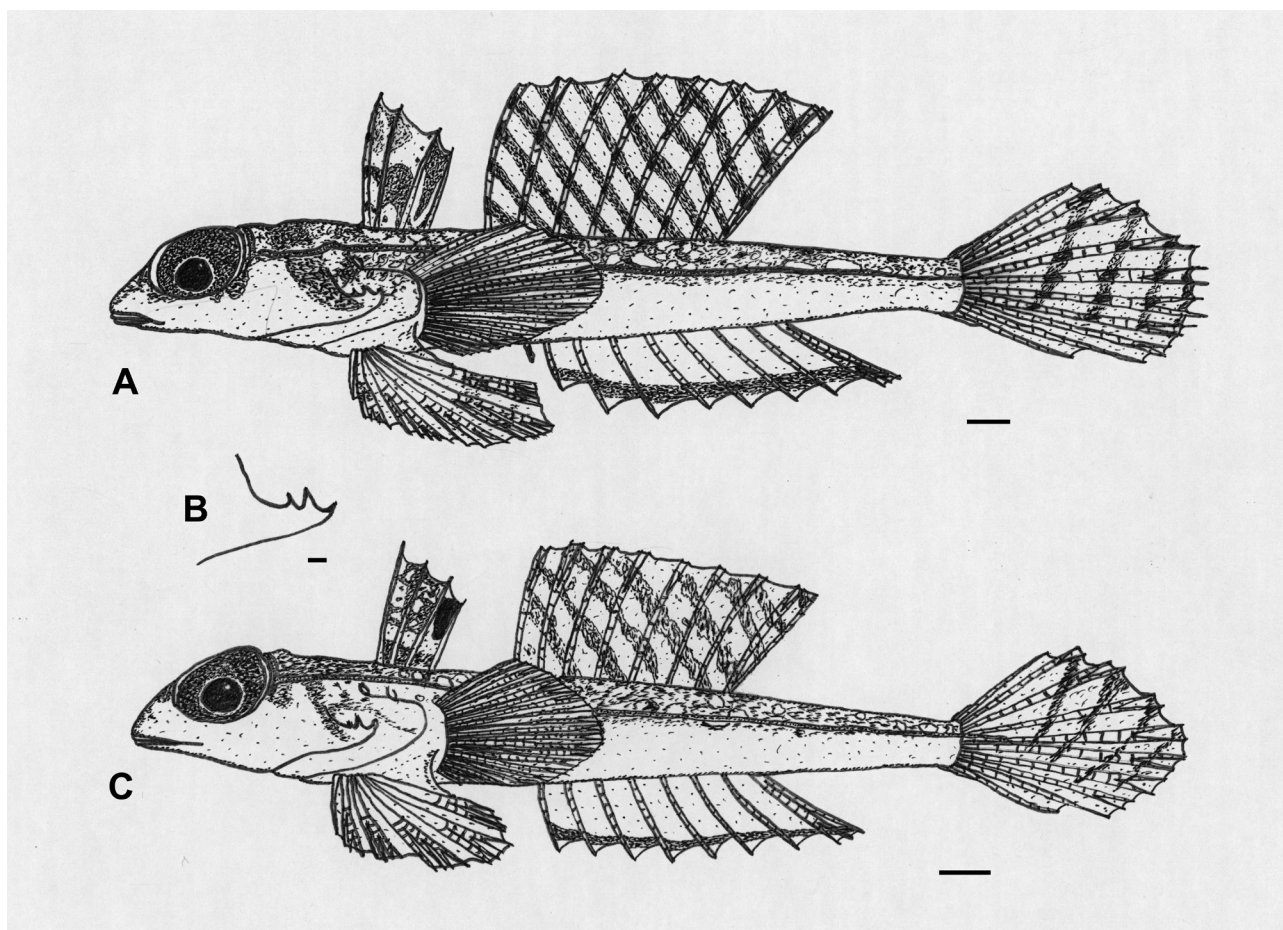


Fig. 1. *Synchiropus flavistrigatus* sp. n., SMNS 27157, holotype, 111.7 mm SL, male, eastern Atlantic Ocean, Guinea-Bissau, 230 km southwest of Bissau. **A.** Lateral view, left side (scale indicates 5 mm). **B.** Left preopercular spine (scale indicates 1 mm). CFM-IEOMA 7442, paratype, specimen 2, female (88.5 mm SL), eastern Atlantic Ocean, Guinea-Bissau, 213 km southwest of Bissau. **C.** Lateral view, left side (scale indicates 5 mm); **D.** Left preopercular spine (scale indicates 1 mm).

Description

D IV + 8 [IV + 8]; A vii,1 [vii,1]; P1 i,19,i (total 21) [i,17–19,i-ii (total 20–21)]; P2 I,5 [I,5]; C (ii),i,7,ii,(ii) [(ii),i,7,ii,(ii)]. Vertebrae 8 + 14. [Data of the holotype are given in Table 1; proportions of the paratypes are given in Table 2.]

