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Revalidation of *Arnoglossus blachei*, a species of flounder from off West Africa, with a redescription of *Arnoglossus imperialis* from the northeastern Atlantic and Mediterranean (Teleostei: Bothidae)

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Summary: Blache's flounder, *Arnoglossus blachei* Stauch, 1965, is redescribed from the eastern Atlantic (Morocco south to Namibia, including the Canary Islands, larvae reaching South Africa) and distinguished from the imperial flounder *A. imperialis* (Rafinesque, 1810) by having a live colouration of the lower side of males which is bright red (whitish in *A. imperialis*), the caudal fin with lateral-line scales 52-57 (vs. 58-63), and the dorsal-fin filaments in male light grey, with black margins, distally yellowish (vs. plain white). A lectotype is selected for *Arnoglossus blachei*. The species is compared with similar species. The externally similar species *Arnoglossus imperialis* is also redescribed; its distibution range is restricted to the Mediterranean and northeastern Atlantic, including Madeira and the Azores. Neotypes are selected to stabilize the usage of the names *Bothus imperialis* Rafinesque, 1810, *Bothus punctatus* Rafinesque, 1814, *Rhombus cristatus* Lowe, 1839 and *Charybdia rhomdoidichthys* Facciolà, 1885. Molecular analyses based on two mitochondrial fragments (*12s rRNA* and *COI*) clearly support the validity of *A. blachei*. Moreover, though *A. blachei* is morphologically close to *A. imperialis*, the two species show the highest genetic distances among all *Arnoglossus* species compared (including *A. capensis*, *A. imperialis*, *A. laterna*, *A. rueppelii* and *A. thori*). A key to the eastern Atlantic and Mediterranean species of *Arnoglossus* is presented.

Keywords: biodiversity; Blache's flounder; imperial flounder; eastern Atlantic Ocean; Mediterranean Sea; distribution; identification key.

Revalidación de *Arnoglossus blachei*, con la nueva descripción de *Arnoglossus imperialis* del Atlántico nororiental y el Mediterráneo (Teleostei: Bothidae)

Resumen: Se vuelve a describir el pez plano de Blache's *Arnoglossus blachei* Stauch, 1965 del Atlántico oriental (desde el sur de Marruecos a Namibia incluido las Islas Canarias, pudiendo sus larvas llegar a Sudáfrica), y se distingue del pez plano imperial *A. imperialis* (Rafinesque, 1810) por tener, en fresco, una coloración rojo brillante en la parte inferior de los machos (blanquecina en *A. imperialis*), la aleta caudal con escamas en la línea lateral 52-57 (vs. 58-63), y en los machos, los filamentos de la aleta dorsal son de color gris claro, con márgenes negros y en su parte distal amarillenta (vs. blanco liso). La especie se compara con especies similares. Asimismo, la especie externamente similar *Arnoglossus imperialis*, se vuelve a describir, cuya área de distribución está restringida al Mediterráneo y Atlántico nororiental, incluidas Madeira y Azores. Además, se seleccionan neotipos para estabilizar el uso de los nombres *Bothus imperialis* Rafinesque, 1810, *Bothus punctatus* Rafinesque, 1814, *Rhombus cristatus* Lowe, 1839 y *Charybdia rhomdoidichthys* Facciolà, 1885. Los análisis moleculares basados en dos fragmentos mitocondriales (*12s rRNA* y *COI*) respaldan claramente la validez de *A. blachei*. Por otra parte, a pesar de que *A. blachei* es morfológicamente más cercano a *A. imperialis*, ambas especies muestran las distancias genéticas más largas entre todas las especies de *Arnoglossus* comparadas (*A. capensis*, *A. imperialis*, *A. laterna*, *A. rueppelii* y *A. thori*). Se presenta una clave para las especies de *Arnoglossus* del Atlántico oriental y Mediterráneo.

Palabras clave: biodiversidad; pez plano de Blache's; pez plano imperial; océano Atlántico oriental; mar Mediterráneo; distribución; clave de identificación.

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INTRODUCTION

The lefteye flounders of the family Bothidae are a large group of marine fishes living in tropical and temperate waters of all oceans. They are arranged in the order Pleuronectiformes (Nelson et al. 2016) and currently contain a total of 168 valid species (Fricke et al. 2022a). The Bothidae are characterized by the presence of myorhabdoi (intermuscular bones), which is a synapomorphy of the family (Hensley 1977, Chapleau 1993). The Bothinae (now classified as the family Bothidae) were characterized by Norman (1934) as left-sided flounders with the pelvic fin on the blind side short-based, that on the ocular side elongate, extending forward to the urohyal, supported by a cartilaginous plate placed in advance of the cleithra, its anterior ray well in advance of first ray of that of the blind side, and caudal vertebrae with well-developed apophyses.

The genus *Arnoglossus* Bleeker, 1862 was originally described by Bleeker (1862: 427) and briefly diagnosed as having the lateral line anteriorly strongly curved, the eyes on the left side of the body, and two preanal spines. The genus was redefined by Amaoka (1969) as having the pelvic fin on the ocular side beginning at the tip of the isthmus, the eyes separated by a bony ridge or a very narrow concave space in the anterior half, interorbital equally wide in both sexes, head large, more than 22% of standard length (SL), the scales on the ocular side cycloid or feebly ctenoid, and the mouth large, maxillary longer than eye diameter. The genus is distributed in the eastern Atlantic and the Indo-Pacific. It currently includes a total of 35 valid species (Fricke et al. 2022b); a list of these species and their distribution is provided in Table 1. However, several authors have noted that *Arnoglossus* is somewhat heterogeneous and is apparently not monophyletic, so it is in need of further revision (Norman 1934, Fukui 1997).

While examining the catch of R/V *Vizconde de Eza* during the BISSAU 1219 cruise in Guinea-Bissau, one of the authors (F.O.) discovered numerous specimens of an unusual species of *Arnoglossus* that was first identified as *Arnoglossus imperialis* (non Rafinesque 1810) but subsequently found to be different. We determined the valid name for this species and redescribe it in the present paper as *Arnoglossus blachei* Stauch 1965.

MATERIALS AND METHODS

Morphological descriptions. Counts and measurements follow Hubbs and Lagler (1947), descriptive methods follow Arai and Amaoka (1996) except for the caudal fin ray formula that follows Fricke (1983); the classification follows Fricke et al. (2022b), references according to Fricke (2022). In the description, the data of the lectotype/neotype of the primary name are given first, followed by those of the primary types of synonyms (in the case of *Arnoglossus imperialis*, the neotype of *Rhombus cristatus* Lowe, 1839) in round brackets, and those of other specimens in square brackets. The distribution map was created using QGIS 3.26.1.

