Taxonomic revision of the genus *Bothus* (Bothidae; Pleuronectiformes)

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ABSTRACT

The taxonomic status of its 59 nominal species of the genus *Bothus* (Pleuronectiformes: Bothidae) has been revised, based on a morphological study of 320 type and non-type specimens. Of the 59 nominal species examined in the study, 18 have found to be valid and are re-described. The genus *Bothus* (pro parte) is considered natural on the basis of two characters previously identified by Hoshino and Amaoka (2006): a ventral expansion of the haemapophyses of the precaudal vertebrae and the bony expansion of the haemal spine of the first caudal vertebrae. These characters were observed in all accepted species of *Bothus*, excluding *B. swio*. The morphology of *B. swio* overlaps with other bothid genera, but its generic placement was not analysed. *Engyrprosopon* and *Crossorhombus* are hypothesized as outgroups of *Bothus* based on the character state identified by Hoshino and Amaoka (2006), an anterior extension of the sciatic part of the urohyal past the main part of the urohyal. A phylogenetic analysis of the Bothidae is needed to substantiate this hypothesis of relationship, to validate the monophyly of *Bothus* and to resolve the generic position of *B. swio*. The geographic distribution of each species is mapped and an up-to-date species identification key has been created. The 18 valid species are as follows, with their synonym species in parenthesis: *Bothus assimilis, Bothus constellatus, Bothus ellipticus, Bothus guibei* (*Rhombus heterophthalmus*)*, Bothus leopardinus, Bothus lunatus, Bothus maculiferus, Bothus mancus (Pleuronectes barfi, Rhombus macropterus*), *Bothus mellissi, Bothus myriaster (Citharicthys aureus*)*, Bothus ocellatus* (*Platophrys nebularis*, *Rhomboidichtys spinosus*, *Rhombus bahianus*)*, Bothus pantherinus, Bothus podas* (*Bothus rumolo, Bothus tappa*, *Rhombus gesneri*)*, Bothus robinsi, Bothus swio, Bothus thompsoni, Bothus tricirrhitus,* and *Bothus ypsigrammus*.

RÉSUMÉ

Le statut taxonomique de 59 espèces nominales du genre de poisson plat *Bothus* (Pleuronectiformes: Bothidae) a été révisé suite à une étude morphologique de 320 spécimens types et non-types. Des 59 espèces nominales examinées, 18 ont été jugées valides et sont redécrites. Le genre *Bothus* (pro parte) est considéré étant naturel sur la base de deux caractères précédemment identifiés par Hoshino et Amaoka (2006): l'expansion ventrale des haemapophyses des vertèbres précaudales et l'expansion osseuse de l'épine hémale de la première vertèbre caudale. Ces caractères ont été observés chez toutes les espèces valides de *Bothus*, excluant *B. swio*. La morphologie de *B. swio* chevauche celle d'autres genres de Bothidae, mais son appartenance générique n'a pas été analysée. *Engyprosopon* et *Crossorhombus* sont considérés comme les genres hors groupes de *Bothus* en se fondant sur l'état d'un caractère identifié par Hoshino et Amaoka (2006) : la présence d'une extension antérieure de la portion sciatique de l'urohyal qui dépasse la portion principale de l'urohyal. Une analyse phylogénétique des Bothidae devra être complétée afin de vérifier cette hypothèse des hors groupes, de valider la monophylie de *Bothus* et la position générique de *B. swio*. La distribution géographique de chaque espèce a été déterminée et une clé d'indentification des espèces est également présentée. Les 18 espèces valides sont les suivantes, avec leurs espèces synonymes entre parenthèses: *Bothus assimilis, Bothus constellatus, Bothus ellipticus, Bothus guibei* (*Rhombus heterophthalmus*)*, Bothus leopardinus, Bothus lunatus, Bothus maculiferus, Bothus mancus (Pleuronectes barfi, Rhombus macropterus*), *Bothus mellissi, Bothus myriaster (Citharicthys aureus*)*, Bothus ocellatus* (*Platophrys nebularis*, *Rhomboidichtys spinosus*, *Rhombus bahianus*)*, Bothus pantherinus, Bothus podas* (*Bothus rumolo, Bothus tappa*, *Rhombus gesneri), Bothus robinsi , Bothus swio, Bothus thompsoni, Bothus tricirrhitus,* et *Bothus ypsigrammus*.

TABLE OF CONTENTS

page

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LIST OF FIGURES

LIST OF TABLES

GENERAL INTRODUCTION

Flatfishes Overview

Commonly known as 'Flatfish', the order Pleuronectiformes has generated interest among biologists since they were first described by Carl Linnaeus in *Systema Naturae* (Linnaeus 1758). Flatfish are not only important from an evolutionary perspective due to their peculiar morphology, but are also an important natural resource with a high commercial value globally.

Adult Pleuronectiformes are benthic animals characterized by an asymmetrical morphology (deep, laterally compressed body, two eyes on one side of head, and asymmetrical jaws). In the larval stage, flatfish inhabit the upper pelagic region of the oceanic water column and have bilaterally symmetrical bodies. During ontogeny the body flattens, the swim bladder is lost, and there is an astonishing reconfiguration of the cranium. One eye migrates to the other side of the body (Schreiber 2013) which allows the flatfish to adapt to a bottom dwelling benthic life. The directionality of the eye migration depends on the species, with some having an eye migration across the left side of the head (sinistral) or conversely across the right side of the head (dextral). Almost all of the Pleuronectiformes have a dominant left or right-eyed migration and asymmetry (Munroe 2015). Flatfish are unique as they are the only vertebrate to have a post-embryonic asymmetrical remodeling during ontogeny (Schreiber 2013). This asymmetrical remodeling can also be observed in the paired fins and the jaws, for example the reduction of the blind-side pectoral fin and the elongation of an eyed-side pectoral fin.

The maximum adult size of flatfish varies between species, for example, adults of *Tarphops oligolepis* (Bleeker 1858) average only 4.5 cm in length, whereas *Hippoglossus* (Linnaeus 1758) can grow over 2.5 m. Flatfish are cryptic animals and most species have the ability to modify their skin pigmentation of the eyed side to instantly to mimic their environment (Ramachandran *et al.* 1996), whereas the blind side is generally devoid of pigmentation. Their protruding eyes (an autapomorphy of

the group) allow them to detect the topography and color of their environment so they can match their skin pigmentation as a predatory and defensive mechanism.

Flatfishes are found in all the oceans of the world. They are distributed across cold, temperate, and tropical seas, from the intertidal zone to the deeper regions of the continental slope (Gibson 2005). The most diverse assemblage of flatfishes, approximately 73.4% of all known flatfish species, inhabits the tropical seas along the continental shelf within 100 m from shore (Munroe 2015). Most flatfish are saltwater species with only 34 species inhabiting freshwater (Munroe 2015).

Flatfishes (sole, halibut, etc.) have a high commercial value in numerous countries. The majority of flatfish fisheries are located within the northern hemisphere in the Pacific and Atlantic oceans. Some commercial fisheries also located in southern temperate regions such as in New Zealand, Australia, and South America (Diaz de Astarloa & Munroe 1998). Off the Atlantic coast of Canada alone, there were 15 508 metric tons/ live weight of flatfish caught commercially in 2008 (DFO 2008). Flatfish accounted for 4.6% of Canada's total commercial fishery landings in 2008 (DFO 2008), and from 2001 to 2007 the average amount of flatfish caught worldwide was 900 909 metric tons (FOA 2008). The abundance of flatfish being fished commercially and consumed worldwide is the force behind understanding their biology.

Order Pleuronectiformes (Flatfishes)

The order Pleuronectiformes (Berg 1940) contains 14 families, 123 genera, with 1363 nominal species, 822 of which are classified as valid (Munroe 2015) (Figure. 1).

	Norman (1934)		Chabanaud (1939)		Munroe (2005a)		Present study[a]	
Family	*Genera*	*Species*	*Genera*	*Species*	*Genera*	*Species*	*Genera*	*Species*
Psettodidae	1	2	1	2	1	2	1	3
Citharidae	2	3	2	3	4	7	4	6
Scophthalmidae	3	10	4	10	4	9	4	9
Paralichthyidae	21	93	21	97	11	95	11	108
Bothidae	11	79	11	89	20	145	20	164
Pleuronectidae	28	61	27	65	21	60	21	61
Tephrinectes	1	1	1	1	1	1	1	1
Paralichthodidae	1	1	1	1	1	1	1	1
Poecilopsettidae	3	11	3	16	4	30	3	21
Rhombosoleidae	8	16	7	16	9	19	9	22
Achiropsettidae	2	2	2	2	4	4	4	6
Samaridae	4	13	2	15	2	28	3	29
Achiridae	–	–	10	31	9	31	9	35
Soleidae	–	–	28	86	29	139	29	192
Cynoglossidae	–	–	4	117	3	145	3	164
Totals	85	292	125	551	121	716	123	822

[a]Includes data for nominal species recognised by taxonomists, but not formally described.

Figure 1. Most recent list of Pleuronectiform fishes recognized from previous studies arranged by family from Munroe (2015), Systematic Diversity of Flatfishes, Chapt. 2, p. 17, Table 2.1.

Pleuronectiform origin remains clouded because of the lack of fossil evidence in the form of transitional species. These species would help map the evolutionary history of the eye migration during ontogeny. A recent study on flatfish intermediate species by Friedman (2008) identified two extinct genera (*Amphistium* and *Heteronectes*) that served as intermediates between species. These fish displayed characters (such as an asymmetrical body) of living flatfish but also displayed primary characters not seen in living flatfish (such as an incomplete eye migration in fully developed mature adults).

Flatfish fossils have been discovered dating back to 53-57 million years ago (Gibson 2005). Species of flatfish were originally described in the genus *Pleuronectes* (Linnaeus 1758) in "*Systema*

Naturae" (Linnaeus 1758). Cuvier (1816) later published "*Le Règne Animal*" and raised the genus to the family level *Pleuronectidae* (Cuvier 1816). Günther (1862) raised the family to the suborder Pleuronectoidei (Günther 1862), which was then reclassified by Cope (1871) as the order Heterosomata (Bonaparte 1846). Jordan and Goss (1889) then did a revision of the order Pleuronectiformes stating it consisted of a single family, seven subfamilies, and multiple subgenera. Lastly, the name Heterosomata was replaced by the current name of the order Pleuronectiformes (Berg 1940).

A key topic within Pleuronectiformes has always been an assessment of the order's phylogeny. Norman (1934) did a systematic monograph of three of the five recognized flatfish families (Psettodidae, Bothidae, and Pleuronectidae) producing a key and characterization of the three families. Hensley and Ahlstrom (1984) developed a hypothesis of Pleuronectiform phylogeny based on the studies of Norman (1934, 1966), Hubbs (1945), Amaoka (1969), Futch (1977), and Hensley (1977). This produced the 'Regan Norman Model' (Hensley and Ahlstrom, 1984:670), which was used as the base for studies on Pleuronectiforms and their interrelationships.

Despite all previous studies pertaining to Pleuronectiformes, Chapleau (1993) was the first to do a cladistic analysis examining phylogenetic relationships within the order. Chapleau's analysis of the Pleuronectiformes used morphological data to hypothesize that flatfishes were monophyletic. Chapleau (1993) based this monophyletic status on three synapomorphies: an asymmetrical development of the cranium in which one eye migrates to the opposite side of the head to produce adult asymmetry, a dorsal-fin that overlaps the neurocranium and often extends in front of the jaws, and the presence of the *recessus orbitalis* muscle that enables flatfish to protrude their eyes (Chapleau, 1993).

Previously, the classification presented by Nelson (2006), based morphological evidence presented by Chapleau (1993), Chapleau & Cooper (1998), and Hoshino (2001), stated that Pleuronectiformes were composed of two suborders with fourteen families based on morphological

evidence. The suborders Pleuronectoidei, being comprised of thirteen families and the suborder Psettodoidei. Recently, this classification has been both supported and challenged due to conflicting molecular studies on Pleuronectiform monophyly.

Studies supporting the monophyly of Pleuronectiformes (Betancur & Ortía 2014, Azevedo *et al.* 2008, Berendzen & Dimmick 2002) have presented phylogenetic molecular evidence to confirm monophyly of the order. Berendzen & Dimmick (2002) proposed Psettodidae as the sister group to all other flatfish based on their molecular phylogenetic analyses of 12S and 16S mitochondrial genes. In contrast, more current molecular studies (Campbell *et al.* 2013, 2014) oppose the monophyletic status of the Pleuronectiforms, based on their conclusion that there is no clear unequivocal molecular evidence to support the monophyly of flatfish. Their molecular data indicated that there are at least two independent flatfish origins resulting in asymmetrical morphology, and thus disclaiming a monophyletic origin of the Pleuronectiformes.