Body elongate and slightly depressed. Head slightly depressed. Eye large. Interorbital narrow, minimum interorbital distance 9.9 [9.5–16.4] in eye diameter. Preopercular spine with an upcurved main tip and one or two curved

points on its dorsal margin, no antrorse spine at the base, ventral margin smooth, without additional points; preopercular spine formula - 2-1 [- (1-2) 1]. Cephalic lateral-line system with a short suborbital branch, a disconnected preopercular branch and a supraoccipital commissure connecting lines of opposite sides. Occipital region with two rugose patches. Supraorbital tentacle absent. Body lateral-line system with few short branches. Urogenital papilla moderately long in the male, shorter in the female.

Table 1. *Synchiropus flavistrigatus* sp. n., SMNS 27157, holotype, male, 111.7 mm SL (= standard length), eastern Atlantic Ocean, Guinea-Bissau, 230 km southwest of Bissau. Meristic data and proportions.

	Measurement [mm]	Proportion of SL	Percentage of SL
Standard length	111.7	--	--
Caudal-fin length	32.4	3.4	29.0
Predorsal(1) length	37.6	3.0	33.7
Predorsal(2) length	53.0	2.1	47.4
Preanal length	59.0	1.9	52.8
Prepelvic fin length	34.9	3.2	31.2
Prepectoral fin length	44.9	2.5	43.9
Length from tip of snout to end of preopercular spine	38.0	2.9	34.0
Head length	32.8	3.4	29.4
Body depth	15.1	7.4	13.6
Body width	21.7	5.1	19.4
Orbit diameter	13.8	8.1	12.4
Preorbital length	9.7	11.4	8.7
Bony interorbital	1.4	79.8	1.2
Caudal peduncle length	22.5	5.0	20.1
Caudal peduncle depth	5.4	20.7	4.8
Upper-jaw length	9.3	12.0	8.3
Urogenital papilla length	2.8	39.9	2.5
Length of left preopercular spine	8.4	13.9	7.5
Length of first spine of first dorsal fin	15.8	7.1	14.1
Length of second spine of first dorsal fin	14.9	7.5	13.3
Length of third spine of first dorsal fin	13.0	8.6	11.6
Length of fourth spine of first dorsal fin	9.9	11.3	8.9
Length of first ray of second dorsal fin	18.9	6.0	16.9
Length of last ray of second dorsal fin	21.3	5.2	19.1
Length of first anal-fin ray	6.9	16.2	6.2
Length of last anal-fin ray	17.1	6.5	15.3
Pectoral-fin length (left side)	23.5	4.8	21.0
Length of first pelvic-fin spine	8.6	13.0	7.7
Pelvic-fin length	27.7	4.0	24.8

Table 2. *Synchiropus flavistrigatus* sp. n., paratypes, eastern Atlantic Ocean, Guinea-Bissau. Proportions. SL = standard length.

	Proportion of SL (n = 13)	Proportion as percentage of SL (n = 13)
Caudal-fin length	males (n = 8): 3.1–3.6; females (n = 5): 3.6–3.9	males (n = 8): 27.7–32.2; females (n = 5): 25.5–27.9
Predorsal(1) length	2.7–3.2	31.2–37.0
Predorsal(2) length	2.0–2.3	43.8–50.0
Preanal length	1.8–1.9	52.4–54.9
Prepelvic fin length	3.2–3.8	26.7–31.2
Prepectoral fin length	2.5–3.2	31.4–40.6
Length from tip of snout to end of preopercular spine	2.8–3.4	29.1–35.8
Head length	3.1–3.8	26.4–32.2
Body depth	6.3–7.7	12.9–15.9
Body width	4.5–6.5	15.4–22.2
Orbit diameter	6.8–9.2	10.8–14.8
Preorbital length	males (n = 8): 11.9–14.9; females (n = 5): 12.0–13.8	males (n = 8): 6.7–8.4; females (n = 5): 7.2–8.3
Bony interorbital	73.0–129.1	0.8–1.4
Caudal peduncle length	4.6–5.6	17.9–21.6
Caudal peduncle depth	19.4–23.5	4.3–5.2
Upper-jaw length	9.9–13.0	7.7–10.10
Urogenital papilla length	males (n = 8): 33.4–61.3; females (n = 5): 110.6–866.0	males (n = 8): 1.6–3.0; females (n = 5): 0.1–0.9
Length of left preopercular spine	11.5–15.8	6.3–8.7
Length of first spine of first dorsal fin	males (n = 8): 6.3–7.8; females (n = 5): 6.5–6.9	males (n = 8): 12.8–15.9; females (n = 5): 14.5–15.4
Length of second spine of first dorsal fin	males (n = 8): 7.2–8.4; females (n = 5): 7.1–7.6	males (n = 8): 11.8–13.7; females (n = 5): 13.1–14.0
Length of third spine of first dorsal fin	males (n = 8): 8.0–9.7; females (n = 5): 8.0–9.2	males (n = 8): 10.3–12.5; females (n = 5): 10.9–12.5
Length of fourth spine of first dorsal fin	males (n = 8): 10.8–14.6; females (n = 5): 9.7–14.0	males (n = 8): 6.8–9.2; females (n = 5): 7.1–10.3
Length of first ray of second dorsal fin	males (n = 8): 5.6–6.6; females (n = 5): 5.2–6.3	males (n = 8): 15.4–17.7; females (n = 5): 15.9–18.9
Length of last ray of second dorsal fin	males (n = 8): 4.6–5.5; females (n = 5): 6.4–7.9	males (n = 8): 18.2–21.6; females (n = 5): 12.7–15.6
Length of first anal-fin ray	9.6–15.0	6.6–10.4
Length of last anal-fin ray	males (n = 8): 5.8–6.8; females (n = 5): 6.6–7.7	males (n = 8): 14.6–17.1; females (n = 5): 13.0–15.1
Pectoral-fin length (left side)	4.6–5.5	18.2–21.7
Length of first pelvic-fin spine	11.8–18.1	5.5–8.5
Pelvic-fin length	3.8–4.6	21.4–26.4