Comparative material. *Arnoglossus arabicus*: HUJ 13300 (9, 43.7-84.2 mm SL), Red Sea, Eritrea, 14°18'N 41°38'E; USNM 109488 (1), Yemen. *Arnoglossus capensis*: CFM_IEOMA 5258b (1), Morocco; MNHN 1967-0506 (8), Liberia; SMNS 25264 (1), São Tomé and Principe, São Tomé Island. *Arnoglossus dalgleishi*: MNHN 2014-2211 (2), New Caledonia, Chesterfield Islands; SMNS 23571 (1), Loyalty Islands, Lifou. *Arnoglossus grohmanni* (formerly known as *A. kessleri*): HUJ 13310 (7), Israel, Haifa; HUJ 17039 (1), Israel, Jaffa; HUJ 18627 (1), Israel, Zikim Beach; SMNS 11325 (4), Croatia, Cres Island; SMNS 11532 (1), Turkey, Muğla Province; SMNS 12416 (1), Balearic Islands, Formentera; SMNS 15734 (1), Greece, Chalkidiki; SMNS 16088 (1), Croatia, Cres Island; SMNS 16713 (1), Croatia, Cres Island; SMNS 19095 (1), Northern Cyprus, 9 km west Girne; SMNS 24486 (1), Croatia, Cres Island. *Arnoglossus laterna*: HUJ 232 (1), Israel, Mediterranean coast; HUJ 6575 (3), Israel, Mediterranean coast; HUJ 6598 (2), Egypt, northern Sinai, Wadi Hesi; HUJ 6609 (1), Egypt, Bardawil, Katib el Galss; HUJ 7128 (4), Egypt, Bardawil; HUJ 8494 (1), Cyprus, Akrotiri; HUJ 8501 (2), Cyprus, Famagusta; HUJ 10947 (1), Israel, Tel-Aviv; HUJ 11333 (2), Israel, Ashdod; HUJ 12135 (6), Israel, Haifa; HUJ 13192 (6), Cyprus, Famagusta; HUJ 13205 (4), Israel, Mediterranean coast; HUJ 13246 (3), Israel, Rubin; HUJ 13247 (3), Israel, Rubin; HUJ 13295 (1), Cyprus, Famagusta; HUJ 13302 (4), Israel, Haifa; HUJ 13308 (1), Israel, Rubin; HUJ 13309 (1), Israel, Haifa; HUJ 13329 (2), Gaza Strip and Egypt, Gaza to Al Arish; HUJ 13332 (3), Israel, Rubin; HUJ 13333 (1), Israel, Kishon; HUJ 13676 (1), Cyprus, southeast of Paphos; HUJ 13677 (1), Cyprus, Famagusta; HUJ 13695 (1), Cyprus, southeast coast; HUJ 13827 (1), Israel, Jaffa; HUJ 13963 (3), Israel, Mediterranean coast; HUJ 13980 (1), Egypt, Bardawil, Katib el Galss; HUJ 13981 (2), Israel, Rubin; HUJ 13996 (1), Israel, Haifa; HUJ 17906 (2), Spain, Malaga; HUJ 20081 (2), Israel, Jaffa; SMNS 8761 (30), Italy, Santa Margherita Ligure; SMNS 9237 (1), Balearic Islands, Mallorca; SMNS 14981 (1), Turkey, Sea of Marmara; SMNS 20571 (4), Italy, Venice; SMNS 20571 (1), Italy, Venice. *Arnoglossus macrolophus*: HUJ 5147 (4), Eritrea; HUJ 13334 (7), Eritrea, Massawa; HUJ 20666 (4), Eritrea; MNHN 2014-1160 (3), Madagascar; MNHN 2014-1690 (3), Madagascar; MNHN 2014-2009 (1), Madagascar; MNHN 2014-2149 (4), Madagascar; SMNHTAU P.2062 (1), Israel, Eilat. *Arnoglossus nigrofilamentosus*: HUJ 20663 (holotype), Israel, off Jaffa; HUJ 20664 (3 paratypes), Israel, off Jaffa. *Arnoglossus rueppelii*: HUJ 13689 (1), Israel, Haifa; HUJ 13692 (1), Gaza Strip to Egypt, Gaza to El Arish; HUJ 13693 (1), Gaza Strip, Chan Yunis; HUJ 16099 (5), Israel, Hadera to Herzliya; HUJ 16508 (1), Israel, Ashdod; HUJ 16586 (3), Israel, Ashdod; HUJ 19066 (1), Israel, Haifa; SMNS 24438 (1), Madeira Region, Seine Seamount. *Arnoglossus sayaensis*: MNHN 2014-1625 (1), Madagascar; MNHN 2014-2189 (1), Madagascar; USNM 307494 (1), Saya de Malha Bank. *Arnoglossus thori*: HUJ 13202 (1), Israel, Mediterranean coast; HUJ 13240 (1), Cyprus, Famagusta; HUJ 13303 (1), Cyprus, Famagusta; HUJ 13322 (1), Cyprus, Famagusta; HUJ 13439 (2), Cyprus, Famagusta; HUJ 13678 (1), Israel, Tel-Aviv to Herzliya; HUJ 13709 (1), Israel, Haifa; HUJ 13938 (5), Israel, Hadera; HUJ 13986 (2), Israel, Haifa; HUJ 14058 (11), Israel, Caesarea; HUJ 18337 (1), Greece, Crete Island, Heraklion; HUJ 20601 (1), Balearic Islands, northwest of Mallorca, 63-64 m depth; HUJ 20610 (5), Balearic Islands, 111-109 m depth; HUJ 20612 (1), Balearic Islands, north of Mallorca, 65 m depth; HUJ 20622 (1), Balearic Islands, southsoutheast of Mallorca; HUJ 20665 (1), Israel, Jaffa; SMNS 9856 (4), Greece, Varkisa; SMNS 11587 (4), Greece, Varkisa; SMNS 15577 (1), Croatia, Cres Island; SMNS 16087 (1), Croatia, Cres Island.

Genetic analyses. A piece of the right pectoral fin was removed from fresh specimens and preserved in 96% ethanol. A total of 19 samples were used for molecular analyses including specimens of *A. blachei* (3) and *A. capensis* (3) collected in Guinea-Bissau during the BISSAU1219 survey, and *A. imperialis* (5), *A. laterna* (3), *A. rueppelli* (2), and *A. thori* (2) collected during the MEDITS survey in the Balearic Islands in 2020 (Table 2).

DNA was extracted from the 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 (mtD-

Table 1. – Valid species in the genus *Arnoglossus* Bleeker, 1862 and their distribution, arranged according to their mean depth distribution. EA, eastern Atlantic; EI, eastern Indian Ocean; EP, eastern Pacific; MS, Mediterranean Sea; RS, Red Sea; WA, western Atlantic; WI, western Indian Ocean; WP, western Pacific.

Species	Depth range (m)	Geographical distribution	Remarks
A. coeruleosticta (Steindachner, 1898)	shallow	EP: Juan Fernandez and Desaventurados Islands	
A. andrewsi Kurth, 1954	6-38	EI, WP: Bass Strait and Tasmania, Australia	
A. yamanakai Fukui, Yamada and Ozawa, 1988	20-30	WP: East China Sea	
A. grohmanni (Bonaparte, 1837)	1-50	MS: Mediterranean and Black Sea	Junior synonym: *A. kessleri* Schmidt, 1915
A. nigrofilamentosus Fricke, Golani and Appelbaum-Golani, 2017	20-40	RS: probably Gulf of Suez. MS: southeastern Mediterranean	
A. fisoni Ogilby, 1898	26-50	WP: New South Wales and Queensland, Australia	
A. micrommatus Amaoka, Arai and Gomon, 1997	5-60	EI: Southwestern Australia	
A. bassensis Norman, 1926	10-70	EI, WP: South Australia to New South Wales, Australia	
A. aspilos (Bleeker, 1851)	30-71	EI, WP: Persian Gulf east to Philippines and New Guinea	
A. waitei Norman, 1926	16-90	EI, WP: Arafura Sea and Queensland (Australia)	
A. macrolophus Alcock, 1889	18-141	RS, WI, EI: Central Red Sea, Persian Gulf and Madagascar east to Indonesia	Recorded from Eritrea, Red Sea by Dor (1970) as *A. tapeinosoma* (non Bleeker 1865)
A. tenuis Günther, 1880	80-100	EI, WP: Northern Australia to southern Japan	
A. muelleri (Klunzinger, 1872)	5-200	EI, WP: Southwestern to southeastern Australia	
A. blachei Stauch, 1965	34-175	EA: Guinea-Bissau south to Angola	Revalidated in the present paper; previously synonymized with *A. imperialis*
A. japonicus Hubbs, 1915	85-154	EI, WP: Southern Japan to northern Australia	
A. laterna (Walbaum, 1792)	45-200	EA, MS: Mediterranean and Black seas; eastern Atlantic from Norway to Angola	
A. dalgleishi (von Bonde, 1922)	50-220	WI, EI, WP: South and East Africa east to Loyalty Islands	
A. capensis Boulenger, 1898	70-200	EA, WI: Morocco to South Africa, Saint Helena and Ascension Is.	Synonym: *A. entomorhynchus* Stauch, 1967
A. arabicus Norman, 1939	83-220	RS, WI: southern Red Sea and northwestern Indian Ocean	
A. thori Kyle, 1913	5-300	EA, MS: Mediterranean and Black seas, and eastern Atlantic from Ireland to Sierra Leone	Synonym: *A. moltonii* Torchio, 1961
A. elongatus Weber, 1913	100-224	EI, WP: Taiwan to Indonesia and northwestern Australia	
A. kotthausi Klausewitz and Schneider, 1986	138-225	WI: northwestern Indian Ocean	Synonym: *A. profundus* Kotthaus, 1977, preoccupied by *A. profundus* Weber, 1913
A. imperialis (Rafinesque, 1810)	15-350	EA, MS: western Mediterranean and eastern Atlantic from Scotland to northern Mauritania, including Azores and Madeira	
A. sayaensis Amaoka and Imamura, 1990	125-254	WI: Saya de Malha Bank and Madagascar	
A. polyspilus (Günther, 1880)	4-390	EI, WP: India east to New Caledonia, north to Japan	
A. multirastris Parin, 1983	160-265	EP: Nazca Ridge	
A. oxyrhynchus Amaoka, 1969	215	WP: Japan; Chesterfield Islands	
A. brunneus (Fowler, 1934)	187-292	WP: Philippines to Vanuatu	
A. septemventralis Amaoka and Mihara, 2000	240-250	WP: New Caledonia	
A. nigrifrons Amaoka and Mihara, 2000	300	WP: Chesterfield Islands	
A. debilis (Gilbert, 1905)	150-440	WP: Indonesia east to Hawaiian and Line Islands	
A. scapha (Forster, 1801)	4-737	WP: New Zealand	Junior synonym: *Pseudorhombus boops* Hector, 1875
A. marisrubri Klausewitz and Schneider, 1986	363-383	RS: Central Red Sea	
A. rueppelii (Cocco, 1844)	85-897	EA, MS: Mediterranean Sea and eastern Atlantic from Gibraltar to western Sahara	
A. armstrongi Scott, 1975	?	EI: Tasmania, Australia	
A. tapeinosoma (Bleeker, 1865)	?	EI, WP: Sumatra (Indonesia), China	

NA): *12s rRNA* with primers 12SL1091/12SH1478 (Kocher et al. 1989) and the cytochrome c oxidase subunit I (*COI*; DNA barcode) with primers FF2d / FR1d (Ivanova et al. 2007). PCR was performed in 25 µl volume: 17.7µl ddH2, 2.5µl Mangobuffer (Bioline), 1 µl DNTPs, 1.75 µl $MgCl_2$, 0.5 µl each primer (each 10 pmol), 0.05 µl TAQ (Bioline) and 1 µl DNA. The PCR thermal profile used for both mitochondrial genes was as follows: initial stage of 96°C for 5 min; then 35 cycles at 94°C for 60 seconds, 52°C/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 QIAquickR 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 were obtained with ClustalW (Thompson et al. 1994). The DNA sequences obtained for two mitochondrial fragments were deposited in the GenBank database (http://www.ncbi.nlm.nih.gov/genbank/) under the following numbers: OP341515-31 and OP345057-OP345073.