Current studies are ongoing, as such Pleuronectiform origin and monophyly will continue to be a topic of debate until an all-encompassing analysis examining morphological characters, molecular data and evolutionary relationships within the order, has been completed.

Family Bothidae (Lefteye Flounders)

The family Bothidae was first mentioned by Regan (1910) and was identified as: being sinistral (left eyed) with a few species showing exception, all sinistral species have the right eye (Fig. 11) on the upper dorsal portion of the cranium, and the olfactory laminae was arranged transversely or radiated from a central rachis. Norman (1934) later described Bothidae as a family of left eyed flatfishes that include three sub-families (Regan 1910); Paralichthyinae, Bothinae, and Scophthalminae. Norman identified members of Bothinae based on the position/structure of the pelvic fins, and whether or not caudal vertebrae had transverse apophyses.

Hensley and Ahlstrom (1984) summarized the current views of flatfish familial interrelationships based on the previous studies of Regan (1910, 1929), Norman (1934, 1966) Hubbs (1945), Amaoka (1969), Hensley (1977), and Futch (1977). They examined the two subfamilies within the Bothidae assigned by Amaoka (1969): Taeniopsettinae and Bothinae. In their summary, they stated that Taeniopsettinae was not believed to be monophyletic. They did indicate that the family Paralichthyidae Regan, 1910 was suspected to be the sister group of the Bothidae, within a bothoid lineage. This bothoid lineage included Pleuronectinae, Paralichthyidae (except *Tephrinectes* and *Thysanopsetta*), Scophthalmidae, one citharid (*Brachypleura*), and the Bothidae (except *Mancopsetta*).

The Bothidae were deemed monophyletic by the presence of three derived adult characters (Hensley and Ahlstrom 1984). Based on Amaoka (1969), Hensley and Ahltstrom (1984) identified these three adult characters as: asymmetrical ventral-fin morphology (an elongated ocular-side pectoral fin on the mid-ventral line of the body); the loss of the blind side preorbital; and the presence of myorhabdoi (Chapleau 1993: 528). Consequently, the monophyletic status of Bothidae was proposed via morphological phylogenetic studies in Chapleau (1993). However, the status of bothid subfamilies could not be established due to overlapping characters with non-bothoid taxa. Molecular phylogenetic studies are ongoing and will provide further insight into the interfamilial relationships of the Pleuronectiformes (Munroe 2015) as well as Bothidae.

In some molecular analyses on the phylogenetic relationships of Pleuronectiformes, the hypothesized monophyly of the Bothidae has been supported. Using 12S and 16S mitochondrial ribosomal genes Berendzen and Dimmick (2002) found four genera of the family Bothidae to be monophyletic, recognizing Paralychthyidae as the sister group of Bothidae. Pardo *et al.* (2005) did a study on the phylogenetic relationships of Pleuronectiformes using 16S mitochondrial DNA and found that Paralichthyidae was not monophyletic and should be split into Paralichthyidae 1 and

Paralichthyidae 2. Paralichthyidae 1 containing Citarichthys, Etropus, and Syacium was found to be closely related to Bothidae. They did not provide a hypothesis of relationships between families. Betancur-R (2013) did a molecular study on the phylogeny of spiny-finned fishes that included all major lineages. Bothidae was found to be a sister group of Paralichthyidae however, Paralichthyidae was also found to be a sister group of Pleuronectidae, leaving the relationships between the three families in question and open to further investigation. The monophyletic status of the Paralichthyidae needs to be examined in order to help decipher relationships between Bothidae, Paralichthiydae, and Pleuronectidae. Regardless of the relationships between families, all Bothidae do share unique character states and its monophyletic status is most probably valid.

Our definition of the family refers to the concept currently indicated in Munroe (2005, 2015), Chapleau (1993), and corroborated in Berendzen and Dimmick (2002), and Pardo *et al.* (2005). Currently, with this definition, there are 164 species in 20 genera in the family Bothidae (Munroe, 2015).

The Present Study

The objective of the thesis is to complete the first taxonomic revision of the genus *Bothus* (Rafinesque 1810) and all of its 59 nominal species to determine valid taxa. The goals of the thesis are as follows: revise all nominal species belonging to *Bothus,* and determine valid species, map the geographic distribution of each species and produce a revised species key.

A literature review followed by an exhaustive examination of morphological characters (morphometric, meristic and osteology) of type and non-type specimens was done. This study will provide a much-needed clarification of the taxonomic status of species within my definition of *Bothus*.

Bothus Introduction

Bothus is currently located in the family Bothidae and contains 59 nominal species. The taxonomic history of nominal species of *Bothus* with their status and author can be found in Appendix A.

Rafinesque (1810a) created the genus *Bothus* while describing three new species: *B. rumolo, B. imperialis,* and *B. tappa*. Rafinesque (1810a) used the following characters to describe the genus: "*two eyes on the left hand side, a distinct dorsal and anal-fin ray extending to the caudal, and a distinct pectoral fin,*" (Rafinesque 1810a, pg. 23). According to Eschmeyer (2015), the type species of the genus is *Bothus rumolo* by subsequent designation of Jordan (1917). Rafinesque's original *Bothus rumolo* Rafinesque 1810a description states: "*the body length is equal to its depth, the lateral line curves above the ocular-side pectoral fin, the blind side of the body lacks pigmentation, and has a rounded caudal-fin*.".

Figure 2. Modified image of *Pleuronectes podas* from Delaroche (1809, Pl. 24), Annales du Muséum d'Histoire Naturelle, Paris v. 13.

Jordan and Goss (1889) performed a review of all known European and North American genera of flounders and soles. They stated that the Heterosomata contained the family Pleuronectidae consisting of seven subfamilies forming a natural group that was easily recognizable. One of these seven sub-families, Pleuronectinae, contained the genus *Pleuronectes* that contained the sub-genus *Bothus*. Jordan and Goss (1889) stated that *Bothus* Rafinesque (1810a) and *Pleuronectes* Linneaus 1758 should be seen as different due to the scaly nature of *Bothus* Rafinesque (1810a). Although recognized as different, the scaly nature of *Bothus* was not considered significant enough to ascertain genus status, and as such was designated a sub-genus. Jordan (1917) next stated that the descriptions of *Bothus* (Rafinesque 1810a) and *Rhombus* Cuvier, 1816 were based on the same specimen and therefore *Bothus* Rafinesque 1810 was designated a genus and took the name *Bothus* based on the earliest designation.

Norman (1934) did a systematic monograph on flatfishes and provided this definition of the genus *Bothus*: "*More than 74 scales in lateral line; upper angle of gill-opening a short distance above pectoral fin or close to lateral line; membrane joining operculum to pectoral arch scaleless or partly scaled. Eyes generally separated by a broad interspace (at least in male), the lower well in advance of the upper; male nearly always with rostral and orbital spines; teeth in jaws in two or more series (at least anteriorly)'; membrane joining operculum to pectoral arch scaleless*," (Norman 1934 p. 172) (See Appendix B for Characters). Norman also created a species key that split the genus into two groups based on their geographic distributions: Mediterranean/Atlantic and Indo-Pacific species. Norman's monograph contained 14 *Bothus* species considered valid at the time: *B. assimilis, B. bleekeri, B. constellatus, B. ellipticus, B. leopardinus, B. lunatus, B. maculiferus, B. mancus, B. mellissi, B. myriaster, B. ocellatus, B. ovalis, B. pantherinus,* and *B. podas*.

Other species of *Bothus* discovered after Norman's (1934) monograph and proposed to be valid are: *B. thompsoni* (Fowler 1923) from Hawaii, re-described by Struhsaker & Moncrief (1974); *B. guibei* from the Atlantic Ocean near Annabon, described by Stauch (1966); *B. robinsi* from south western coast of Florida, described by the Topp and Hoff (1972) based on a manuscript by Thelma Jutare (1962); *B. tricirrhitus* from the East Coast of Somalia and *B. ypsigrammus* from the Gulf of Aden, described by Kotthaus (1977); and most recently *B. swio* from Mozambique, described by Hensley 1997.

Outgroup of *Bothus*

Although there have been previous analysis of the genus *Bothus* (Norman 1934, Amaoka 1969, Fukui 1997), its monophyletic status and relationships within family Bothidae remain to be clarified. No complete phylogenetic analysis of the family has ever been completed. Amaoka's (1969) eclectic phylogenetic analysis of the Japanese sinistral flounders produced a tree of genera (Fig. 3) where Japanese species of *Bothus* were included. *Bothus* was viewed as an ancestral genus with many possibly related genera because of its overlapping morphological and osteological characters. Amaoka stated that *Bothus* could be closely related to *Engyprosopon* and *Laeops,* although a combination of overlapping characters did not allow for a sister group determination.

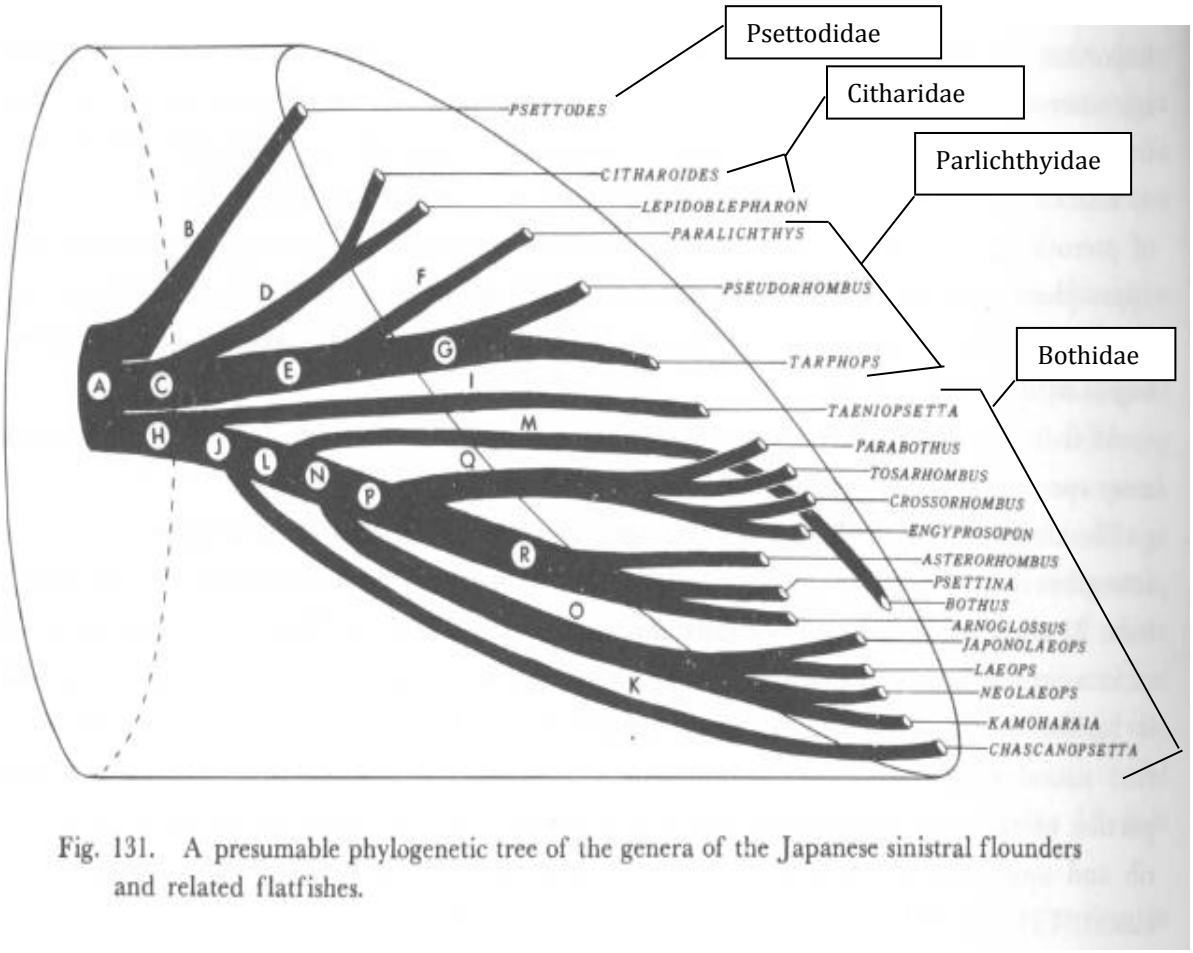


Fig. 131. A presumable phylogenetic tree of the genera of the Japanese sinistral flounders and related flatfishes.