Fig. 2. *Synchiropus flavistrigatus* sp. n., female specimen, eastern Atlantic Ocean, Guinea-Bissau, 230 km southwest of Bissau. Live colouration. Lateral view. (Photograph: F. ORDINES)

First ray of second dorsal fin 1.2 (1.0–1.3) times as long as first spine of first dorsal fin in the male, without filaments, the first spine longest; dorsal fins similarly shaped in the female, 1.0–1.2 times as long. Second dorsal fin distally slightly concave, rays branched, the last divided at its base. Anal fin beginning on vertical through third [third] ray of second dorsal fin. Anal fin distally nearly straight; anal-fin rays unbranched, the last divided at its base, the anterior tip bifurcate. Pectoral fin reaching to base of first anal-fin ray when adpressed. Pelvic fin reaching to base of second anal fin ray when adpressed. Membrane connecting 5th pelvic-fin ray with pectoral fin base ending opposite 14th (14th–17th) pectoral-fin ray (counted from above). Caudal fin in both sexes slightly elongate, slightly asymmetrical in the male with the lower rays longer than the upper rays, with several short distal filaments in males, nearly symmetrical in the female.

Colour immediately after collection (Fig. 2). Male: Head and body rose, dorsal sides mottled with dark brown, sides of body with irregular yellow and bright red blotches. Eye dorsally grey, ventrally silver, centrally yellow, pupil black. First dorsal fin pale, first spine with three dark grey spots, second and third membranes with large grey blotches. Second dorsal fin translucent, with oblique yellow bars partly bordered with grey. Anal fin translucent, with a distal brown streak. Caudal fin pale, distally red, with 4 oblique yellow bars. Pectoral fins translucent, basally rose. Pelvic fins rose, with grey mottling.

Female: Similar to male, but first dorsal fin with a distal black blotch on fourth membrane.

Colour in preservative. Similar to fresh colouration, except that the yellow and rose colours fade to pale white.

Sexual dimorphism. The male has a slightly higher first dorsal fin than the female, a slightly more asymmet-

rical caudal fin, longer last rays of the second dorsal and anal fins, a shorter urogenital papilla, and a lighter overall colouration.

Distribution

The species is only from the tropical eastern Atlantic, distributed off the coast of West Africa between Guinea-Bissau and Angola (Fig. 3). It was collected at depths of 104–386 m.

Etymology

Flavus (Latin) means yellow; *strigatus* (Latin) means striped. The name of this species refers to the yellow bars on the second dorsal fin. The name is an adjective in the male form when in the male genus *Synchiropus*.

Morphological comparisons

The new species is a member of the deep-water subgenus *Synchiropus* (*Yerutius*) that is usually living below 100 metres depth, and is defined by having large eyes, branched second dorsal-fin rays but unbranched anal-fin rays (except for the last ray, which is divided at its base), the first dorsal-fin ray in males not elongate, and lacking a membrane behind the fourth spine of the first dorsal fin. In the eastern Atlantic, it could be confused with *Synchiropus phaeton*; proportions of that species are given in Table 3. The new species differs from *S. phaeton* in the following characters: 8 rays in the second dorsal fin (versus 9–10 in *S. phaeton*); first spine of first dorsal fin in female 14.5–15.4% of SL (versus 17.6–19.6% of SL); male caudal fin significantly shorter and less elongate, caudal-fin length in male 27.7–32.2% of SL, without elongate or filamentous median rays (versus 37.3–47.4% of SL, with two median rays elongate and filamentous); last second dorsal-fin and anal fin rays of males also significantly shorter, last ray of second dorsal fin in male 18.2–21.6% of SL