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 average values of both genetic indices between our study sample sequences were compared.

The sequences were concatenated and used to determine the phylogenetic relationships between the *Arnoglossus* species. To do so, a phylogenetic tree based on Bayesian inference was reconstructed. The optimal substitution model of molecular evolution was the Kimura 2-parameter (Kimura 1980) plus gamma. This model was selected following the Bayesian inference criterion using MEGA. Bayesian inference was performed with MrBayes v.3.2.1 (Ronquist et al. 2012) by conducting four independent MCMC runs (with four chains each) for 10 million generations, sampling every 2000 generations and discarding the first 25% of samples as burn-in. This scheme was applied for all the fragments. Convergence was assessed by effective sample size calculation and was visualized using TRACERv.1.5. *Arnoglossus tenuis* was included as an outgroup for the phylogenetic analysis (GenBank ID for the complete mitochondrial DNA genome: NC044494; Li et al. 2015).

TAXONOMY

Arnoglossus blachei Stauch, 1965
Blache's flounder
(Figs 1-4, Table 3)

Arnoglossus imperialis (non Rafinesque 1810): Chabanaud and Monod 1927: (Port Etienne/Nouadhibou, Mauritania). Norman 1930: 360 (Angola; Gabon). Chabanaud 1931a: 392 (Morocco). Chabanaud 1931b: 19 (part: Atlantic). Chabanaud 1933: 41 (Morocco). Norman 1934: 181 (part: Morocco; An-

Table 2. – Geographic information and GenBank identifiers for both mitochondrial fragments (*COI* and *12s RNA*) for genetic samples of the studied species of *Arnoglossus*. The samples of *A. blachei* are printed in bold face.

Species	Sample ID	Deep	Latitude	Longitude	Area	COI	12S
A. blachei	**ArAF77**	**118**	**10.5788**	**17.0778**	**Atlantic**	**OP341515**	**OP345057**
A. blachei	**ArAF77b**	**118**	**10.5788**	**17.0778**	**Atlantic**	**OP341516**	**OP345058**
A. blachei	**ArAF77c**	**118**	**10.5788**	**17.0778**	**Atlantic**	**OP341517**	**OP345059**
A. capensis	ArcaM77	118	10.5788	17.0778	Atlantic	OP341523	OP345065
A. capensis	Arca77b	118	10.5788	17.0778	Atlantic	OP341524	OP345066
A. capensis	Arca77a	118	10.5788	17.0778	Atlantic	OP341525	OP345067
A. imperialis	Aglm76	131	39.7978	4.4397	Mediterranean	OP341518	OP345060
A. imperialis	AgIm76_2	131	39.7978	4.4397	Mediterranean	OP341519	OP345061
A. imperialis	AgIm76_3	131	39.7978	4.4397	Mediterranean	OP341520	OP345062
A. imperialis	AgIm76	131	39.7978	4.4397	Mediterranean	OP341521	OP345063
A. imperialis	AgIm76_4	131	39.7978	4.4397	Mediterranean	OP341522	OP345064
A. laterna	Agla11	61	40.3105	0.608	Mediterranean	OP341526	OP345068
A. laterna	Agla11_2	61	40.3105	0.608	Mediterranean	OP341527	OP345069
A. laterna	Agla71	112	39.9335	3.3058	Mediterranean	OP341528	OP345070
A. rueppelii	AgRo73	276	40.1917	4.1132	Mediterranean	OP341532	OP345074
A. rueppelii	AgRo73_2	276	40.1917	4.1132	Mediterranean	OP341533	OP345075
A. thori	Agth5	95	39.8313	0.7073	Mediterranean	OP341529	OP345071
A. thori	Agth5_2	95	39.8313	0.7073	Mediterranean	OP341530	OP345072

gola; Gabon). Fowler 1936: 1258 (part). Cadenat 1937: 519 (southern Morocco; Mauritania). Cadenat 1951: 141, 299, 315 (Mauritania to Senegal). Cadenat 1953: 1073 (Port Etienne/Nouadhibou, Mauritania). Cadenat 1954: 566 (alimentation). Collignon et al. 1957: 232 (Mauritania). Roux 1957: 232. Poll 1959: 312 (Congo). Postel 1959: 167. Cadenat 1960: 1379 (Sierra Leone, Gambia, Senegal). Bassindale 1961: 508 (Ghana). Nielsen 1961: 113, pl. 2, fig. C (Guinea-Bissau to Ivory Coast). Blache 1962: 76. Sanches 1966: 17 (Angola). Maurin 1968: 48, 62 (Mauritania). Williams 1968: 817 (Guinea). Troadec et al. 1969: tabs. 8-10 (Ivory Coast). Aldebert 1970: 215 (Mauritania). Maurin et al. 1970: 20 (Morocco). Groot and Nijssen 1971: 8 (Mauritania). Aboussouan 1972: 999 (Senegal). Bravo de Laguna and Santaella Álvarez 1973: 21, 74 (western Sahara). Bas et al. 1976: tab. 3 (western Sahara). Maul 1976: 61 (part: Morocco). Lleonart i Alberas 1979: 136 (western Sahara). Nielsen in Whitehead et al. 1986: 1294 (part). Lloris and Rucabado 1979: 21, 129 (western Sahara). Gutherz and Quéro 1981: BOTH Arno 3, 2 pp. (eastern-central Alantic). González and Hernández 1987: 159 (Tenerife, Canary Islands). Aldebert et al. 1990: 1028 (with question). Lloris et al. 1991: 221 (part: Canary Islands; Africa). Bianchi and Carpenter in Bianchi et al. 1993: 178 (Namibia). Lalithambik Devi and Stephen 1998: 112 (larvae reaching Agulhas Bank, South Africa, Indian Ocean). Desoutter et al. 2001: 302 (MNHN type catalogue). Brito et al. 2002: 329, fig. 418 (Tenerife, Canary Islands/Spain). Serghini et al. 2008: 119 (southern Morocco). Munroe in Carpenter and De Angelis 2016: 2981. Fricke et al. 2017: 3. Reiner 2019: 290 (São Tomé and Principe). Amaoka et al. 2020: 4 (part: eastern Atlantic). Fermon et al. 2022: 230 (Gabon).

Arnoglossus blachei Stauch 1965: 256, fig. 7 (Angola, 13°31’36’’S, 12°19’36’’E; Cameroon, 3°40’1.2’’N, 9°13’1.2’’E, 34 m depth). Williams 1968: 342 (Guinea). Blache et al. 1970: 425 (West Africa). Bas 1974: 193, 196, 235 (western Sahara). Lloris and Rucabado 1979: 22, 131 (western Sahara). Sobrino Yraola and García Jiménez 1997: 14 (Mauritania).

Lectotype of Arnoglossus blachei *Stauch 1965 (designated herein)***:** BMNH 1930.5.6.36, one male, 73.7 mm SL, Gabon, 27.2 km west of Cap Lopez, 0°36’S 8°28’E, 64-65 m depth, RRS Discovery, 10 Aug. 1927.

Paralectotypes of Arnoglossus blachei: BMNH 1930.5.6.34 (one female), 66.7 mm SL, Angola, Elephant Bay, 13°31’36’’S 12°19’36’’E, 73-97 m depth, RRS Discovery, 28 July 1927. BMNH 1930.5.6.35 (one female), 62.0 mm SL, Angola, off Luanda, 08°40’15’’S 13°13’45’E, 64-65 m depth, RRS Discovery, 4 Aug. 1927.

Other material: CFM_IEOMA 2102 (2), Mauritania, northwest of El-Mamghar, 19°50’24’’N 17°17’24’’W, 108 m depth; CFM_IEOMA 2832 (2), Mauritania, northwest of El-Mamghar, 20°10’12’’N 17°36’36’’W, 112 m depth; CFM_IEOMA 2838 (2), Mauritania, northwest of El-Mamghar, 19°40’12’’N 17°04’12’’W, 158 m depth; CFM_IEOMA 5258a (1), western Sahara, north to Dakhla, 24°33’36’’N 16°09’36’’W, 239 m depth; CFM_IEOMA 7767 (5), Guinea-Bissau, 11°27’43.2’’N 17°11’06’’W - 11°28’37.2’’N 17°11’16.8’’W, 103-105 m depth; CFM_IEOMA 7768 (2), Guinea-Bissau, 10°10’18.48’’N 16°34’26.4’’W, 207-206 m depth; CFM_IEOMA 7766 (3), Guinea-Bissau, 10°34’44.4’’N 17°04’40.8’’W 10°33’54’’N 17°04’19.2’’W, 118-104 m depth; SMNS 27381 (2), Guinea-Bissau; SMNS 27382 (2), Guinea-Bissau; SMNS 27383 (1), Guinea-Bissau.

Diagnosis. A species of *Arnoglossus* with the second to fifth dorsal-fin rays elongate and filamentous in males, dorsal-fin rays 89-99, anal-fin rays 66-77, pectoral-fin rays on ocular side 10-12, on blind side 9-10, caudal-fin rays iii,11,iii , lateral-line scales 52-57, gill rakers 0 + 5-8, not serrated, interorbital a narrow bony ridge without scales in the middle, interorbital width 4% to 17% of upper orbit diameter, no enlarged teeth anteriorly in upper jaw, and prevomer small, not enlarged, weakly projecting into mouth cavity; male body on ocular side rose in life, on blind side bright red; male dorsal-fin filaments grey, bordered black, tips yellow; peritoneum on orbital side black, on blind side silver.