Figure 3. Phylogenetic tree of genera for Japanese sinistral flounders **(**Amaoka 1969, Fig. 131).

Fukui (1997) did a phylogenetic analysis based on larval characters for 16 of the 20 bothid genera. He created a branching diagram (Fig. 4), where *Bothus* was split into Indo-Pacific (IP) and Atlantic-Mediterranean (AM) groups based on larval morphometric differences. The AM *Bothus* shared morphological traits with *Tosarhombus, Psettina,* and some Atlantic-Mediterranean species of *Arnoglossus;* whereas the IP *Bothus* was part of a polytomy with several other bothid genera. The conclusion was that *Bothus* was not monophyletic based on larval characters.

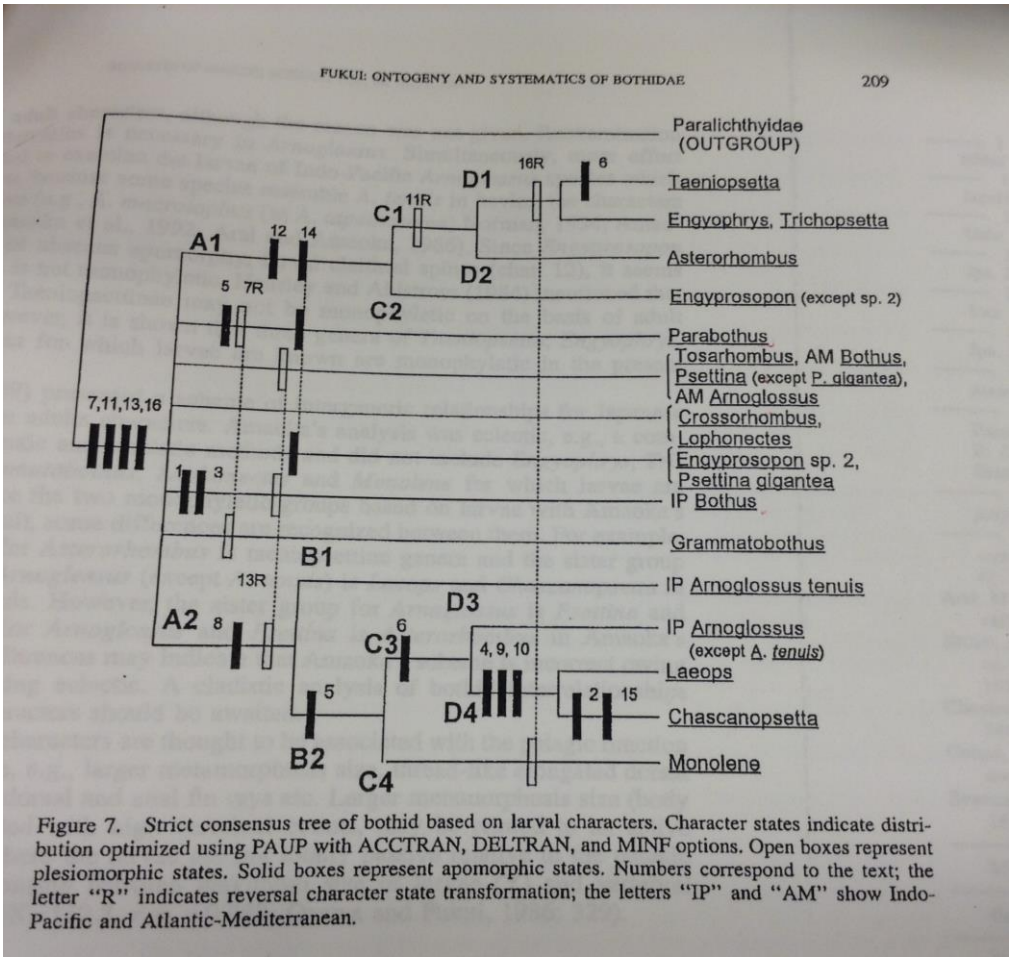


Figure 7. Strict consensus tree of bothid based on larval characters. Character states indicate distribution optimized using PAUP with ACCTRAN, DELTRAN, and MINF options. Open boxes represent plesiomorphic states. Solid boxes represent apomorphic states. Numbers correspond to the text; the letter "R" indicates reversal character state transformation; the letters "IP" and "AM" show Indo-Pacific and Atlantic-Mediterranean.

Figure 4. Branching diagram depicting phylogenetic analysis of the Bothidae family based on larval characters of 16 of the 20 bothid genera (Fukui, 1997:209: Fig. 7).

Hensely (1997) suggested a possible relationship between *Bothus* and *Grammatobothus* based on the descriptions of Norman (1934, 1966), and his own analyses of *Bothus swio*. Hensley did not state any characters that support this relationship, and his statement was most likely based on general appearance and the elongated pectoral-fin rays on the ocular side in males, a shared character state in both genera. Hensley indicated that the main morphological difference between the two genera was the absence of a lateral line (Fig. 5) on the blind side in *Bothus* and its presence in *Grammatobothus* (Norman 1934, 1966). Henlsey (1997) noted other distinguishing characters of *Grammatobothus* that

were absent in *Bothus* such as elongated dorsal-fin rays along the anterior of the head and two short dark bars on the head.

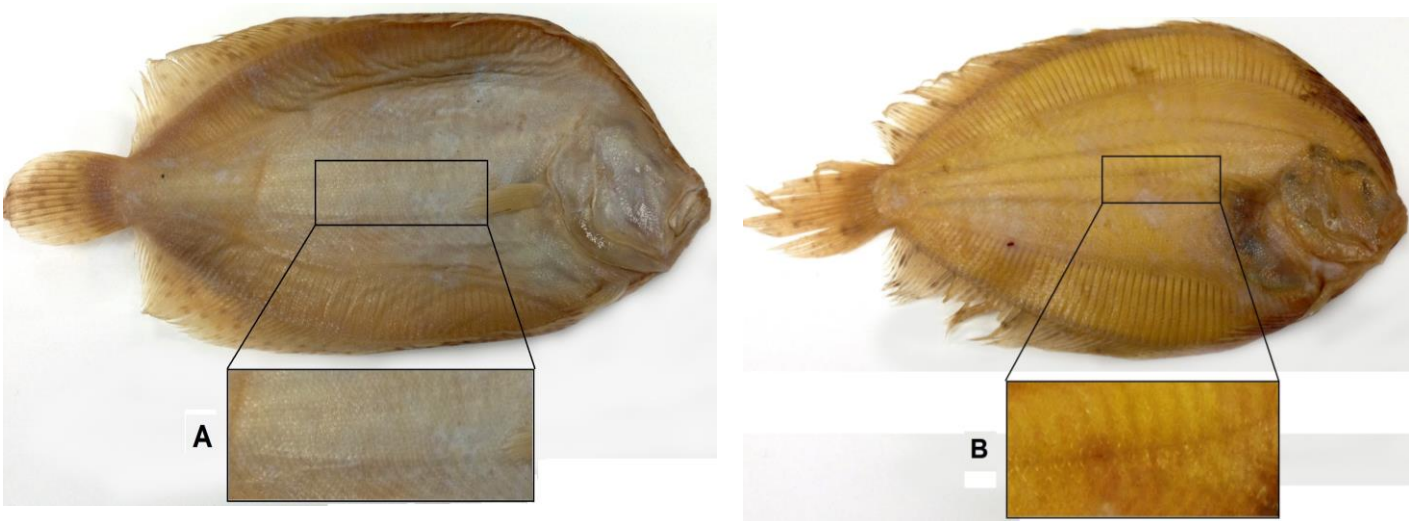


Figure 5. Photographs depicting absence of lateral line on blind side in *Bothus* (*Bothus lunatus* NMC 68-2101) (**A**), and presence on blind side in *Grammatobothus* (*Grammatobothus polyophthalmus* SNM 262520, Spec. 1) (**B**).

Hoshino and Amaoka (2006) hypothesized that *Bothus* may have a close relationship to *Engyprosopon* and *Crossorhombus* because they share an anterior extension of the sciatic part of the urohyal beyond the main part of the urohyal (Fig. 6). Some species of *Crossorhombus* and *Engyprosopon* also exhibit extended pectoral-fin rays on the ocular side as exhibited in *Grammatobothus* and *Bothus*. This extension of the sciatic part of the urohyal is not present in *Grammatobothus,* as the sciatic part of the urohyal does not extend past the main part of the urohyal, as it does in *Bothus*, *Crossorhombus*, and *Engyprosopon*. Figure 7 are radiographs of *Bothus, Engyprosopon, Crossorhombus,* and *Grammatobothus* showing the urohyal morphology of the four genera. This evidence supports the idea that *Grammatobothus* is not the sister group of *Bothus*.

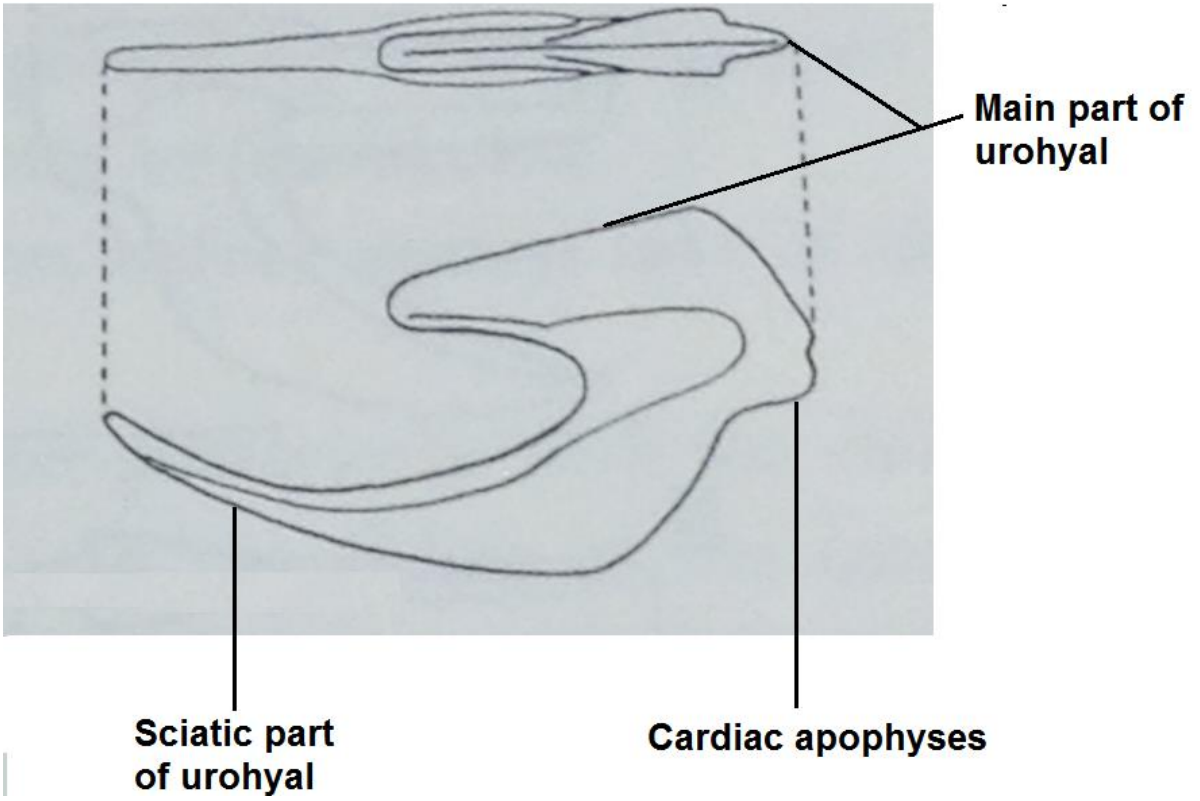


Figure 6. Dorsal (above) and lateral (below) aspect of urohyal in *Bothus*, depicting the three main components of the osteological structure. Note the extension of the sciatic part of the urohyal beyond the tip of the main part. Diagram modified from 'Studies on the sinistral flounders found in the waters around Japan-taxonomy, anatomy and phylogeny`, Amaoka (1969).