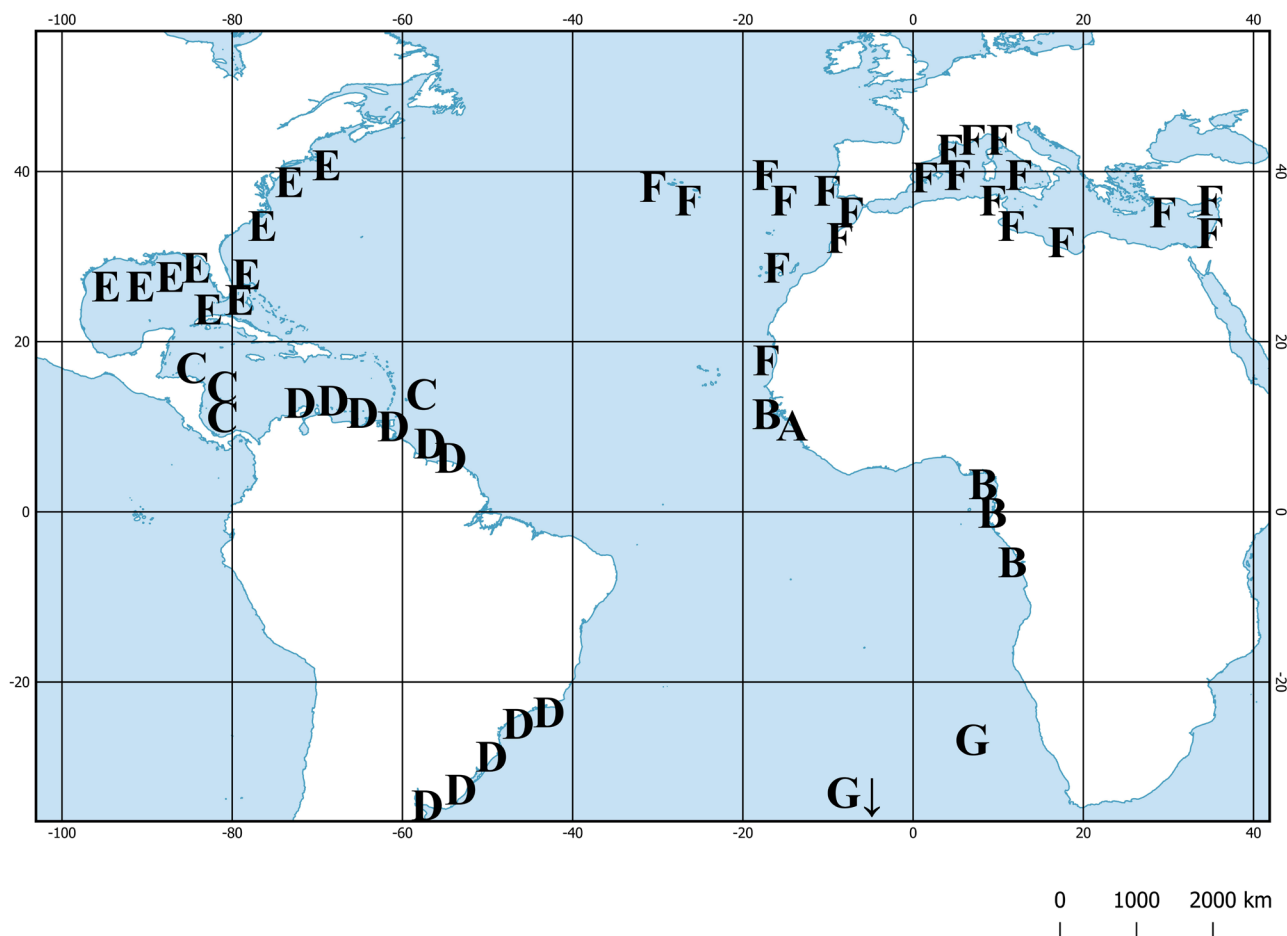


Fig. 3. Geographical distribution of the genus *Synchiropus* in the Atlantic Ocean. **A.** *Synchiropus flavistrigatus* sp. n., type locality. **B.** *Synchiropus flavistrigatus* sp. n., other localities. **C.** *S. agassizii*. **D.** *S. dagmarae*. **E.** *S. goodenbeani*. **F.** *S. phaeton*. **G.** *S. valdiviae*.