Description. Counts and measurements of the lectotype of *Arnoglossus blachei* Stauch 1965 and other material listed in Table 3 are part of this description.

Body oval, laterally strongly compressed, eyes on the left side of body (“ocular side”), right side of body without eyes (“blind side”). Body depth 2.5 [2.2-2.5] in SL, 39.6 [39.7-45.6]% of SL. Head length of ocular side 4.1 [3.6-4.4] in SL, 24.6 [22.9-27.8]% of SL. Snout slightly pointed, not completely scaled, tip naked**.** Anterior teeth in upper jaw not enlarged, prevomer not enlarged, weakly projecting into mouth cavity. Anterior nostril situated anterior to the eyes, posterior nostril on level of anterior margin of eyes. Upper orbit diameter 2.9 [1.7-3.0] in head length, 8.4 [6.5-9.6]% of SL; lower orbit diameter 3.0 [2.1-3.1] in head length, 8.2 [6.5-9.3]% of SL. Interorbital a narrow, low bony ridge, in the middle without scales, interorbital distance 0.9 [0.3-0.8]% of SL. Scales on orbital and blind sides cycloid. Lateral line barely arched over pectoral fin (arch formed by anterior 12-13 scales); lateral-line scales 50 [52-57]. Caudal peduncle depth 10.6 [8.8-11.6] in SL, 9.4 [8.6-11.3]% of SL. Precaudal vertebrae 10 [10], caudal vertebrae 31 [30-33].

Dorsal fin with 94 [89-99] soft rays, the second to fifth rays elongate and filamentous in the male. Anal fin with 73 [66-77] soft rays. Caudal fin distally rounded, caudal fin rays iii,11,iii [iii,11,iii]. Length of longest caudal-fin ray 7.0- [5.0-5.7] in SL, 14.2+ [17.4-20.7]% of SL, damaged in lectotype. Pectoral fin with 10 [10-12] soft rays on ocular side, with 9 [9-10] rays on blind side. Pectoral-fin length 8.7- [5.7-6.6] in SL, 11.4+ [14.4-17.5]% of SL on ocular side, damaged in lectotype, 12.2 [12.0-16.1] in SL, 8.2 [6.2-8.3]% of SL on blind side. Pelvic-fin length 12.6 [6.4-9.7] in SL, 7.9 [10.3-15.6]% of SL on ocular side, 12.2 [8.8-12.5] in SL, 8.2 [8.0-11.3]% of SL on blind side.

Colour of fresh specimens (Figs 3, 4). Head and body with ocular side yellowish in females, rose in males, with margins of scales dark brown, head and opercle grey; blind side pale in females, bright red in males, head pale, belly white; peritoneum black on eyed side, silvery white on blind side. Dorsal-fin filaments of males light grey, with black margins, distally yellowish; dorsal, anal, pelvic and caudal fins otherwise with a dark grey margin. Pectoral fins on both sides translucent.

Colour in preservative (Figs 1, 3). Similar to live colouration, but red colours fade to pale yellowish.

Distribution. Eastern Atlantic Ocean (Canary Islands, Morocco, western Sahara, Mauritania, Senegal, Gambia, Guinea-Bissau, Sierra Leone, Ghana, Ivory Coast, Cameroon, Guinea, São Tomé and Principe, Congo, Gabon, Angola, Namibia); southwestern Indian Ocean (larvae reaching Agulhas Bank/South Africa) (Fig. 5). This species has been collected on sand bottoms at 34-175 m depth.

Remarks. Specimens from the eastern Atlantic, previously assigned to *Arnoglossus imperialis* (non Rafinesque 1810), were found to represent a different species that was previously named *A. blachei* Stauch 1965. *Arnoglossus blachei* is revalidated in the present paper. As the species was originally based on several

Table 3. – Counts and proportions [% of SL] of *Arnoglossus blachei* Stauch, 1965.

	Lectotype of *Arnoglossus blachei* Stauch, 1965, BMNH 1930.5.6.36 (Gabon)	Paralectotypes of *Arnoglossus blachei* Stauch, 1965 (Angola)		Other material: CFM_IEOMA 2102 (1), 2832 (2), 2838 (2), 7766 (4), 7767 (5), 7768 (2); SMNS 27381 (2), 27382 (2), 27383 (1)	
		Spec. 1, BMNH 1930.5.6.34	Spec. 2, BMNH 1930.5.6.35		
Sex	Male	Female	Female	Males (n = 11)	Females (n = 9)
Dorsal-fin rays	95	94	91	89-96	89-99
Anal-fin rays	71	64	69	66-75	70-77
Pectoral-fin rays (ocular side)	10	10	10	10-12	11
Pectoral-fin rays (blind side)	9	7	7	9-10	9-10
Caudal-fin rays	iii,11,iii	iii,11,iii	iii,11,iii	iii,11,iii (1 specimen: iii,12,ii)	iii,11,iii
Lateral-line scales	55	52	55	53-56	53-57
Gill rakers on first arch, lower branch (ocular side)	6	6	6	5-8	6-7
Vertebrae	10 + 31	10 + 30	10 + 30	10 + 31-33	10 + 31-33
SL	73.7	66.7	62.0	66.7-110.8	89.0-107.0
Head length (ocular side)	24.6	26.1	26.0	23.0-27.8	22.9-25.1
Body depth	39.6	42.4	41.4	39.9-45.6	39.7-43.8
Upper orbit diameter	8.4	8.7	9.1	6.9- 9.6	6.5- 8.5
Lower orbit diameter	8.2	8.5	9.3	6.9- 9.0	6.5- 8.3
Interorbital distance	0.9	0.8	0.4	0.4- 0.7	0.3- 0.5
Upper jaw length (ocular side)	9.4	8.4	9.6	7.0- 8.6	7.0- 8.1
Lower jaw length (ocular side)	6.7	6.6	7.3	5.2- 7.0	5.1- 6.1
Lower jaw length (blind side)	6.9	7.2	8.3	5.2- 6.8	5.3- 5.9
Caudal peduncle depth	9.4	11.2	10.2	8.6-11.3	8.8- 9.5
Length of longest dorsal-fin ray	22.8	12.4	13.6	23.9 -34.7	7.3-10.9
Length of longest anal-fin ray	9.6	10.3	13.4	10.2-12.7	10.4-11.5
Pectoral-fin length (ocular side)	11.4+	16.2	15.7	14.4-17.3	15.4-17.5
Pectoral-fin length (blind side)	6.4	6.2	6.7	7.2- 8.3	6.7- 7.1
Pelvic-fin length (ocular side)	13.9	12.7	10.3	14.2-15.6	11.5-16.2
Pelvic-fin length (blind side)	8.2	8.0	10.8	8.5-11.3	8.1-10.5
Length of pelvic-fin base (ocular side)	7.9	6.8	6.4	7.0- 9.4	6.5- 8.8
Length of pelvic-fin base (blind side)	4.6	4.8	6.9	3.3- 4.5	2.4- 4.0
Length of longest caudal-fin ray	14.2+	18.6	18.8	17.6-20.1	17.4-19.5

syntypes from various localities off West Africa, the specimen BMNH 1930.5.6.36 (male, 73.7 mm SL, Gabon, 27.2 km west of Cap Lopez, 0°36'S 8°28'E, 64-65 m depth) (Figs 1, 2) is selected as a lectotype to stabilize the identity of this species, and the nomenclature within this group.

A specimen recorded as *Arnoglossus* sp. by Wirtz et al. (2007: 41) from São Tomé and Principe was reidentified (SMNS 25264) and turned out to represent a specimen of *Arnoglossus capensis* Boulenger 1898. *Arnoglossus blachei* is known neither from São Tomé and Principe nor from the Cape Verde Islands, but occurs on sand bottoms on the southern side of the Canary Islands.

This species is distributed from Morocco and the Canary Islands southward along the coast of West Africa. Populations in the northeastern Atlantic from the Strait of Gibraltar, Madeira and the Azores northward, including the Mediterranean Sea, belong to *Arnoglossus imperialis*. Apparently, the two species are allopatric. We thus confirm the geographic separation proposed by Stauch (1965) but provide some more precision for the northern range of *A. blachei* (Fig. 5).

The bright red colour of the blind side of males of *A. blachei* is very unusual. This is the only flatfish species we are aware of with such a striking sexual dichromatism. Furthermore, we do not know how the fishes can see the red colour, as they are living below 34 m depth; at this depth red colour is not visible with natural illumination. A plausible explanation would be the pres-

Fig. 1. – *Arnoglossus blachei* Stauch, 1965, BMNH 1930.5.6.36, one male, 73.7 mm SL, lectotype of *A. blachei*, 96.6 mm SL, Gabon, 27.2 km west of Cap Lopez. Photographs of preserved specimen taken by L. Goodayle. Above: Ocular side. Below: blind side. Scale indicated 5 cm.