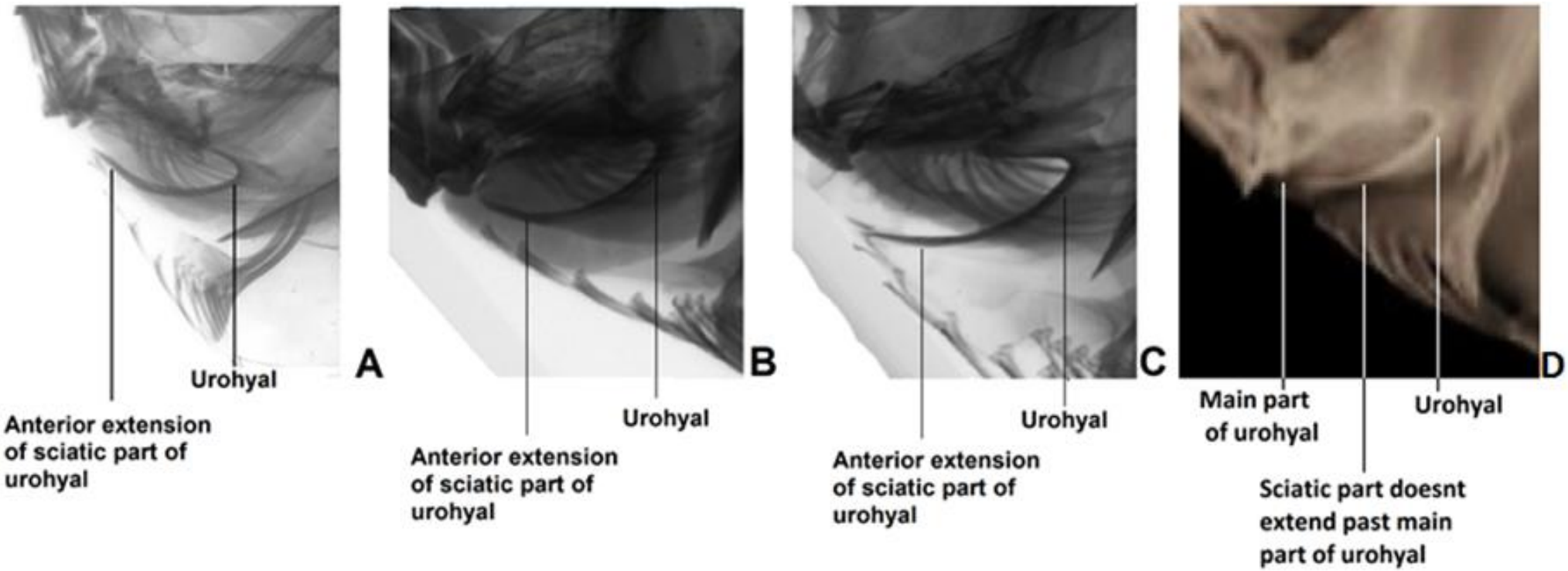


Figure 7. Radiographs of *Bothus assimilis* holotype BMNH 2012.1.12.11 (A), *Engyprosopon* mogkii syntype BMNH 1862.6.3.28 (B), *Crossorhombus* azureus syntype BMNH 1927.1.6.41 (C), *Grammatobothus* polyophthalmus USNM 362520 (D); showing the anterior extension of the sciatic part of the urohyal past the tip of the main part in all three genera.

With *Crossorhombus* and *Engyprosopon* hypothesized to be the suspected outgroups of *Bothus* (Hoshino and Amaoka, 2006), a simple diagram (Fig. 8) has been created using potentially derived character states, which to support this hypothesis of relationship. Original genus descriptions of non-*Bothus* genera (*Engyprosopon* Günther 1862, *Crossorhombus* Regan 1920), relevant literature (Amaoka 1969, Hoshino & Amoaka 2006), as well as photographs and radiographs of type and non-type material were used for the comparisons of genera.

Figure 8. Hand drawn diagram depicting possible outgroups of *Bothus*. Hypothesized derived character states are as follows: 1. anterior extension of the sciatic part of the urohyal past the main part of the urohyal; 2. Ventrally expanded haemapophyses of the precaudal vertebrae; 3. Large expansion of the first haemal spine located on the first caudal vertebrae. A description of characters can be found in Appendix B.

As depicted by the diagram (Fig.8) *Engyprosopon*, *Crossorhombus*, and *Bothus* all share Character 1: the anterior extension of the sciatic part of the urohyal past the main part of the urohyal (Fig. 7). This osteological character is unique to these three genera and supports a possible outgroup relationship as proposed by Hoshino & Amaoka (2006). Character state 2 (ventrally expanded haemapophyses of the precaudal vertebrae) and 3 (bony expansion of the anterior haemal spine as to

almost touch the succeeding spine, of the first caudal vertebrae) are considered character states unique to all *Bothus,* except *B swio.*

As for the sister-group of *Bothus*, the current knowledge of intrafamilial relationships of the Bothidae does not permit the elaboration of a hypothesis including *Engyprosopon* or *Crossorhombus*.

In conclusion, the anterior extension of the sciatic part of the urohyal past the main part of the bone, is an osteological character state unique to *Engyprosopon, Crossorhombus and Bothus*. After reviewing the literature and examining the evidence, I propose that both *Engyprosopon* and *Crossorhombus* are the outgroups of *Bothus* as it was not possible to determine a sister-group.

Monophyly of *Bothus*

Amaoka (1969) as well as Hoshino & Amoaka (2006) discussed the presence of ventrally expanded haemapophyses of the precaudal vertebrae and the bony expansion of the anterior haemal spine of the first caudal vertebrae in species of *Bothus* (Fig. 9, 10). Amaoka (1969) only studied Japanese sinistral flounders and Hoshino & Amoaka (2006) only discussed six proposed valid species of *Bothus*.

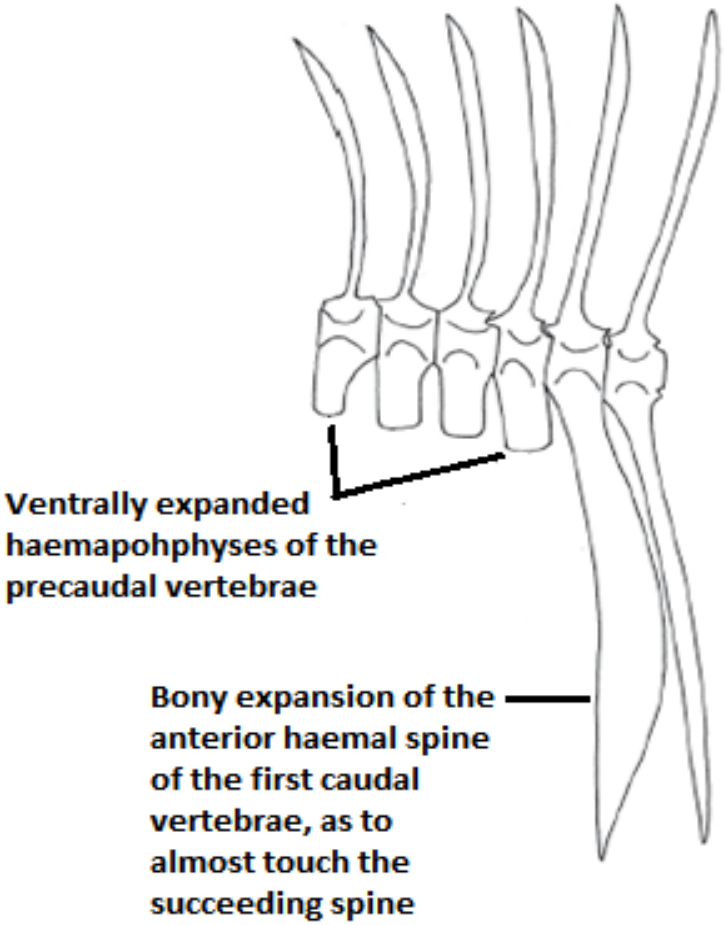


Figure 9. Lateral aspect of caudal and precaudal vertebrae depicting ventrally expanded haemapophyses and bony expansion of the anterior haemal spine in a species of *Bothus podas* (BMNH1938-11-15:54-55). Diagram modified from 'New record of the rare flounder *Bothus* swio (Pleuronectiformes: Bothidae) from the eastern Indian Ocean (northwestern Australia) with consideration on its generic affiliations', Hoshino & Amaoka (2006).

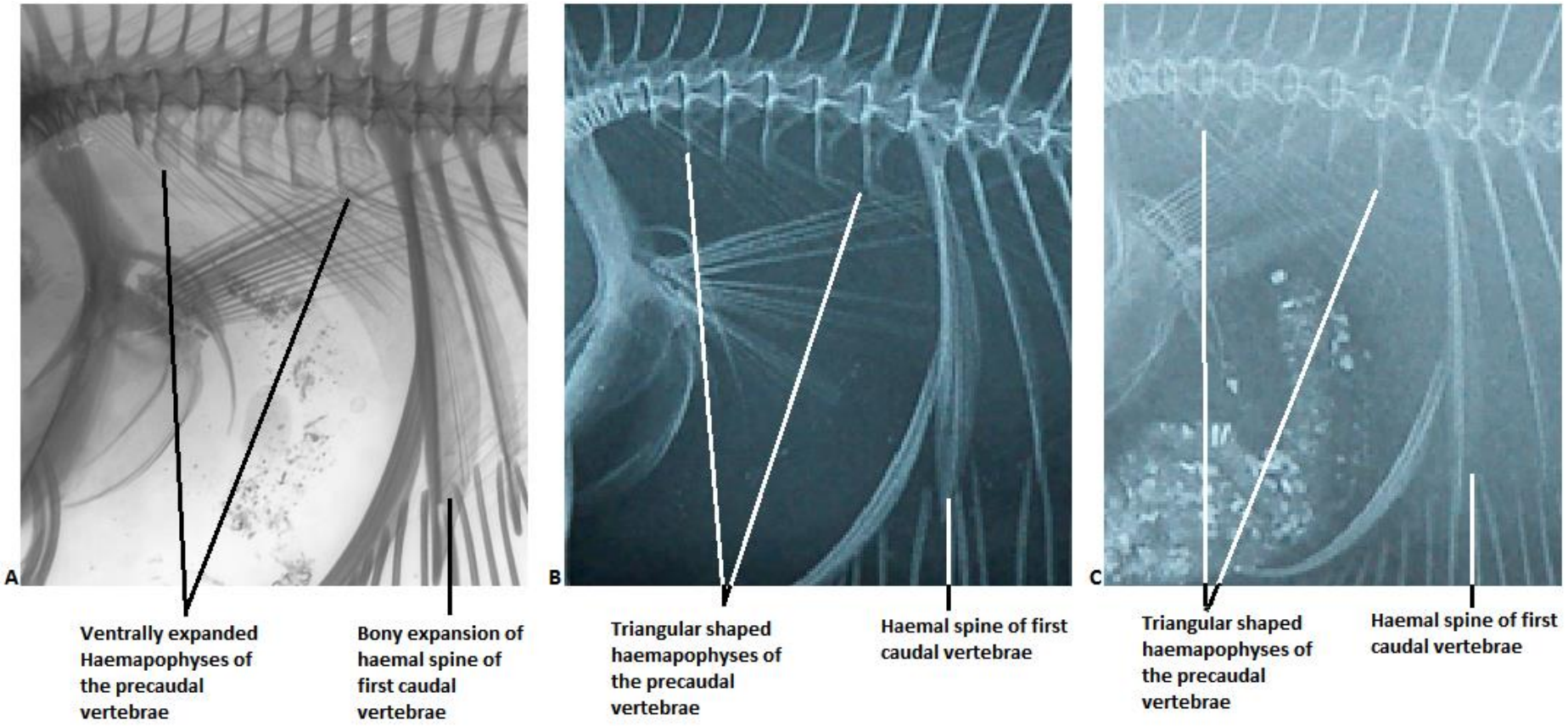


Figure 10. Radiographs of *Bothus assimilis* holotype BMNH 2012.1.12.11 (**A**), *Engyprosopon grandisquama* ASIZP 0059046 (**B**), *Crossorhombus kanekonis* ASIZP 0061731 (**C**); depicting the ventrally expanded haemapophyses of the precaudal vertebrae and bony expansion of the haemal spine of the first caudal vertebrae present in *Bothus*, compared to the triangular shape haemapophyses and less expanded haemal spines present in *Engyprosopon* and *Crossorhombus*.