(versus 23.1–28.7% of SL), last anal-fin ray in male 14.6–17.1% of SL (versus 17.9–24.0% of SL), and second dorsal fin in life translucent, with oblique yellow bars partly bordered with grey (versus second dorsal fin with oblique series of yellow to brownish spots; Fig. 4). It is compared with other Atlantic species of the genus in Table 4; it is distinguished from these species by its vii,1 anal-fin rays (versus vi,1 rays in *S. agassizii*, *S. dagmarae*, *S. goodenbeani* and *S. valdiviae*), only one unbranched upper pectoral-fin ray (versus 2 unbranched rays in *S. dagmarae* and *S. goodenbeani*), a shorter first spine of the male first dorsal fin, its length 12.8–15.9% of SL (versus 16.0–61.0% of SL in *S. agassizii*, *S. dagmarae*, *S. goodenbeani* and *S. valdiviae*), a shorter first spine of the female first dorsal fin, its length 14.5–15.4% of SL (versus 15.9–50.0% of SL in *S. agassizii*, *S. dagmarae* and *S. goodenbeani*, situation of *S. valdiviae* unknown), a shorter male caudal fin without long filaments, its length 27.7–32.2% of SL (versus 33.3–90.9% of SL in *S. agassizii*, *S. dagmarae*, *S. gooden-*

beani and *S. valdiviae*, often with long median filaments), a shorter last ray of the male's second dorsal fin, its length 18.2–21.6% of SL (versus 21.3–26.6% of SL in *S. agassizii* and *S. valdiviae*), a shorter last ray of the male's second dorsal fin, its length 14.6–17.1% of SL (versus 19.2% of SL in *S. valdiviae*), and the presence of a distal black band in the male anal fin (versus absent in *S. dagmarae* and *S. goodenbeani*).

The new species is compared with the two Indo-Pacific species of the subgenus *Synchiropus* (*Yerutius*) in Table 5. It differs from these species in its 8 second-dorsal fin rays (versus 9 in *S. atrilabiatus*), anal-fin rays vii,1 (versus v,1 or vi,1 in *S. phasis*), first spine of first dorsal fin in male 12.8–15.9% of SL (versus 24.4–33.3% of SL in *S. phasis*), male caudal-fin length 27.7–32.2% of SL (versus 27.0–43.5% of SL in *S. phasis*), last ray of second dorsal fin in male 18.2–21.6% of SL (versus 13.2–15.9% of SL in *S. phasis*), and second dorsal fin with yellow stripes (versus pale in *S. phasis* and *S. atrilabiatus*).

Table 3. *Synchiropus phaeton*, proportions (as percentage of standard length). Examined males: HUI 8077 (1), HUI 8092 (2), HUI 8099 (6), HUI 8387 (1), HUI 9134 (3), HUI 18650 (1), HUI 20683 (1), HUI 20813 (1), SMNS 15282 (1). Examined females: HUI 8077 (2), HUI 8078 (2), HUI 8092 (1), HUI 8099 (5), HUI 9134 (2), HUI 17110 (1), HUI 20698 (1), HUI 20813 (1).

	Males (n = 17)	Females (n = 15)
Standard length (mm)	53.0–120.2	59.9–108.1
Caudal-fin length	37.3–47.4	26.0–36.8
Predorsal(1) length	30.7–34.6	33.8–34.5
Predorsal(2) length	45.6–47.7	47.0–48.8
Preanal length	50.7–53.5	54.4–55.5
Prepelvic fin length	27.8–30.7	28.7–30.5
Prepectoral fin length	37.2–38.3	39.4–40.3
Length from tip of snout to end of preopercular spine	30.3–34.7	33.0–33.2
Head length	25.8–29.5	27.9–30.7
Body depth	11.4–15.1	13.0–15.0
Body width	16.8–18.8	17.8–19.1
Orbit diameter	10.7–14.7	11.2–14.6
Preorbital length	7.4–8.9	8.3–8.7
Bony interorbital	0.5–1.4	0.4–1.1
Caudal peduncle length	20.4–22.2	20.7–20.9
Caudal peduncle depth	4.2–4.5	3.9–4.2
Upper-jaw length	8.7–9.7	9.0–9.8
Urogenital papilla length	1.4–3.0	0.2–0.9
Length of left preopercular spine	6.3–7.6	6.9–8.8
Length of first spine of first dorsal fin	14.8–20.3	17.6–19.6
Length of second spine of first dorsal fin	15.2–15.6	14.5–17.0
Length of third spine of first dorsal fin	12.3–15.1	11.9–14.9
Length of fourth spine of first dorsal fin	10.5–12.3	9.3–11.1
Length of first ray of second dorsal fin	14.0–20.4	18.1–18.4
Length of last ray of second dorsal fin	23.1–28.7	12.5–16.2
Length of first anal-fin ray	8.4–10.3	8.7–9.2
Length of last anal-fin ray	17.9–24.0	13.1–17.3
Pectoral-fin length (left side)	18.4–21.9	18.2–21.3
Length of pelvic-fin spine	7.6–7.8	7.6–8.1
Pelvic-fin length	19.5–25.9	22.5–26.8