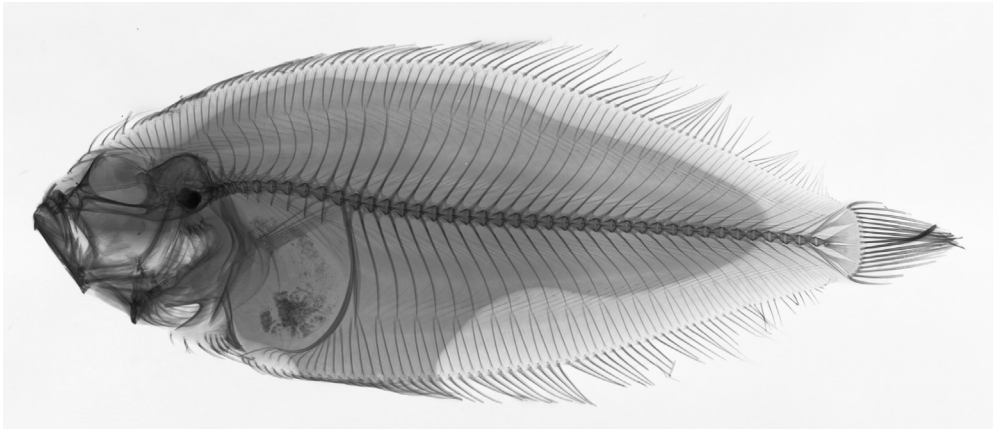

Fig. 2. – *Arnoglossus blachei* Stauch, 1965, BMNH 1930.5.6.36, one male, 73.7 mm SL, lectotype of *A. blachei*, 96.6 mm SL, Gabon, 27.2 km west of Cap Lopez. X-ray taken by J. Maclaine.

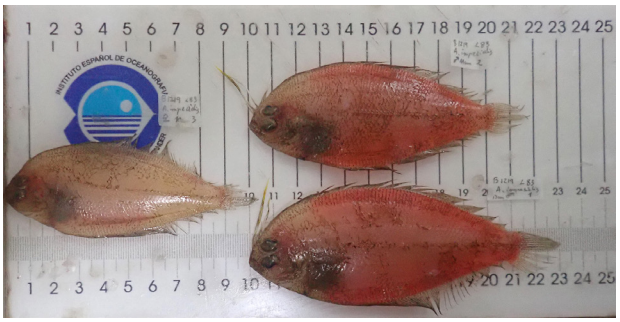

Fig. 3. – *Arnoglossus blachei* Stauch, 1965, B1219, L83, one female (left) and two males (right), Guinea-Bissau. Photographs of fresh specimens taken by Pere Oliver Reus. Ocular side.

Fig. 4. – *Arnoglossus blachei* Stauch, 1965, B1219, L83, one female (left) and two males (right), Guinea-Bissau. Photographs of fresh specimens taken by Pere Oliver Reus. Blind side.

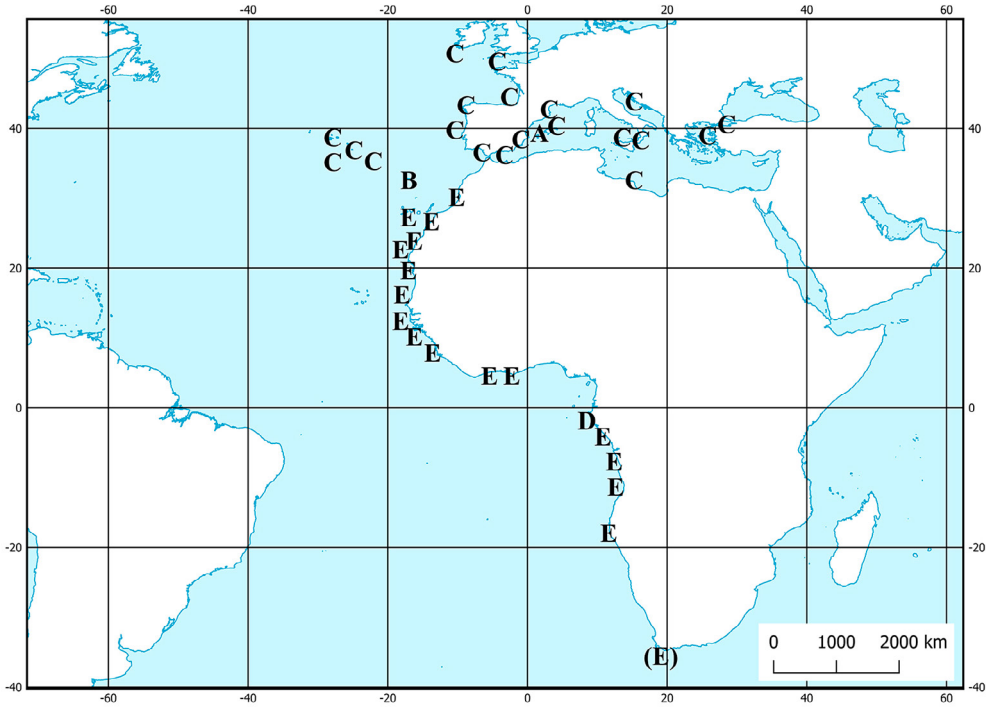

Fig. 5. – Geographical distribution of *Arnoglossus imperialis* and *A. blachei* in the eastern Atlantic and Mediterranean Sea. **A.** *A. imperialis* neotype. **B.** *A. imperialis,* neotype of *Rhombus cristatus* Lowe 1839. **C.** *A. imperialis*, other records. **D.** *A. blachei* lectotype. **E.** *A. blachei*, other records.

ence of bioluminiscence in this species. There might be a luminiscent organ in the belly area, as the peritoneum is black only dorsally, but not ventrally. Luminiscence has apparently been observed by Cornish fishermen in live *A. laterna* (see Pennant 1776: 233 as "The lantern fish"). So far, we have been unable to locate luminiscent organs in either of these species, or in *A. imperialis*. The question whether there is bioluminiscence in *A. blachei* or *A. imperialis* needs further research.

Arnoglossus imperialis (Rafinesque, 1810)
Imperial flounder
(Figs 6-11, Table 4)

Bothus imperialis Rafinesque 1810a: 23 (Sicily, Italy, Mediterranean Sea). Rafinesque 1810b: 15.
Bothus punctatus Rafinesque 1814: 17 (Sicily Italy, Mediterranean Sea). Parenti 2019: 108 (questionably a synonym of *Arnoglossus imperialis*).
Rhombus cristatus Lowe 1839: 88 (Madeira).
Arnoglossus lophotes Günther 1862: 417 (?British coast, Europe). Collett 1896: 95 (Azores; Gulf of Gascogne, France). Murray and Hjort 1912: 407. Nobre 1935: 205 (Portugal).
Arnoglossus grohmanni (non Bonaparte 1837): Day 1882: 748, pl. 53.
Charybdia rhomdoidichthys Facciolà 1885: 266 (Messina, Sicily, Italy, Mediterranean Sea).
Arnoglossus imperialis: Petersen 1909: Figs 26-29. Kyle 1913: 79 (English Channel to western Mediterranean). Bertin 1929: fiche 378. Chabanaud 1931b: 19 (part: English Channel). Bertin 1932: 242 (Banyuls-sur-Mer, France). Norman 1934: 181 (part: Madeira; Europe). Fowler 1936: 1258 (part). Chabanaud 1939: 7. Albuquerque 1954-1956: 961 (Portugal). Padoa 1956: 800. Bauzá Rullán 1958: 117 (otoliths). Stauch 1965: 255 (Ireland and southern England south to Portugal; western Mediterranean Sea). Bini 1968: 47 (Italy). Wheeler 1969: 530 (western English Channel, southern Ireland). Nielsen 1973: 621. Deniel 1975: 109 (France: alimentation). Maul 1976: 61 (part: Portugal; Gettysburg Bank; Josephine Bank). Deniel 1983: 234 (France; reproduction). Nielsen in Whitehead et al. 1986: 1294 (part). Jardas and Pallaoro 1987: 2 (Croatia, Adriatic Sea). Aldebert et al. 1990: 1028. Lloris et al. 1991: 221 (part: Azores; Madeira). Wheeler 1992: 16. Gil de Sola Simarro 1994: 67 (Alboran Sea, Spain). Arruda 1997: 118 (Azores). Merella et al. 1997: 67 (Balearic Islands/Spain). Santos et al. 1997: 129 (Azores). Evseenko 1998: 59. Bilecenoğlu et al. 2002: 149 (Turkey). Cabral et al. 2002: 97 (Portugal; trophic niche overlap). Fricke et al. 2007: 114 (Turkey). Henriques et al. 2007: 270 (Portugal). Pakhorukov 2008: 137 [121] (Irving, Meteor, Hyéres, Josephine and Ampere seamounts, southern Azores region). Wirtz et al. 2008: 19 (Madeira). Abecasis et al. 2009: 4 (Gorringe Seamount). Lipej and Dulčić 2010: 72 (Croatia, Adriatic Sea). Carneiro et al. 2014: 61 (Portugal). Jaramillo et al. 2014: 64 (Valencia/Spain). Martins and Carneiro 2018: 78 (Portugal; Galicia/Spain). Artüz and Fricke 2019: 560 (Sea of Marmara/Turkey). Almeida and Biscoito 2019: 153 (Azores). Carneiro et al. 2019: 189 (Portugal; Azores; Madeira). Elbaraasi et al. 2019: 101 (Libya). Parenti 2019: 101. Amaoka et al. 2020: 4 (part: northeastern Atlantic and Mediterranean). Kovačić et al. 2020: 27 (Adriatic Sea). Bañón and Maño 2021: 96 (Galicia/Spain). Kovačić et al. 2021: 44 (Mediterranean Sea).