This study has examined all currently proposed valid members of the genus *Bothus* and found the ventrally expanded haemapophyses and the bony expansion of the haemal spine of the first caudal vertebrae are shared by all species in the genus except *Bothus swio*. Radiographs of all specimens were examined and the ventral expansion of the haemapophyses was consistent throughout proposed *Bothus* species (except *Bothus swio,* see pg. 213). Both hypothesized outgroups of *Bothus* (*Engyprosopon* and *Crossorhombus*) have haemapophyses that are triangular (Fig. 10). The bony expansion of the haemal spine of the first caudal vertebrae is somewhat developed in the proposed outgroups, however, neither of the outgroups had haemal spines that extend to almost touch the succeeding spine (Fig. 10). Consequently, this study suggests that *Bothus* might be monophyletic, as previously suggested by Hoshino and Amaoka (2006), but until a cladistic anlaysis is preformed, this hypothesis is only tentative.

MATERIALS and METHODS

Specimen Acquisition

A total of 320 type and non-type specimens of nominal species of *Bothus* were examined; 1 *Bothus assimilis*, 15 *Bothus constellatus*, 4 *Bothus guibei*, 8 *Bothus leopardinus,* 16 *Bothus lunatus*, 14 *Bothus maculiferus*, 20 *Bothus mancus*, 13 *Bothus mellissi*, 23 *Bothus myriaster*, 28 *Bothus ocellatus*, 38 *Bothus pantherinus*, 63 *Bothus podas*, 56 *Bothus robinsi*, 12 *Bothus thompsoni*, 1 *Bothus tricirrhitus*, 8 *Bothus ypsigrammus*; 1 *Pleuronectes lunulatus*, 3 *Bothus ovalis*, 1 *Platophrys circularis, 1 Bothus bleekeri*, 1 *Platophrys nebularis*, 1 *Passer marchchionessarum*, 3 *Rhombus rhomboids*, 11 *Bothus podas africanus*, *Bothus podas maderensis*, 3 *Rhombus serratus*, *Rhombus bahianus*. Original descriptions and literature were used to provide data for any nominal species that could not be examined (e.g. *Bothus ellipticus, Bothus swio*).

Specimens, radiographs, and literature of non-*Bothus* genera examined were; *Asterorhombus* Tanaka 1915, *Crossorhombus* Regan 1920*, Engyprosopon* Günther 1862*, Grammatobothus* Norman 1926*, Parabothus* Norman 1931*, Taeniopsetta* Gilbert 1905, *Tosarhombus* Amaoka 1969.

Specimens were obtained on loan, or examined at the following institutions (abbreviations from Eschmeyer 2015): Academy of Natural Sciences, Philadelphia, USA; Natural History Museum, London, U.K; Bishop Museum, Honolulu, Hawai'i, U.S.A; Canadian Museum of Nature, Ottawa, Canada; Fish & Wildlife Research Institute. St. Petersburg, Florida, U.S.A; Museum of Comparative Zoology, Harvard University, Cambridge, U.S.A.; Muséum National d'Histoire Naturelle, Paris, France; Royal Ontario Museum, Toronto Canada, Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt am Main, Germany; Smithsonian Institution National Museum of Natural History, Washington D.C., USA; Universität Hamburg, Hamburg, Germany ZMH. Specimens were chosen to provide a representation of the entire geographical distribution of the species.

Of the 18 valid *Bothus* species mentioned in Eschmeyer (2015), only 13 types were available for examination. Of the 13 types available, nine were examined in this study: holotypes of *Bothus assimilis*, *Bothus guibei*, *Bothus leopardinus*, *Bothus mellissi*, *Bothus podas*, *Bothus tricirrhitus*, and *Bothus ypsigrammus*; lectotype of *Bothus pantherinus*; syntypes of *Bothus constellatus*.

Methodology

Species Concept

Nixon and Wheeler (1990) did a revision of the phylogenetic species concept, which was applied in this study. Their definition of the phylogenetic species concept ``*the smallest aggregation of populations (sexual) or lineages (asexual) diagnosable by a unique combination of character states in comparable individuals (semaphoronts)*. `` (Nixon & Wheeler, 1990, p. 229), is based on the definitions of Eldredge and Cracraft (1980), Platnick (1981) and Cracaft (1983). This definition is the framework for which the species validity was determined. This study has attempted to find characters common to a group of individuals that are indicative of common ancestry. The identification of these diagnostic characters (or combination of characters) allowed definitions of valid species to be created.

Measurements

Morphometric, meristic, and qualitative morphological observations were made on each specimen examined. Characters examined in this thesis that were deemed taxonomically relevant to *Bothus* are presented in Figures 11-14. A complete list of all measurements, counts, character description techniques, and pigmentation definitions are listed in Appendix B. A glossary of itchthyological, systematics, and taxonomic terms pertaining to *Bothus* and this thesis are available in Appendix C.

Morphological measurements were taken with an electronic caliper and were rounded to the nearest 0.01 of a mm. Measurements used for proportional measurements are expressed as a percentage of standard length (% SL) or percentage of head length (% HL) as indicated in the text. Descriptions of pigmentation were made on preserved specimens or through high definition photographs of preserved specimens. Film and digital radiographs were used to take meristic measurements. Radiographs were taken when on location at respective institutions when available, sent from scientific institutions, or taken by the author at the Canadian Museum of Nature.

Species were defined by identification of unique diagnostic characters. Diagnostic characters believed to be unique to a specific taxon were recorded and assessed through specimen data collection (copy of data collection sheet in Appendix B). Diagnostic characters found consistently across a group of specimens led to led to the substantiation and identification of taxonomically valid species.

The methods of Hubbs and Lagler (1958, 2004) were used for morphological measurements and counts except for the following characters: head depth, snout length, postorbital head length, interorbital width, length of ventral eye, and gill raker counts. Measurements and counts had to be created or altered to accommodate *Bothus* as all species are sinistral (left eyed) and asymmetrical (Figure: 11) with an ocular-side (o.s.) and blind-side (b.s.). The majority of measurements and counts were taken on the ocular side unless indicated (Appendix B). The following measurements and counts were taken on both sides: length of the longest pectoral and pelvic-fin ray, length of base of the pelvic-fins, length of the mouth, number of pectoral and pelvic-fin rays, membranes on pelvic-fin rays, spines on the snout, presence of fleshy flap on nostril, type of scale (ctenoid or cycloid), and pigmentation.

Sexual Dimorphism

Sexual dimorphic assessments and measurements were taken for all specimens. The assessment of specimen's sex was based on previous literature (Norman 1934, Amaoka 1969) and was addressed in

all species descriptions where applicable. The following characters were examined and compared for both male (M) and female (F) species: head length, head depth, length of pectoral fin, length of pectoral fin, interorbital distance, interorbital; width, head morphology, number of eye appendages, number of spines on eye orbitals, and spines on the snout. These sexually distinct characters were used to assess the sex of specimens as well as the sexually dimorphic characters of each *Bothus* species.

T-tests were conducted for the two morphological body ratio characters (ocular-side pectoral-fin ray lengths in relation to SL, and interorbital distances in relation to HL) to test their suitability for discriminating gender for each species. Bivariate plots comparing the two morphological body ratios of males versus females were created. Species where no sexual dimorphism was determined have been omitted from species description. Examples of sexually dimorphic morphology between sexes of the same species are depicted in Figure. 14.

It is important to note that species sexually dimorphic characters become more prominent as species mature, and as such, some discrepancies are observed when comparing ranges between males and females. This has been addressed and noted in the individual dimorphism interpretations of each valid species.

Geographical Mapping

Geographical distribution maps were created using ArcGIS (ArcMap 10). The geographical collection point for every specimen examined is presented. When provided, precise latitude and longitude coordinates were used for geographic distribution. When no latitudes or longitudes were available, the described collection location was translated to Google Earth 7.0 and used to determine geographical coordinates. Once latitudes and longitudes were established, they were converted to decimal degrees, to the nearest tenth of a degree, for entry into ArcGIS. Data points on maps that

appear to be touching landmasses indicate that the collection point was in very close proximity to land; some data points have been enlarged for clarity on large-scale map.

Possible Sources of Error in Data Collection

In this study, some morphometric and meristic data show discrepancies from original type descriptions. Characters such as lateral-line scale count, dorsal-fin ray count, anal-fin ray count, pectoral-fin ray count, and the number gill-rakers on the lower/upper limb of the anterior arch account for most of the conflicting data. In all cases standard length (SL) and other identifying characters of the species were examined to confirm the type specimen used in the original description. Discrepancies in descriptions and analyses can be accounted for by the following:

- Original description authors commonly use the word 'about' to describe a count and do not give a definitive number (Norman 1934).
- Preserved specimens are damaged and degrade over time rendering lateral-line scale, dorsal/anal-fin ray, and pectoral-fin ray counts difficult to assess.
- Radiographs were not available when the original descriptions were made, resulting in less precise osteological counts.
- Exact counts of dorsal and anal-fin rays become increasingly smaller and less prominent towards the posterior end of the body making them hard to count accurately when no radiograph was available.
- Gill-rakers of the lower/upper limb on the first arch have large prominent gill-rakers as well as small less noticeable gill-rakers (Fig. 13). It is apparent that some authors did not account for the smaller gill-rakers where as this study accounted for any prominence on the anterior arch.
- The most superior pectoral-fin ray in *Bothus* is significantly shorter and therefore can be easily missed or overlooked during data collection. This would account for a higher pectoral-fin ray count in this paper compared to other previous descriptions.

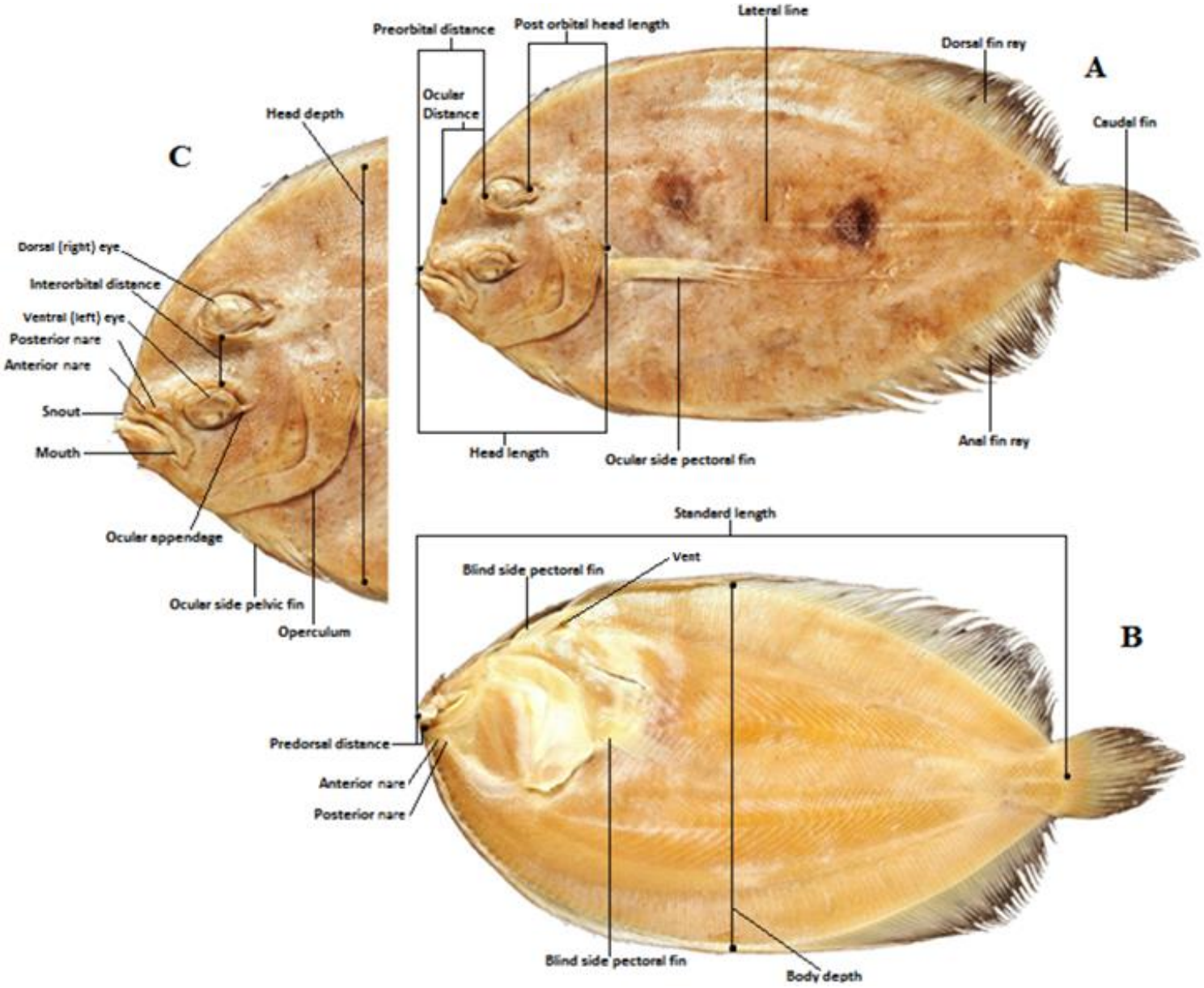


Figure 11. Photograph of *Bothus maculiferus* (BMNH 1931.2.5.367) depicting morphological characters and measurements used in this study; displaying the ocular-side (A), blind side (B), and magnification of head (C). List of all characters found in Appendix B.