Genetics

A total of 546 and 373 base pairs (bp) for *COI* and *12s rRNA* were sequenced for *Synchiropus flavistrigatus* **sp. n.** and *S. phaeton*, respectively. For the *COI* fragments, *S. flavistrigatus* **sp. n.** showed the closest genetic distance with *S. phaeton* (3% and 16.6 bp differences; Table 6). This genetic distance was larger than the inter-

specific distance between *S. goodenbeani* and *S. agassizii* (2.7% and 15 bp differences). Greater differences were observed between *S. phaeton* and *S. agassizii* (5.2% and 28.6 bp differences), and *S. goodenbeani* and *S. phaeton* (6.3% and 34.4 bp differences). In the case of the *12s rRNA* fragments, sequences were only obtained for *S. altivelis* (Temminck & Schlegel, 1845). Lower genetic dis-



Fig. 4. *Synchiropus phaeton*, female specimen, western Mediterranean Sea, Balearic Islands, Menorca Channel, 40°03.52'N 3°12.35'E–40°03.73'N 3°18.44'E, 155–214 m depth. Live colouration. Lateral view. (Photograph: M. FORTEZA SALOM)

Table 4. Comparison of the Atlantic species of *Synchiropus*, with values different from those of *S. flavistrigatus* **sp. n.** in bold font. Abbreviations: A = anal fin; D1 = first dorsal fin; D2 = second dorsal fin; P1 = pectoral fin; SL = standard length.

	<i>S. flavistrigatus</i> sp. n.	<i>S. phaeton</i>	<i>S. agassizii</i>	<i>S. dagmarae</i>	<i>S. goodenbeani</i>	<i>S. valdiviae</i>
D2	8	9 (–10)	7–8	8	8	8
A	vii,1	(vi,1)–vii,1 (–viii,1)	vi,1	vi,1	vi,1	vi,1
P1 (total)	20–21	21–26	20–23	20–22	20–22	22–23
Upper unbranched P1 rays	i	i	i	ii	ii	i–ii
Points on dorsal margin of preopercular spine	1–2	1	1	1 (–3)	1	2
Male first D1 spine length (% of SL)	12.8–15.9	14.8–20.3	16.0–25.0	17.2–38.5	23.6–61.1	47.6
Female first D1 spine length (% of SL)	14.5–15.4	17.6–19.6	16.4–20.0	15.9–33.3	32.3–50.0	
Male caudal-fin length (% of SL)	27.7–32.2	37.3–47.4	55.6–90.9	37.0–66.7	33.4–90.5	33.3
Female caudal-fin length (% of SL)	25.5–27.9	26.0–36.8	25.0–30.3	25.0–30.3	26.0–50.7	
Male length of last D2 ray (% of SL)	18.2–21.6	23.1–28.7	21.3–24.4	19.6–24.4	19.1–37.4	26.3
Male length of last A ray (% of SL)	14.6–17.1	17.9–24.0	16.7–18.5	15.4–24.4	16.3–24.1	19.2
Female length of last A ray (% of SL)	13.0–15.1	13.1–17.3	13.5–15.6	13.5–16.7	15.2–20.6	
Male anal fin colouration: distal black band	present	present	present	absent	absent	faintly present

tance was observed between *S. flavistrigatus* **sp. n.** and *S. phaeton* (0.5% and 2 bp differences), while the comparisons between *S. flavistrigatus* **sp. n.** and *S. altivelis* and *S. phaeton* and *S. altivelis* showed the same distance (2.7% and 10 bp differences).

Maximum-Likelihood phylogenetic reconstructions for both fragments clearly separate *S. flavistrigatus* **sp. n.** and *S. phaeton* (Fig. 5). Both species were included in the same clade.

Table 5. Comparison of *Synchiropus flavistrigatus* **sp. n.** with the Indo-Pacific species of *Synchiropus* (*Yerutius*), with values different from those of the new species in bold font. Abbreviations: A = anal fin; D1 = first dorsal fin; D2 = second dorsal fin; P1 = pectoral fin; SL = standard length.

	<i>S. flavistrigatus</i> sp. n.	<i>S. phasis</i> (incl. <i>S. apricus</i>)	<i>S. atrilabiatus</i>
D2	8	(7–)8(–9)	9
A	vii,1	(v,1–)vi,1	vii,1
P1 (total)	20–21	17–23	20–24
Upper unbranched P1 rays	i	(o–)i(–iii)	i
Points on dorsal margin of preopercular spine	1–2	(1–)2	1
Male first D1 spine length (% of SL)	12.8–15.9	24.4–33.3	14.7–19.2
Female first D1 spine length (% of SL)	14.5–15.4	13.3–15.4	14.5–18.1
Male caudal-fin length (% of SL)	27.7–32.2	37.0–43.5	22.4–34.3
Female caudal-fin length (% of SL)	25.5–27.9	25.0–27.8	22.3–34.5
Male length of last D2 ray (% of SL)	18.2–21.6	13.2–15.9	15.4–22.2
Male second dorsal fin colouration	yellow stripes	pale	pale
Male anal fin colouration: distal black band	present	present	faintly present

Table 6. Mean genetic distances (%) and numbers of bp differences for *COI* barcode fragment of *Synchiropus* spp., respectively below and above the diagonal.