Neotype of Bothus imperialis *Rafinesque 1810*, Bothus punctatus *Rafinesque 1814 and* Charybdia rhomdoidichthys *Facciolà 1885 (designated herein)***:** SMNS 27387, male, 118.7 mm SL, Balearic Islands, northeast of Ibiza, 39°09'40.8"N 1°39'10.8"E, 108 m depth, Francesc Ordines, R/V Miguel Oliver, Cruise MEDITS_PITIUSES_2021, St. 11, 20 Aug. 2021.
Neotype of Rhombus cristatus *Lowe 1839 (designated herein)*: BMNH 1895.7.16.7, 1 male, 110.8 mm SL, Madeira, J. Y. Johnson, 1895.
*Other material***:** HUJ 20600 (3), Balearic Islands, northwest of Menorca, 63-64 m depth; HUJ 20638 (1), Balearic Islands, northeast of Mallorca, 144-139 m depth; CFP_IEOMA 7769 (5), Balearic Islands, southeast of Menorca, 133 m depth; CFP_IEOMA 7770 (2), Balearic Islands, northeast of Ibiza, 108 m depth; CFP_IEOMA 7771 (2), eastern Atlantic, Spain, Cádiz Province, 110 m depth; CFP_IEOMA 7772 (1), Balearic Islands, northwest of Ibiza, 130 m depth; CFP_IEOMA 7773 (4),

Table 4. – Counts and measurements [mm] of *Arnoglossus imperialis* (Rafinesque, 1810).

	Neotype of *Bothus imperialis* Rafinesque, 1810, *Bothus punctatus* Rafinesque, 1810 and *Charybdia rhomdoid-ichthys* Facciolà, 1885: SMNS 27387 (Baleares Islands, northeast of Ibiza)	Neotype of *Rhombus cristatus* Lowe, 1839, BMNH 1895.7.16.7 (Madeira)	Other material: SMNS 27384 (2), 27385 (2), 27386 (4), 27390 (1), 27393 (1), 27396 (1)	
Sex	Male	Male	Males (n = 9)	Females (n = 2)
Dorsal-fin rays	101	96	98-101	97-98
Anal-fin rays	75	74	74-79	76-77
Pectoral-fin rays (ocular side)	10	10	11	10-11
Pectoral-fin rays (blind side)	10	7	9-10	9-10
Caudal-fin rays	ii,13,ii	ii,13,ii	ii-iii,11-13,ii-iii	iii,11,iii
Lateral-line scales	58	63	58-62	61
Gill rakers on first arch, lower branch (ocular side)	8	8	7-9	8-9
Vertebrae	10 + 31	10 + 32	10 + 31-32	10 + 33
Measurement:				
SL	118.7	110.8	92.0-146.9	92.0-104.0
Proportions (% of SL):				
Head length (ocular side)	24.8	25.4	24.7-25.7	24.8-26.3
Body depth	38.7	40.8	36.1-43.9	36.6-39.0
Upper orbit diameter	7.6	8.4	6.7- 8.4	7.1- 7.7
Lower orbit diameter	7.5	8.2	6.7- 8.4	7.1- 7.6
Interorbital width	0.7	1.0	0.4- 0.8	0.4
Upper jaw length ocular side)	8.1	8.5	7.9- 8.7	8.5- 8.8
Lower jaw length (ocular side)	5.7	7.4	5.7- 6.9	6.8- 7.0
Lower jaw length (blind side)	5.5	6.3	5.5- 6.6	6.5- 7.1
Caudal peduncle depth	9.3	8.7	8.5-10.2	8.8- 9.0
Length of longest dorsal-fin ray	17.9	15.5	16.4-23.1	7.3- 7.9
Length of longest anal-fin ray	11.5	9.5	11.0-11.5	9.1-12.9
Pectoral-fin length (ocular side)	17.3	15.2	16.6-19.1	17.0-17.9
Pectoral-fin length (blind side)	7.7	10.1	7.8-11.8	8.2
Pelvic-fin length (ocular side)	19.1	15.3	13.6-19.1	15.2
Pelvic-fin length (blind side)	11.9	12.4	10.2-11.9	10.1-11.0
Length of pelvic-fin base (ocular side)	9.3	8.6	6.6- 9.9	8.0-8.8
Length of pelvic-fin base (blind side)	4.4	7.4	3.4- 5.0	4.0- 5.0
Length of longest caudal-fin ray	19.0	20.1	17.8-20.4	18.5-20.5

Balearic Islands, northwest of Ibiza, 125 m depth; SMNS 27384 (2), Balearic Islands, northeast of Ibiza, 108 m depth; SMNS 27385 (2), Balearic Islands, southeast of Menorca, 133 m depth; SMNS 27386 (4), eastern Atlantic, Spain, Cádiz Province, 110 m depth; SMNS 27390 (1), Balearic Islands, north of Cabrera, 49-61 m depth; SMNS 27393 (1), Balearic Islands, northwest of Menorca, 148-152 m depth; SMNS 27396 (1), Balearic Islands, southeast of Menorca, 130-134 m depth.

Diagnosis. A species of *Arnoglossus* with the second to fifth, sixth or seventh (male), second to third (female) dorsal-fin rays elongate and filamentous, dorsal-fin rays 96-101, anal-fin rays 74-82, pectoral-fin rays on ocular side 10-11, on blind side 9-10, caudal-fin rays ii-iii,11-13,ii-iii , lateral-line scales 58-63, gill rakers 0 + 8-9, not serrated, interorbital a narrow bony ridge without scales in the middle, interorbital width 4%-11% of upper orbit diameter, no enlarged teeth anteriorly in upper jaw, and prevomer small, not enlarged, weakly projecting into mouth cavity; ocular side yellowish, blind side whitish, fins translucent, spotted with brown; male dorsal-fin filaments white (maybe basally greyish).

Description. Counts and measurements of the neotype of *Bothus imperialis* Rafinesque 1810, the neotype of *Rhombus cristatus* Lowe 1839, and other material listed in Table 4 are part of this description.

Body oval, laterally strongly compressed, eyes on the left side of body ("ocular side"), right side of body

Fig. 6. – *Arnoglossus imperialis* Rafinesque, 1810, SMNS 27397, male, 118.7 mm SL, neotype of *Bothus imperialis* Rafinesque, 1810, *Bothus punctatus* Rafinesque, 1814 and *Charybdia rhomdoidichthys* Facciolà, 1885, Balearic Islands, northeast of Ibiza. Photograph of preserved specimen. Ocular side.

Fig. 7. – *Arnoglossus imperialis* Rafinesque, 1810, SMNS 27397, male, 118.7 mm SL, neotype of *Bothus imperialis* Rafinesque, 1810, *Bothus punctatus* Rafinesque, 1814 and *Charybdia rhomdoidichthys* Facciolà, 1885, Balearic Islands, northeast of Ibiza. Photograph of preserved specimen. Blind side.

Fig. 8. – *Arnoglossus imperialis* Rafinesque, 1810, BMNH 1895.7.16.7, one male, 110.8 mm SL, neotype of *Rhombus cristatus* Lowe, 1839, Madeira. Photographs of preserved specimen taken by L. Goodayle. Above: Ocular side. Below: blind side. Scale indicated 5 cm.

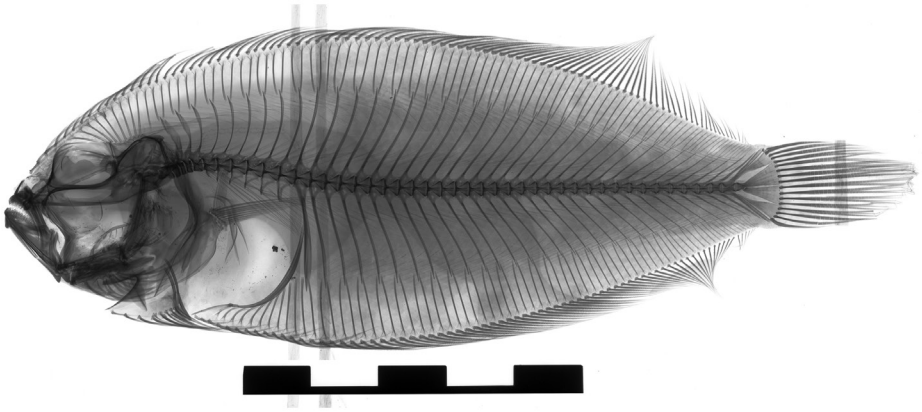

Fig. 9. – *Arnoglossus imperialis* Rafinesque, 1810, BMNH 1895.7.16.7, one male, 110.8 mm SL, neotype of *Rhombus cristatus* Lowe, 1839, Madeira. X-ray taken by J. Maclaine.

Fig. 10. – *Arnoglossus imperialis* Rafinesque, 1810, SMNS 27385, one male, 101.0 mm SL, southeast of Menorca, 133 m depth. Photograph of fresh specimens taken by Francesc Ordines. Ocular side.