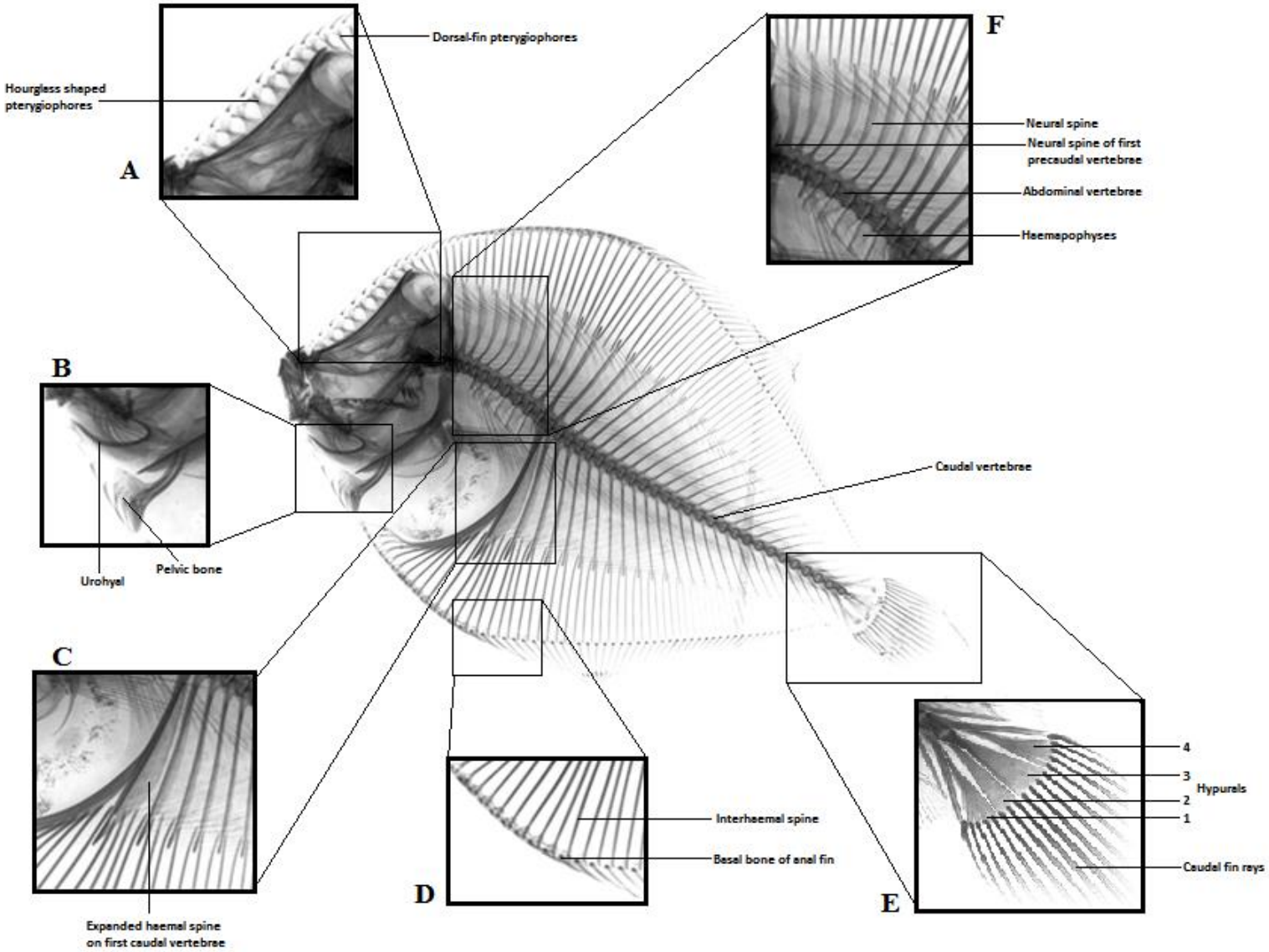


Figure 12. X-ray of *Bothus assimilis* Holotype (BMNH 2012.1.12.11) depicting osteological features examined in this study; Supracranium (A), Urohyal (B), Haemal spines (C), Ribs (D), Caudal skeleton (E), Precaudal vertebrae (F). Lists of structures are available in Appendix B.

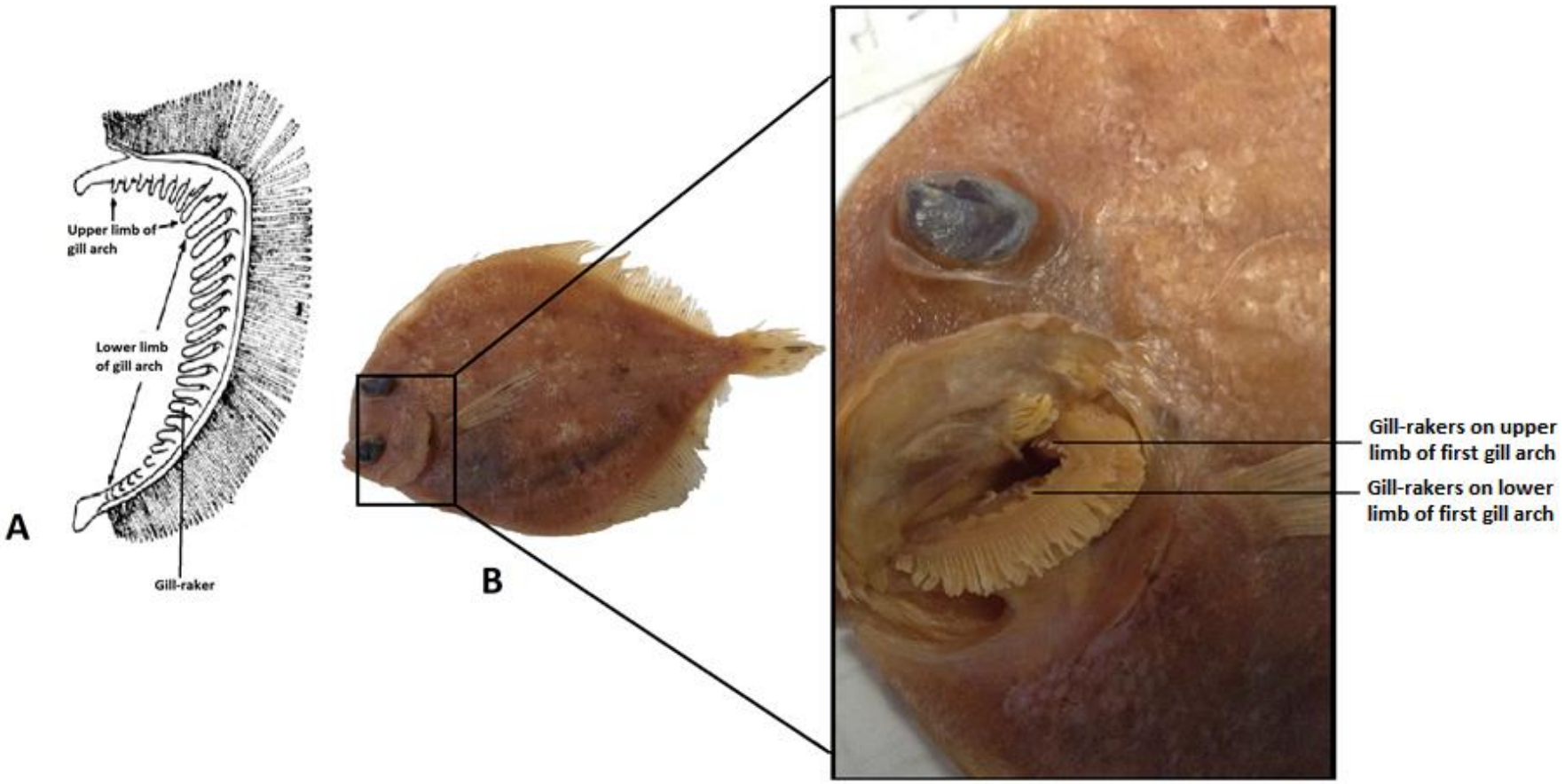


Figure 13. Lateral view cross section of first gill arch with upper and lower limbs (**A**), Diagram modified from 'Guide to the coastal marine fishes of California', Miller & Robert (1972). *Bothus robinsi* (FSBC 13894) depicting gill-rakers located under ocular-side operculum on the upper and lower limbs of the first gill arch (**B**). Lists of structures are available in Appendix B.

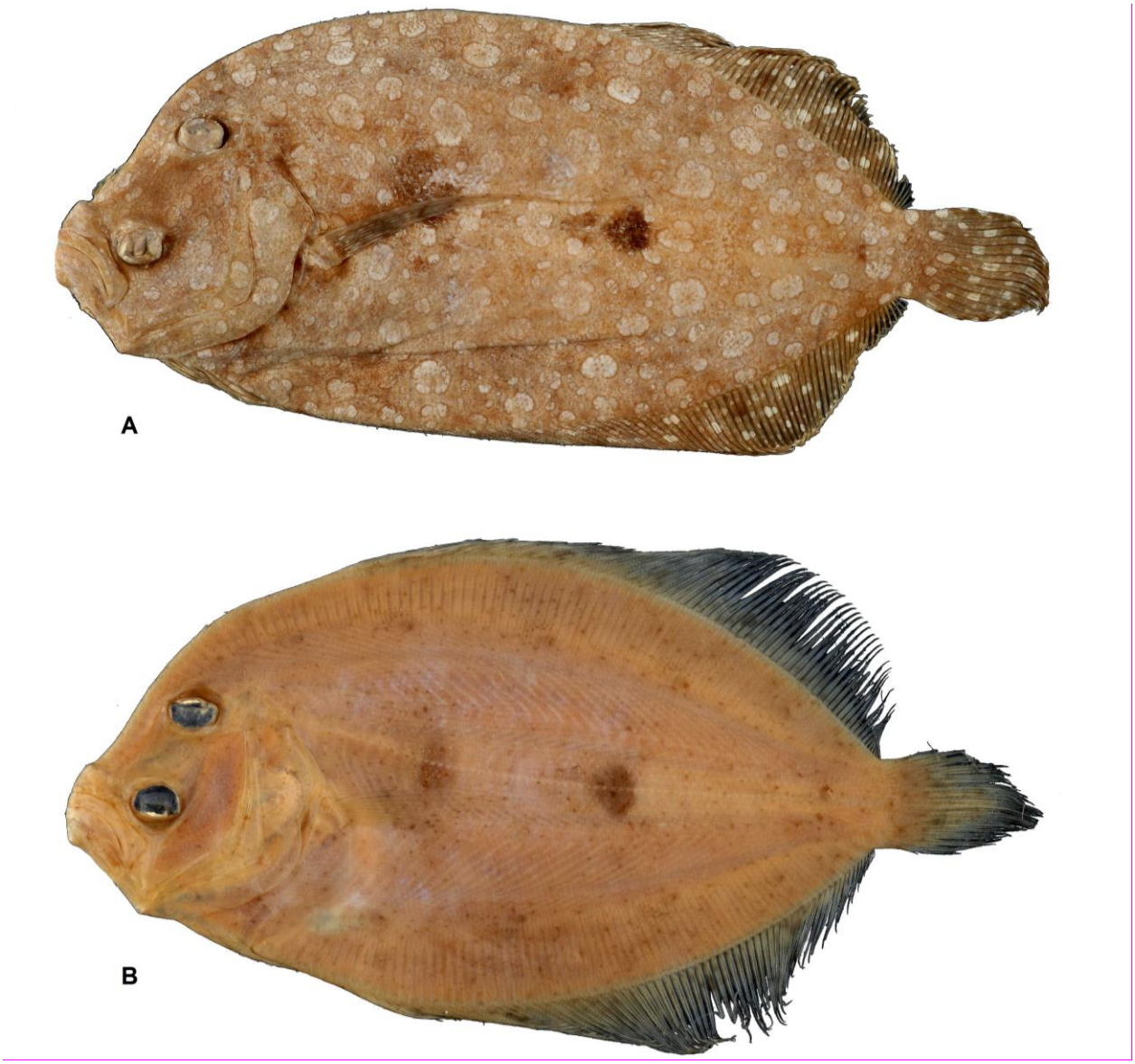


Figure 14. Male (**A**) (*Bothus mancus* SMF 6602) and female (**B**) (*Bothus* mancus SMF 6000-2) *Bothus* depicting sexually dimorphic morphology in the same species. Sexual dimorphism includes: larger interorbital space in males, extended pectoral fins in males, larger spines/prominences on snout, spines on the orbitals in males. Lists of structures assessed for both males and females are available in Appendix B.