Species	<i>flavistrigatus</i>	<i>phaeton</i>	<i>agassizii</i>	<i>altivelis</i>	<i>atrilabiatus</i>	<i>goodenbeani</i>	<i>marmoratus</i>	<i>monacanthus</i>	<i>postulus</i>	<i>rameus</i>
<i>S. flavistrigatus</i> sp. n.	-	16.6	22.7	87.8	52.5	28.7	105.0	89.2	115.3	112.7
<i>S. phaeton</i>	3.04	-	28.6	84.5	52.9	34.4	107.8	86.5	114.8	114.8
<i>S. agassizii</i>	4.15	5.24	-	81.5	55.0	15.0	111.0	83.5	113.0	111.0
<i>S. altivelis</i>	16.09	15.48	14.93	-	77.5	82.5	118.0	38.0	114.5	120.0
<i>S. atrilabiatus</i>	9.62	9.69	10.07	14.19	-	61.5	116.0	85.0	128.5	122.0
<i>S. goodenbeani</i>	5.25	6.30	2.75	15.11	11.26	-	107.0	87.5	113.0	110.0
<i>S. marmoratus</i>	19.23	19.74	20.33	21.61	21.25	19.60	-	114.0	93.0	77.0
<i>S. monacanthus</i>	16.33	15.84	15.29	6.96	15.57	16.03	20.88	-	113.0	113.0
<i>S. postulus</i>	21.12	21.03	20.70	20.97	23.53	20.70	17.03	20.70	-	97.0
<i>S. rameus</i>	20.63	21.03	20.33	21.98	22.34	20.15	14.10	20.70	17.77	-

Discussion

The presence of this new species in the eastern Atlantic of West Africa was already suggested by FRICKE (1985), but it took several decades to acquire sufficient material from the area to describe it and separate it from the similar species *S. phaeton*. This is in part due to the fact that deep-water habitats in that region are rarely sampled, and also to the loss of the examination sheets for eastern Atlantic *Synchiropus* in a car accident in 1984 (so the work had to be done again, and the material had to be re-examined).

The new species was previously confused with *S. phaeton*, which is now restricted to the waters off Northwest Africa and the Mediterranean Sea. It lives in similar habitats as *S. phaeton*, on deep sand or mud bottoms, of the lower continental shelf and upper continental slope. During the BISSAU1219 Survey, a total of 86 bottom trawl samples were obtained from 25 to 900 m depth. In this range, *S. flavistrigatus* **sp. n.** was only detected in hauls from 104 to 386 m depth. While in the past, the western Atlantic was thought to harbour a greater diversity of *Synchiropus* with a total of three species (*S. agassizii*, *S. dag-*