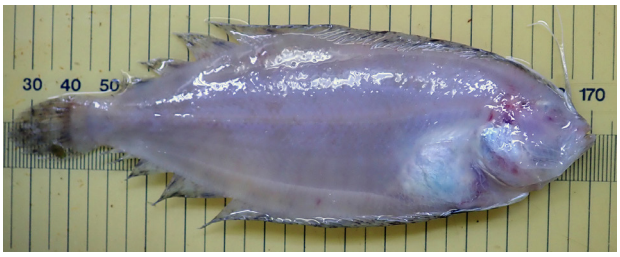

Fig. 11. – *Arnoglossus imperialis* Rafinesque, 1810, SMNS 27385, one male, 101.0 mm SL, southeast of Menorca, 133 m depth. Photograph of fresh specimens taken by Francesc Ordines. Blind side.

without eyes ("blind side"). Body depth 2.6 (2.4) [2.3-2.8] in SL, 38.7 (40.8) [36.1-43.9]% of SL. Head length 4.0 (3.9) [3.8-4.2] in SL, 24.8 (25.4) [24.0-26.3]% of SL Snout slightly pointed, not completely scaled, tip naked**.** Anterior teeth in upper jaw not enlarged, prevomer not enlarged, weakly projecting into mouth cavity. Anterior nostril situated anterior to the eyes, posterior nostril on level of anterior margin of eyes. Upper orbit diameter 3.5 (3.2) [3.2-4.0] in head length, 7.6 (8.4) [6.7-8.4]% of SL; lower orbit diameter 3.6 (3.3) [3.2-4.0] in head length, 7.5 (8.2) [6.7-8.4]% of SL. Interorbital a narrow, low bony ridge, in the middle without scales, interorbital distance 0.7 (1.0) [0.4-0.8]% of SL. Scales on orbital and blind sides cycloid. Lateral line barely arched over pectoral fin (arch formed by anterior 17-18 scales); lateral-line scales 58 (63) [58-62]. Caudal peduncle depth 10.8 (11.5) [9.8-11.8] in SL, 9.35 (8.7) [8.5-10.2]% of SL. Precaudal vertebrae 10 (10) [10], caudal vertebrae 31 (32) [31-33].

Dorsal fin with 101 (96) [97-101] soft rays, the second to fifth to seventh rays (male), second to third (female) elongate and filamentous. Anal fin with 75 (74) [74-79] soft rays. Caudal fin distally rounded, caudal fin rays ii,13,ii (ii,13,ii) [ii-iii,11-13,ii-iii]. Length of longest caudal-fin ray 5.3 (5.0) [4.9-5.6] in SL, 19.0 (20.1) [17.8-20.5]% of SL. Pectoral fin with 10 (10) [10-11] soft rays on ocular side, with 10 (7) [9-10] rays on blind side. Pectoral-fin length 5.8 (6.6) [5.2-7.3] in SL, 17.3 (15.2) [16.6-19.1]% of SL on ocular side, 13.0 (9.9) [8.4-12.9] in SL, 7.7 (10.1) [7.7-11.8]% of SL on blind side. Pelvic-fin length 5.2 (6.5) [5.1-7.4] in SL, 19.1 (15.3) [13.6-19.2]% of SL] on ocular side, 8.4 (8.0) [8.4-9.9] in SL, 11.9 (12.4) [10.1-11.9]% of SL on blind side.

Colour of fresh specimens (Figs 10, 11). Head and body with ocular side yellowish in both sexes, margins of scales brown, head brown, opercle grey; blind side pale in both sexes, head pale, belly white (liver can be seen through it as a circular black blotch); peritoneum black on eyed side, silvery white on blind side. Dorsal-fin filaments of males plain white, may be basally greyish; dorsal, anal and caudal fins pale, with irregular brown spots; pelvic fins dark grey. Pectoral fins on both sides translucent, on ocular side with brown spots.

Colour in preservative (Fig. 6-9). Similar to live colouration, but fading to pale yellowish.

Distribution. Northeastern Atlantic Ocean (UK, Ireland, France, Portugal, Spain, Madeira, Azores, seamounts in the Azores region), Mediterranean Sea (Spain, France, Italy, Croatia, Libya, Turkey), Sea of Marmara (Turkey) (Fig. 5). This species has been collected on sand bottoms at 15-350 m depth.

Genetics. A total of 376 (32 variable sites, 31 informative sites) and 523 (135 variable sites and 132 informative sites) base pairs (bp) for 12s rRNA and COI mitochondrial fragments were sequenced, respectively. The average interspecific divergence for the 12s rRNA fragments between any two species of *Ar-*

noglossus was 3.9% and 14.8 bp differences. *Arnoglossus blachei* showed the closest genetic distance to *A. rueppelii* (2.82% and 10.5 bp differences, Table 5). This genetic distance was larger than the interspecific distance observed in other species of *Arnoglossus* such as *A. imperialis* vs. *A. thori* (0.81% and 3 pb differences) and *A. capensis* vs. *A. thori* (0.99% and 3.7.5 pb differences). Based on the COI fragments, the average interspecific distance between the species of *Arnoglossus* was 12.98% and 67.9 pb differences. The closest genetic distance of *A. blachei* was observed with *A. rueppelii* (10.07% and 52.7 bp differences, Table 5). This genetic distance was greater than the interspecific distance observed in other species of *Arnoglossus* such as *A. capensis* vs. *A. imperialis* (4.69% and 24.5 pb differences) and *A. imperialis* vs. *A. thori* (8.34% and 43.6 pb differences).

The phylogenetic reconstruction for concatenated fragments clearly separates *A. blachei* from other species of *Arnoglossus* species included in the present study, with the phylogenetically closest species being *A. rueppelii* (Fig. 12). These two species are placed within a major clade that includes *A. laterna*. In addition, a second major clade is observed, including *A. imperialis*, *A. capensis* and *A. thori* (Fig. 12).

Remarks. Some of the previously recognized synonyms of *A. imperialis* are here confirmed, including *Bothus punctatus* Rafinesque, 1814, *Arnoglossus lophotes* Günther 1862 and *Charybdia rhomdoidichthys* Facciolà, 1885. However, the original description of *Bothus imperialis* Rafinesque, 1810 from northern Sicily (Italy) is very brief and does not allow a clear identification as the *Arnoglossus imperialis* of current usage. No type material of this taxon is extant, nor is any available for *Bothus punctatus* Rafinesque 1814 or *Charybdia rhomdoidichthys* Facciolà, 1885 (see Fricke et al. 2022b). In order to stabilize the current usage of these names, a neotype is hereby selected for *Bothus imperialis* Rafinesque, 1810, *Bothus punctatus* Rafinesque, 1814 and *Charybdia rhomdoidichthys* Facciolà, 1885: SMNS 27387 (male, 118.7 mm SL, Balearic Islands, northeast of Ibiza) (Figs 6, 7). This specimen originates as close as practical to the original localities (northern Sicily, Italy); we preferred to select a fresh specimen of which we had seen the live colouration after it had been collected. The neotype of *Rhombus cristatus* agrees well with the characters of the *Arnoglossus imperialis* of current usage, including a high number of lateral-line scales and plain white dorsal-fin filaments. This neotype designation links the three names involved, and fixes *Bothus punctatus* Rafinesque, 1814 and *Charybdia rhomdoidichthys* Facciolà, 1885 as permanent synonyms of *Arnoglossus imperialis* (Rafinesque, 1810).

During our studies on the synonymy of *A. imperialis*, another, unused synonym of *A. imperialis* was detected, i.e. *Rhombus cristatus* Lowe 1839 from Madeira. No type material of this taxon is extant (Fricke et al. 2022b). In order to establish the identity of this name, a neotype is hereby selected to stabilize its usage: BMNH 1895.7.16.7 (male, 110.8 mm SL, Madeira, J. Y. Johnson, 1895) (Figs 8, 9). The neotype is needed owing to a possible confusion of Madeira populations with *A. blachei*; the neotype originates as close as practical to the original locality (Madeira). The neotype of *Rhombus cristatus* agrees well with the characters of *Arnoglossus imperialis*, including a high number of lateral-line scales, caudal-fin rays ii,13,ii, and plain white dorsal-fin filaments.

This species apparently prefers cooler water; in the western Mediterranean, it is mainly found in regions with cool upwelling water, e.g. in southern France and Liguria, and off the northern coasts of Menorca or Sicily islands. In recent years, it has become rare in some of these habitats, so it may now be considered Near Threatened in the Mediterranean. Amaoka et al. (2020) treated this species as of Least Concern, with population trends unknown, but they did not distinguish be-

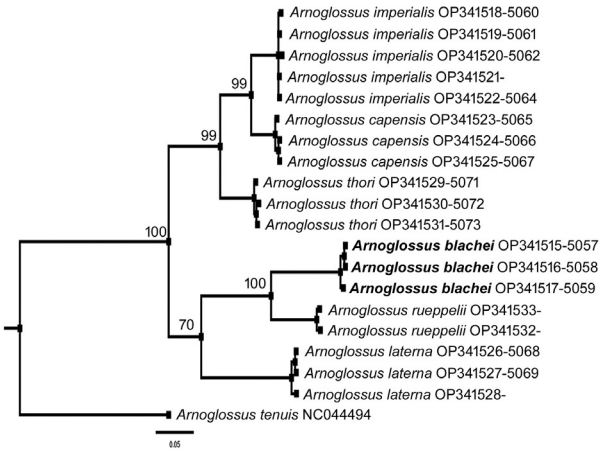

Fig. 12. – Phylogenetic relationship based on Bayesian inference for mitochondrial concatenated fragments (*12s rRNA* + *COI*) for *Arnoglossus* species studied here. Posterior probabilities are shown as percentages and are indicated near the nodes. The samples of *A. blachei* are indicated in bold face.

Table 5. – Mean genetic distances (%) and numbers of base differences for *COI* of species pairs of *Arnoglossus* below and above the diagonal, respectively.