Genus *Bothus* Rafinesque 1810

Figures 15 - 22; Tables 1 - 13

Synonyms *: Platophrys* Swainson, 1839; *Peloria* Cocco, 1844; *Rhomboidichthys,* Bleeker 1856; *Psettyllis* Alcock, 1890; *Pseudocitharichthys* Weber, 1913; *Platotichthys* Nichols, 1921; *Symboulichthys* Chabanaud, 1927

Common name: Wide-eyed flounder

Type species: *Bothus rumolo* Rafinesque, 1810: 23 (by subsequent designation)

Type Locality: Sicily, Italy

Diagnosis: sinistral flatfishes with the following combination of characters; the fourth to tenth precaudal vertebrae have large ventrally expanded haemapophyses (Fig. 15); the bony expansion of the anterior haemal spine of the first caudal vertebrae, as to almost touch the succeeding spine (Fig. 15).

Description: body oval and strongly compressed, body length equaling or surpassing body depth in some species; concave, flat or convex head morphology (Fig. 21); sinistral, eyes separated by flat concave space with ventral eye well in advance or equal to that of dorsal eye; interorbital distance generally greater in males than females; 7–11 hourglass-shaped dorsal-fin pterygiophores along anterior margin of head located anterior to dorsal eye (Fig. 17,Table 4), 13–18 dorsal-fin pterygiophores anterior to the first elongated neural spine of the precaudal vertebrae (Fig.17, Table 5); ventral-eye appendages range from 0–9 (Fig. 11, Table 8), dorsal-eye appendages range from 0–10 (Fig. 11, Table 9); appendages generally in males and sometimes in females; sometimes spines and branching spines located on orbital margins (Fig. 20), males with more; males generally with large spine or prominence on snout (Fig. 20), females with small protuberances; nares located posterior to snout tip on ocular and

blind side, ocular and blind side nares tube-shaped with small fleshy appendage on fringe of nares; tip of isthmus is pointed at symphysis of medial lower jaw; sciatic part of urohyal extending anteriorly past main part of urohyal; mouth terminal, curving ventrally proximal to anterior edge of ventral eye, blind side mouth slightly greater in length, curving ventrally; teeth shape conical, oriented medially, organized in two incomplete rows; gill-rakers 5–16 on lower limb of first gill arch (Fig. 13,Table 6), 0–8 on upper limb of first gill arch (Fig. 13, Table 7), generally pointed curving anteriorly with thick base; 64–132 scales in lateral line (Table 1, part 1 and 2), beginning at base of caudal fin running along median of body, distinct curve above insertion of pectoral fin, ending just posterior to dorsal eye in bifurcated and sometimes trifurcated supratemporal branches (Fig. 18), lateral-line absent on blind side; scales mainly ctenoid on ocular side with some weakly ctenoid, cycloid blind side; haemapophyses expanded between the 6–10 precaudal vertebrae (Figs. 15), anterior haemal spine of the first caudal vertebrae expanded ventrally as to almost contact the succeeding spine; anterior tip of the first haemal spine does not project in front of first anterior anal-fin ray; vent located on blind side posterior to base of blind-side pelvic fin (Fig. 11); 78—106 dorsal-fin rays (Fig. 11, Table 2) originating at base of snout superior to nostrils on blind side; 56—82 anal-fin rays (Fig. 11, Table 3) originate posterior to base of pelvic-fin ray on ocular side; 8—14 pectoral-fin rays on ocular-side (Table 10), 8—12 pectoral-fin rays on blind side (Table 11); asymmetrical; ocular-side rays longer than blind side in both sexes, distinctly elongated in males of some species (Fig. 14, 19); all rays simple, first pectoral-fin ray short almost undetectable on both ocular and blind side; second to fifth pectoral fin-ray greatest in length on ocular and blind side; generally 6 ocular-side pelvic-fin rays, base of pelvic-fin runs from vent to medial tip of isthmus (Fig. 11); 6 blind side pelvic-fin rays, smaller in size, proximal to third or fourth ray of ocular-side pelvic-fin; 17 caudal-fin rays, 16 in one species, truncate shaped, longest caudal-fin rays located along median of fin, rays branched; first precaudal vertebrae with very short neural spine; 9—11 precaudal vertebrae, 25–31 caudal vertebrae including urostyle.

Pigmentation of preserved specimens: Ocular-side dark brown to light tan (red, orange, yellow) ocular side; ocular side generally with one or two large dark blotches located horizontally along median of body (Fig. 19, A), anterior blotch smaller, situated at junction of straight and curved portion of lateral line; second blotch located on lateral line in posterior one fourth of body; generally brown blotches located in a symmetrical arrangement around ventral and dorsal edges of body (Fig. 19 E,F); select species with white or brown circular spots encompassed by white/blue/brown blotches (Fig. 19 B, C, D), located randomly on body; some species with blue speckles along anterior edge of interorbital distance generally with dark speckles on body, dorsal, anal, pectoral, and caudal-fin rays; bind side generally lacking pigmentation; two species exhibit pigmentation on the blind side traversing vertically in a line across the medial section of the body (Fig. 50, 86).

Sexual Dimorphism: Sexual dimorphism only present in some species of *Bothus.* When present males could be identified by either or both of the following characters: a greater interorbital space in relation to head length; a longer ocular-side pectoral-fin ray lengths in relation to standard length. The presence or absence of characters such as spines on the orbitals/snout as well as appendages on the eye could also be used to distinguish sex in some species.

Geographic Distribution: circumglobal; Mediterranean, Atlantic, Pacific, Indo-Pacific, Indian Ocean. Species in this study were collected in waters 1 to 100 meters deep.

Comparison: *Bothus* exhibits haemapophyses of the precaudal vertebrae that are ventrally expanded, whereas other Bothidae genera have triangular/cone shaped haemapophyses. *Bothus* also exhibits the bony expansion of the haemal spine of the first caudal vertebrae, whereas other Bothidae genera have slender less expanded haemal spines. The haemapophyses and haemal spines of other Bothidae genera deemed morphologically similar to *Bothus* (*Asterorhombus* Tanaka, 1915, *Crossorhombus* Regan, 1920,

Engyprosopon Günther, 1862, *Grammatobothus* Norman, 1926*, Parabothus* Norman, 1931*, Taeniopsetta* Gilbert, 1905) based on literature and observed overlapping characters (body depth, interorbital distance, pectoral fin length, lateral-line scales, pigmentation patterns) are presented for comparison in Figure 16.

Bothus can be further distinguished from all Bothidae by: a large concave interorbital space ventral eye well in advance of the dorsal eye (Fig. 21); males with rostral spines on the snout and eye orbitals (Fig. 20): males and some females with distinctly extended pectoral-fin rays (Fig 19 A,C,E) ; seven to eleven hourglass-shaped pterygiophores along anterior of interorbital bone (Fig. 17); absence of lateral line on blind side (Fig 5, 11); one to two large blotches along median of the body (Fig. 19, F). Other genera of Bothidae examined in this study (*Crossorhombus*, *Engyprosopon*, *Grammatobothus* and *Tosarhombus*) exhibit some overlapping morphological characters with *Bothus*. They can be superficially distinguished from *Bothus* by distinct character states unique to their genera.

Crossorhombus exhibits a large interorbital space and extended pectoral fins in some species that are comparable to those of *Bothus*. It can be differentiated by its lower number of lateral-line scales (48–63 scales, Norman 1934, Hensley & Amaoka 2001), the presence of dark colour patterns on the blind side that usually cover up to two-thirds of the body, and pale white blotches in males (Hensley & Amaoka, 2001). *Bothus* only has two species (*Bothus myriaster*, *Bothus tricirrhitus*) that have pigmentation on the blind side. In both species of *Bothus,* the pigmentation on the blind side is characterized by either one individual bar, or numerous dark bands extending vertically along the medial region of the body. *Crossorhombus* also exhibits elongated ctenii scaled on the ocular side whereas all species (Hoshino & Amaoka 2006) of *Bothus* have short ctenii. Lastly, *Crossorhombus* does not have a bifurcation or trifurcation of the lateral line on the ocular side, which was exhibited in all species of *Bothus* examined in this study.

Engyprosopon also has a wide interorbital space and body morphology that is comparable to that of *Bothus.* It can be superficially distinguished from *Bothus* by the size and number of scales in the lateral line. *Engyprosopon* has larger scales in comparison to species of *Bothus* and exhibits 36–61 scales in the lateral line (Amaoka *et al.* 1993). Only one *Bothus* specimen in this study was found to have 64 scales with the rest of the specimens examined having above 65 scales in the lateral line. Some species of *Engyprosopon* also exhibit males with a dark blue pigmentation on the blind side (Hensley & Amaoka 2001) whereas species of *Bothus* only exhibit a varying brown, yellow, orange coloration on the blind side. *Engyprosopon* also does not exhibit a bifurcation or trifurcation of the lateral line system in contrast to all *Bothus* species.

Grammatobothus exhibits elongated pectoral fins on the ocular side, ocular side spot patterns, and a bifurcation of the lateral line system comparable to species of *Bothus*. It can be distinguished through the presence of a lateral line on the blind side of the body (Fig. 5) as well as extended dorsal-fin rays along the anterior portion of the head (Hensley & Amaoka 2001, Hoshino & Amaoka 2001). These features are not exhibited by any valid species of *Bothus* recognized by this study.

Tosarhombus has a wide interorbital space as well as extended pectoral-fin ray ratios comparable to those of *Bothus.* Distinguishable from *Bothus* via the presence of white cephalic blotches along the head anterior to the interorbital space (Hoshino & Amaoka 2006). Only *Bothus assimilis* has diagnostic spots along the anterior margin of the, however the pigmentation and body morphology are nothing like those *Tosarhombus*. *Tosarhombus* is also characterized by its large Interorbital distance in comparison to its relatively shallow body depth not seen in other genera of Bothidae.

Remarks: Species of *Bothus,* like most flatfishes, have the ability to mimic their environment. Ramachandran *et al.* (1996) noted the ability of species of *Bothus* to almost instantaneously change their skin pigmentation (blotches or grain patterning) to match their background environment. This

ability to match skin pigmentation to the surrounding environment can lead to problems when identifying *Bothus* species spot patterns. The difference between spot patterns in species examined has been noted in all species descriptions. Only spot patterns and pigmentation that were consistently seen across specimens were recorded.

Norman (1934) split *Bothus* species in groups distributed to the Mediterranean-Atlantic (*B. ellipticus, B. lunatus, B. maculiferus, B. mellissi, B. ocellatus, B. podas*) and Indo-Pacific (*B. assimilis, B. constellatus, B. leopardinus, B. mancus, B. myriaster, B. pantherinus*) oceans. This was done in order to address the large geographical distribution of the genus and create a species key split into two regions. Norman's study did not contain all of the currently known species of *Bothus*. Therefore, this study assessed all valid species of *Bothus* and their geographical distributions, while accomplishing the creation of new species key that does not separating species into two geographical assemblages (see Species Key, pg. 46 and Results and Discussion, pg. 240).

Norman (1934) discusses that Chabanaud (1927) identified *Bothus maculiferus* in a distinct genus *Symboulichthys* Chabanaud 1927, based on the nature of the dentition, specifically the medial orientation of the teeth and number of series of rows. The dentition of *Bothus* species and *B. maculiferus* examined in this study did not differ in orientation or the number of rows as Chabanaud proposed. Multiple rows of teeth oriented medially are common within the genus and offer no significant diagnostic feature. Furthermore, species of *B. maculiferus* exhibit the diagnostic characters (ventrally expanded haemapophyses, bony expansion of the first haemal spine) of the genus *Bothus*. Therefore, I consider *Symboulichthys* Chabanaud, 1927 a junior synonym of *Bothus* Rafinesque, 1810.