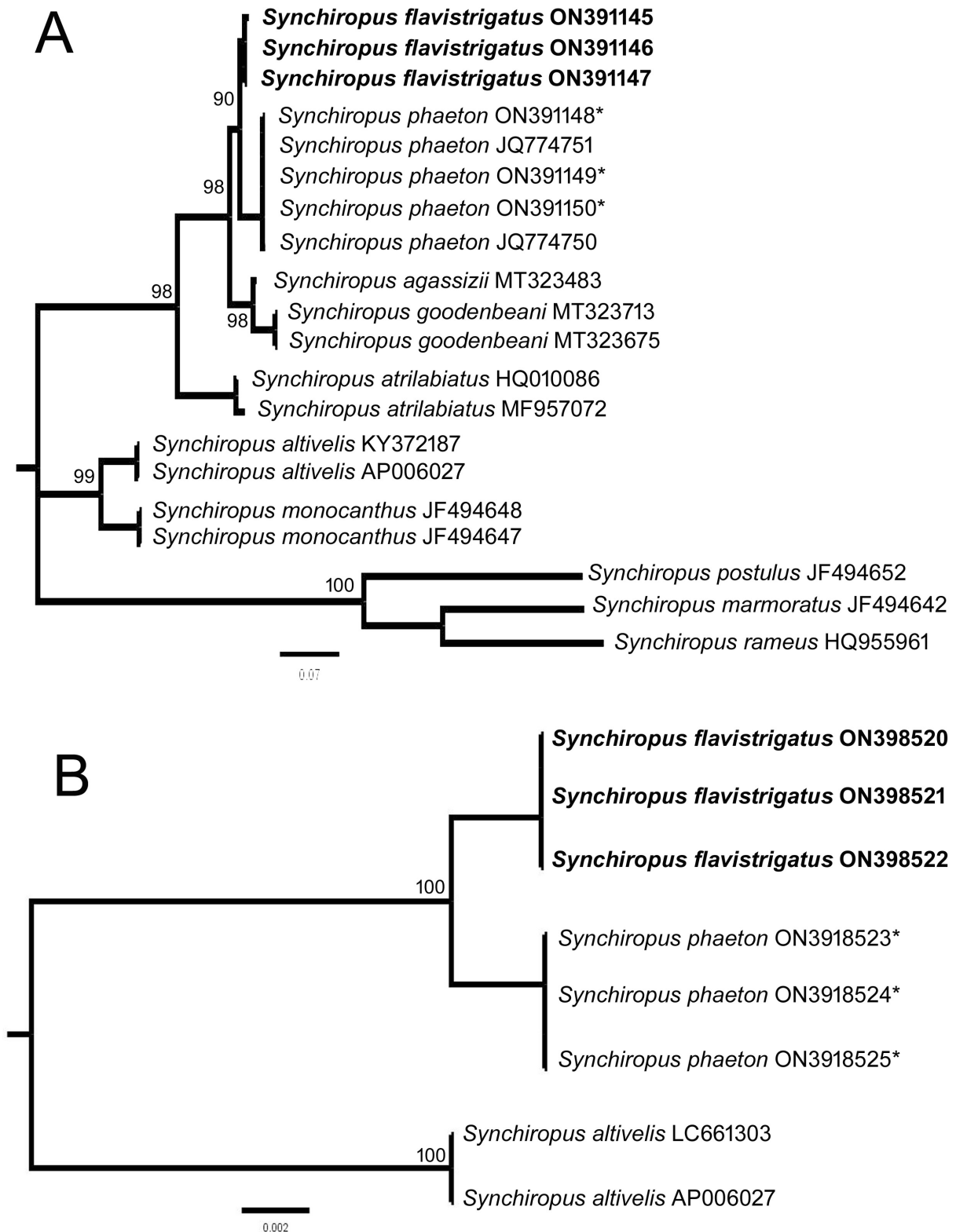


Fig. 5. Phylogenetic relationships based on Maximum Likelihood for *COI* (A) and *12s rRNA* (B) fragments for *Synchiropus* species. Bootstrap values (%) and GenBank accession numbers are indicated near the nodes and the after species name, respectively. The samples of *Synchiropus flavistrigatus* sp. n. sequenced here are indicated in bold, while the samples of *Synchiropus phaeton* are represented by asterisks.

marae, *S. goodenbeani*), now we also know three species of the genus from the eastern Atlantic (*S. phaeton*, *S. valdiviae*, *S. flavistrigatus* sp. n.). In contrast, there is just a single species of callionymid known from continental waters of the eastern Pacific (*S. atrilabiatus*).

The molecular analyses based on *COI* and *12s rRNA* fragments strongly support the morphological results confirming that *S. flavistrigatus* sp. n. corresponds to a new species, distinct from *S. phaeton*. Interspecific divergences between *S. flavistrigatus* sp. n. and *S. phaeton* were high for *COI* (3%) but low for the *12s rRNA* fragment (0.5%). The values for the *COI* fragment exceed the standard threshold for the delimitation of marine fish species, which is around 2% for *COI* fragments (HUBERT et al. 2008). On the other hand, *12s rRNA* is a relatively conserved mitochondrial gene evolving more slowly than the mitochondrial genome as a whole (PALUMBI 1996). Although there is no clear consensus on the percentage of differences to separate marine fishes, CAWTHORN et al. (2012) found that the maximum genetic distance for the species level is 0.5%, which clearly coincides with the interspecific distance for *12s rRNA* obtained here.

The phylogenetic analyses of both fragments showed two clearly divergent and close lineages between *S. flavistrigatus* sp. n. and *S. phaeton*, which might indicate a recent divergence event, as recorded in other fish genera from the eastern Atlantic and Mediterranean, such as *Symphodus tinca* (Linnaeus, 1758) vs. remaining species of *Symphodus* Rafinesque, 1810 (HANEL et al. 2002), *Pagellus acarne* (Risso, 1827) vs. *P. bogaraveo* (Brünnich, 1768) (MEYNARD et al. 2012), or *Coris julis* (Linnaeus, 1758) vs. *C. melanura* (Lowe, 1839) (RAMÍREZ-AMARO et al. 2021), but more molecular studies are needed to confirm this.

While Indo-Pacific species of *Synchiropus* are distributed at all depths between the shallows and 900 m, in the Atlantic only the deep-water subgenus *Yerutius* mainly occurs at depths below 100 m. In shallow waters, *Synchiropus* is here replaced by members of the genus *Callionymus* Linnaeus, 1758.

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