	A. blachei	*A. capensis*	*A. imperialis*	*A. laterna*	*A. rueppellii*	*A. thori*
A. blachei	--	81.7	82.5	74.3	52.7	78.7
A. capensis	15.62	--	24.5	80.7	75.7	45.7
A. imperialis	15.78	4.69	--	81.4	75.4	43.6
A. laterna	14.21	15.42	15.56	--	75.3	72.7
A. rueppellii	10.07	14.47	14.42	14.40	--	73.5
A. thori	15.04	8.73	8.34	13.89	14.05	--

tween populations of *A. imperialis* and *A. blachei* in their assessment.

DISCUSSION

The specimens of *Arnoglossus blachei* described herein agree well with the generic characters of the genus *Arnoglossus* as defined by Norman (1934) and Amaoka (1969), including the pelvic fin on the ocular side beginning at the tip of the isthmus, the eyes separated by a bony ridge, the head large, more than 22% of SL (i.e. 23.2%-24.7%), the scales on the ocular side cycloid, and the mouth large, maxillary longer than eye diameter. However, they are clearly distinct from other species of *Arnoglossus* bearing filaments on the first dorsal fin; these species are compared in Table 6. *Arnoglossus blachei* is distinguished from *A. imperialis* by the live colouration of the lower side of the males which is bright red (whitish in *A. imperialis*) (Figs 4, 11), lateral-line scales 49-58 (vs. 58-66), and the dorsal-fin filaments in the male light grey, with black margins, distally yellowish (vs. plain white), the length of the second and third dorsal rays in males (including filaments) 23.9%-34.7% and 23.6%-37.1% of SL, respectively (vs. 13.4%-19.1% and 16.4-23.1% of SL, respectively), and gill rakers usually 5-8 (usually 6-7) [vs. 7-9 (usually 8-9)]. Unexpectedly, for both fragments studied here, *Arnoglossus blachei* was genetically more similar to *A. rueppelii* than to any other of the species compared. However, the interspecific divergences between *A. blachei* and *A. rueppelii* were high (2.82% and 10.07% for *12s rRNA* and *COI*, respectively). The divergence value for this last fragment significantly exceeds the standard threshold for marine fish species delimitation which is 2% for this fragment (Hubert et al. 2008, Ward et al. 2009, April et al. 2012). On the other hand, although for *12s RNA* there is no standard species delimitation value, Cawthorn et al. (2012) proposed 0.5% as a threshold, a lower percentage than for *COI*, which may be related to its lower mutation rate (Palumbi 1996). Thus, the divergence detected for this fragment also confirms *A. blachei* as a valid species. This is also clear from the phylogenetic analyses of the concatenated fragments, which showed different lineages between *A. blachei* and *A. rueppelii*.

Key to the species of *Arnoglossus* of the Mediterranean Sea and the eastern Atlantic

Remark: This key has been updated on the basis of Munroe (2016), Nielsen in Whitehead et al. (1986), and Fricke et al. (2017).

1a. Dorsal-fin rays 110-118; anal-fin rays 86-94 .... *A. rueppellii*

1b. Dorsal-fin rays less than 110; anal-fin rays less than 85 .. 2

2a. Gill rakers 0 + 4-5; dorsal and anal fins plain black ..... *A. nigrofilamentosus*

2b. Gill rakers 0 + 7-13; dorsal and anal fins pale, sometimes with dark spots or only anterior rays black 3

3a. Dorsal-fin rays 74-80; anal-fin rays 51-57 .... *A. grohmanni*

3b. Dorsal-fin rays 81 or more; anal-fin rays 61 or more 4

4a. Dorsal-fin rays 81 to 93; anal-fin rays 61 to 74; at most one elongate dorsal-fin ray 5

4b. Dorsal-fin rays 95 to 106; anal-fin rays 74 to 82; two or more elongate dorsal-fin rays 6

5a. No elongate dorsal-fin rays; no dark markings on ocular-side pectoral fin; no series of dark spots present along base of caudal fin ..... *A. laterna*

5b. Second dorsal-fin ray of males elongate (more than 60% of head length) with dark-fringed, broad membrane (1st, 3rd and 4th dorsal-fin rays may also be elongate, but these are only about one-third as long as second ray); ocular-side pelvic fin often with dark spot or blotch on posterior rays; a series of dark spots often present along base of caudal fin ..... *A. thori*

6a. Dorsal-fin rays 2 to 5 (-7) elongate (elongate rays nearly equal to head length in males); eyes separated by a bony ridge; lateral-line scales 52 to 66; 5 to 10 gill rakers on lower limb of first gill arch 7

6b. Anterior 3 or 4 dorsal-fin rays of males noticeably prolonged and of nearly equal length; eyes separated by a concave scaly space; lateral-line scales 56 to 67; 10 to 13 gill rakers on lower limb of first gill arch .... *A. capensis*

7a. Lateral-line scales 58-66; dorsal-fin rays 96-106; anal-fin rays 74-82; gill rakers 0 + 8-10; ventral side of males pale in life; dorsal-fin filaments in male plain whitish..... *A. imperialis*

7b. Lateral-line scales 52-57; dorsal-fin rays 89-99; anal-fin rays 64-78; gill rakers 0 + 5-8 (usually 0 + 6-7); ventral side of males bright red in life; dorsal-fin filaments in male light grey, with black margins, distally yellowish ..... *A. blachei*

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Table 6. – Comparison of the species of *Arnoglossus* with several elongate, filamentous rays anteriorly in the dorsal fin, and the closely related species *A. tapeinosoma* (some values taken from Arai and Amaoka 1996, Hensley and Amaoka 2001, Munroe 2016, Fricke et al. 2017). Values differing from *A. blachei* are printed in **bold face**.

	A. blachei	*A. nigrofilamentosus*	*A. tapeinosoma*	*A. macrolophus*	*A. elongatus*	*A. capensis*	*A. imperialis*	*A. thori*
Dorsal-fin rays	89-99	**78-84**	91	91-98	100-108	96-105	96-106	**81-91**
Elongate dorsal fin rays	rays 2 to 5	rays 2 to 6	**none**	rays 1 to 8 (male), rays 1 to 2 (female)	rays 2 to 4 (male), none (female)	**rays 1 to 4**	rays 2 to 5-7 (male), rays 2 to 3 (female)	**ray 1 in males**
Colour of filaments	light grey, rays with black margins, basally yellowish	**black**	**not applicable (anterior dorsal fin light brown)**	brown	light brown	light brown	**white**	**black**
Anal-fin rays	64-77	61-66	69	70-76	78-83	74-81	74-82	61-69
Pectoral-fin rays (ocular side)	10-12	12-13	11	12-14	12	10-13	10-12	10-12
Pectoral-fin rays (blind side)	7-10	7-9	9	8-11	10	9-12	7-10	8-9
Caudal-fin rays	iii,11,iii	iii,11,iii	iii,11,iii	**ii,13,ii**	**ii,14,ii**	iii,**14**,iii	ii-iii,11-14,ii-iii	ii-iii,**13**,ii-iii
Lateral-line scales	45-57	52-54	53	55-62	**63-70**	56-67	**58-66**	49-56
Gill rakers	0 + 5-8 (usually 0 + 6-7)	0 + 4-5	0 + 8	0 + **10-13**	0 + 6-7	0 + **10-13**	0 +7-10	0 + 7-9
Condition of gill rakers	not serrated	not serrated	not serrated	not serrated	not serrated	not serrated	not serrated	not serrated
Vertebrae	10 + 30-33	10 + 30	10 + 30	10 + 31-32	?	10 + **33**	10 + **32-35**	10 + 27-30
Head length (% of SL)	23-28	23-25	23	23-28	27-28	22-28	22-28	26-31
Body depth (% of SL)	40-46	40-44	**39**	36-43	**35-36**	40-45	36-45	**45-62**
Length of 2nd dorsal-fin ray in male (% of SL) (if filamentous)	24-35	**10-13**	--	27-50	17-26	**12-16**	**13-19**	**17-21**
Length of 3rd dorsal-fin ray in male (% of SL) (if filamentous)	24-37	**10-13**	--	28-54	18-28	**12-17**	**16-23**	**--**
Interorbital	bony ridge, no scales	bony ridge, no scales	bony ridge, no scales	bony ridge, no scales	bony ridge, no scales	**broad, scaly, concave**	bony ridge, no scales	bony ridge, no scales in juveniles; **narrow concave, scaled space in adults**
Interorbital (% of upper orbit diameter)	4-17	11-16	11	10-14	10-14	**30-40**	4-11	13-25
Prevomer	small, weakly projecting into mouth cavity	small, weakly projecting into mouth cavity	small, weakly projecting into mouth cavity	**large, strongly projecting into mouth cavity**	small, weakly projecting into mouth cavity	small, weakly projecting into mouth cavity	small, weakly projecting into mouth cavity	small, weakly projecting into mouth cavity
Distribution	eastern Atlantic from Morocco south to Namibia; Canary Islands	[Gulf of Suez?] eastern Mediterranean	Sumatra (Indonesia), China	central Red Sea and Persian Gulf east to Indonesia	Taiwan to Indonesia and northwestern Australia	Morocco to South Africa	Mediterranean and eastern Atlantic from Scotland to Strait of Gibraltar; Azores and Madeira	Mediterranean and Black seas, and eastern Atlantic from Ireland to Sierra Leone
Depth	34-175	ca. 20-30	?	18-141	100-224	70-200	15-350	5-300

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