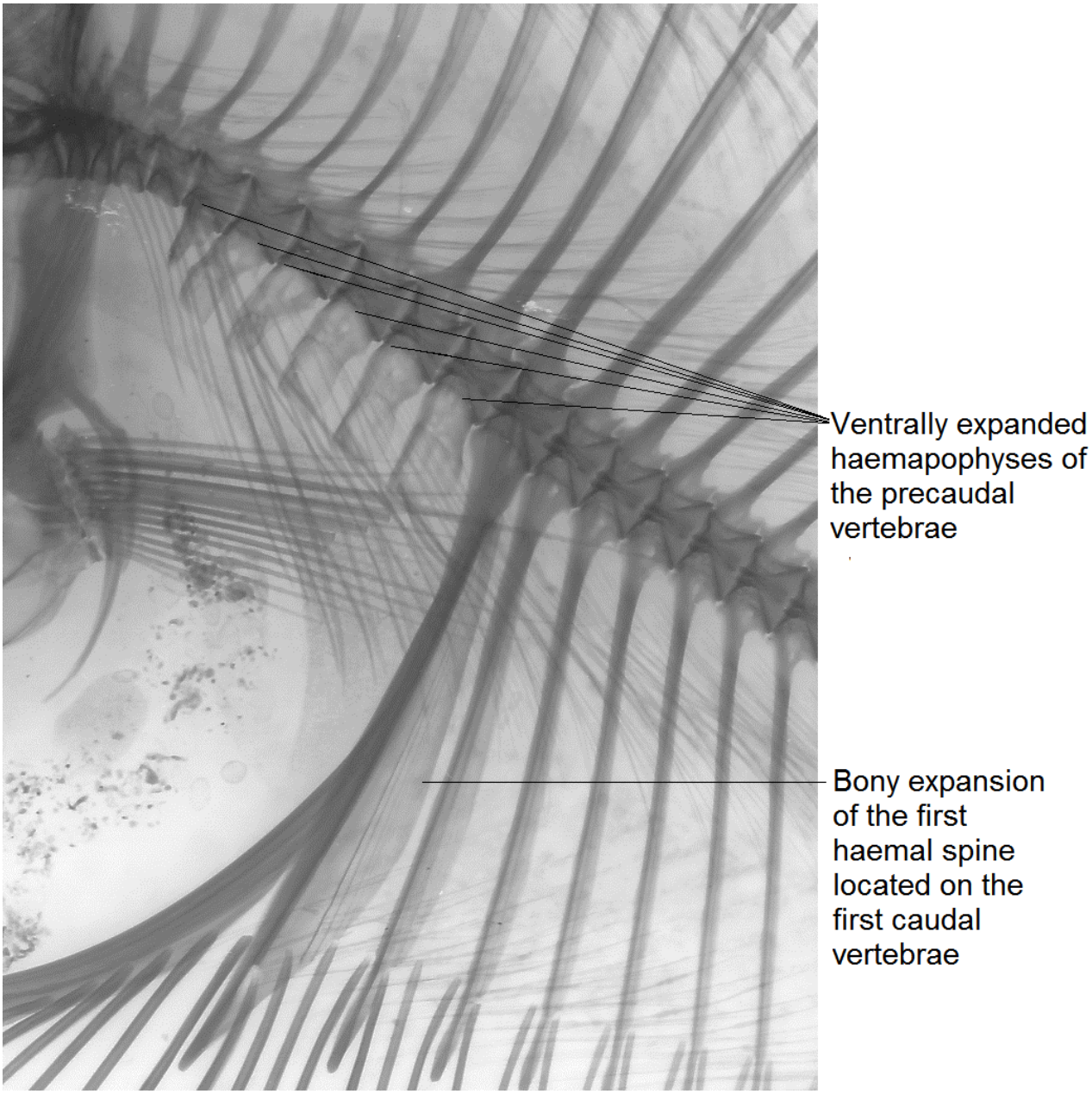


Figure 15. Radiograph of *Bothus assimilis*, BMNH2012.1.12.11 holotype, depicting a bony expansion of the first haemal spine of the first caudal vertebrae, as to almost touch the succeeding spine; six laterally expanded haemapophyses of the precaudal vertebrae.

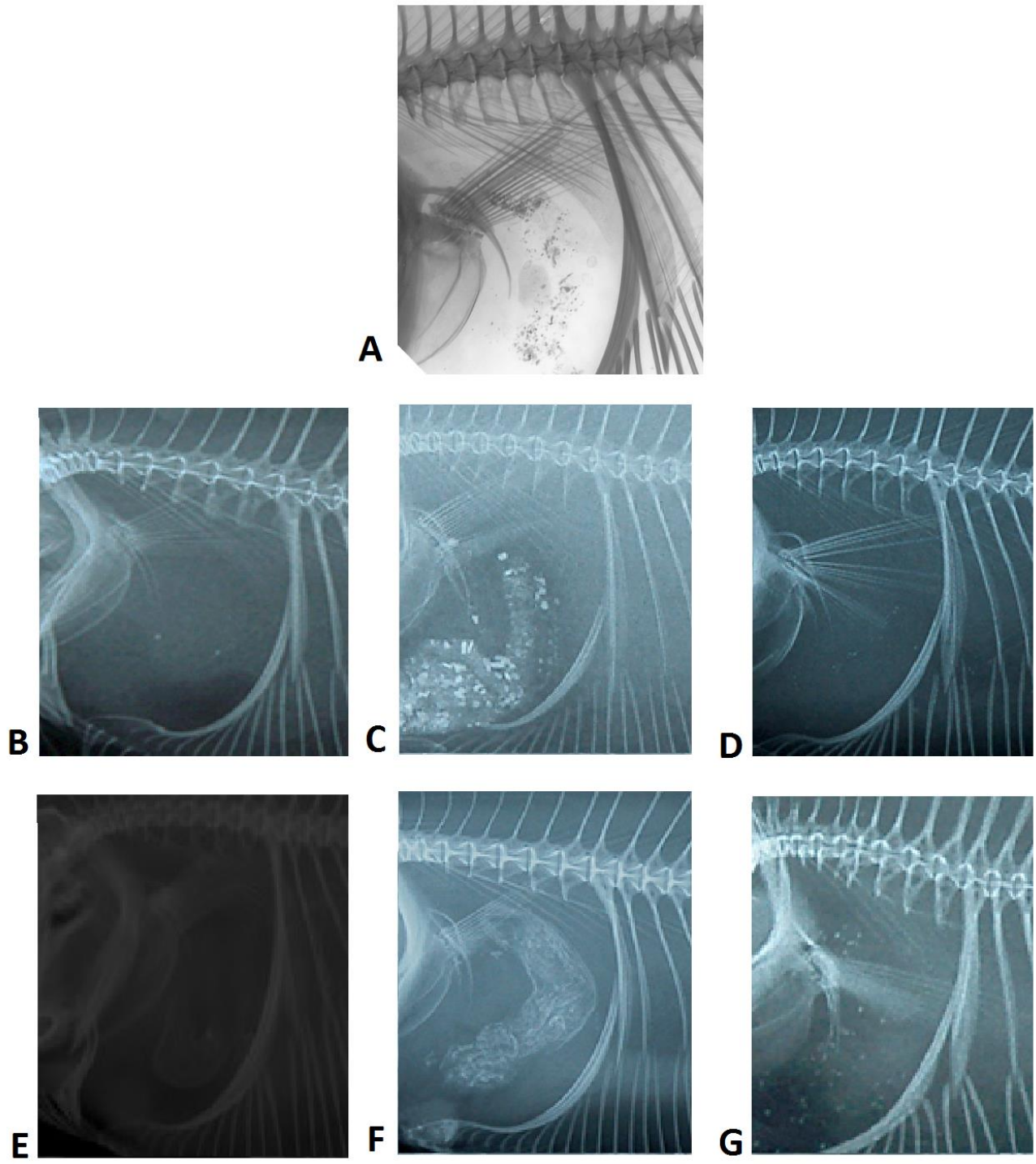


Figure 16. Radiographs of *Bothus* BMNH2012.1.12.11 holotype (A) *Asterorhombus* ASIZP 0057100 (B), *Crossorhombus* ASIZP 0061731 (C), *Engyprosopon* ASIZP 0059046 (D), *Grammatobothus* USNM 362520 spec. 3 (E), *Parabothus* ASIZP 0062614 (F), *Taeniopsetta* ASIZP 0065481 (G); comparing osteological morphology of precaudal haemapophyses and haemal spine of the caudal vertebrae in Bothidae genera deemed morphologically similar to *Bothus*.

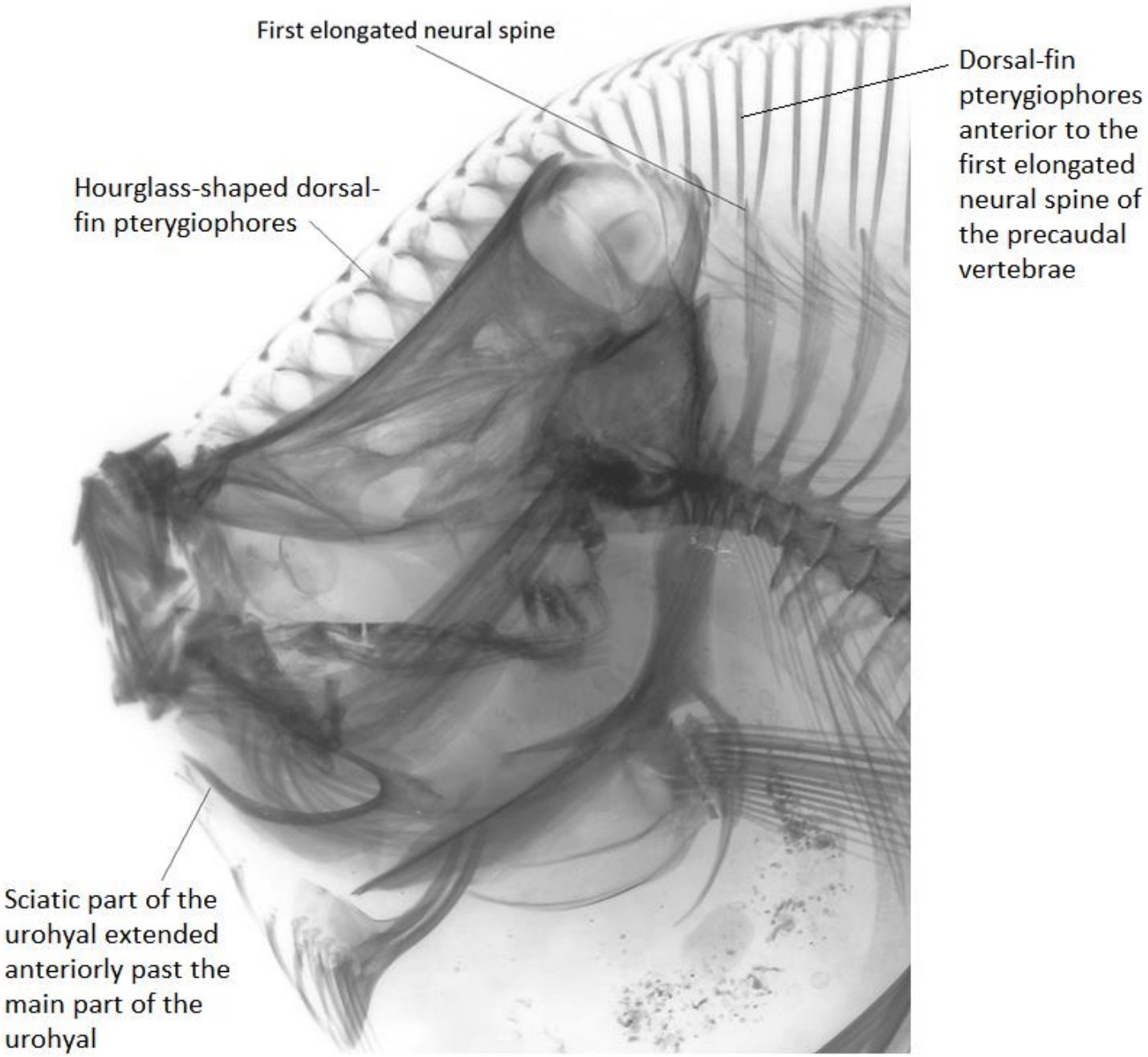


Figure 17. Radiograph of *Bothus assimilis*, BMNH2012.1.12.11 holotype, showing hourglass shaped pterygiophores; dorsal pterygiophores anterior to first elongated neural spine, and the anterior extension of the sciatic part of the urohyal.

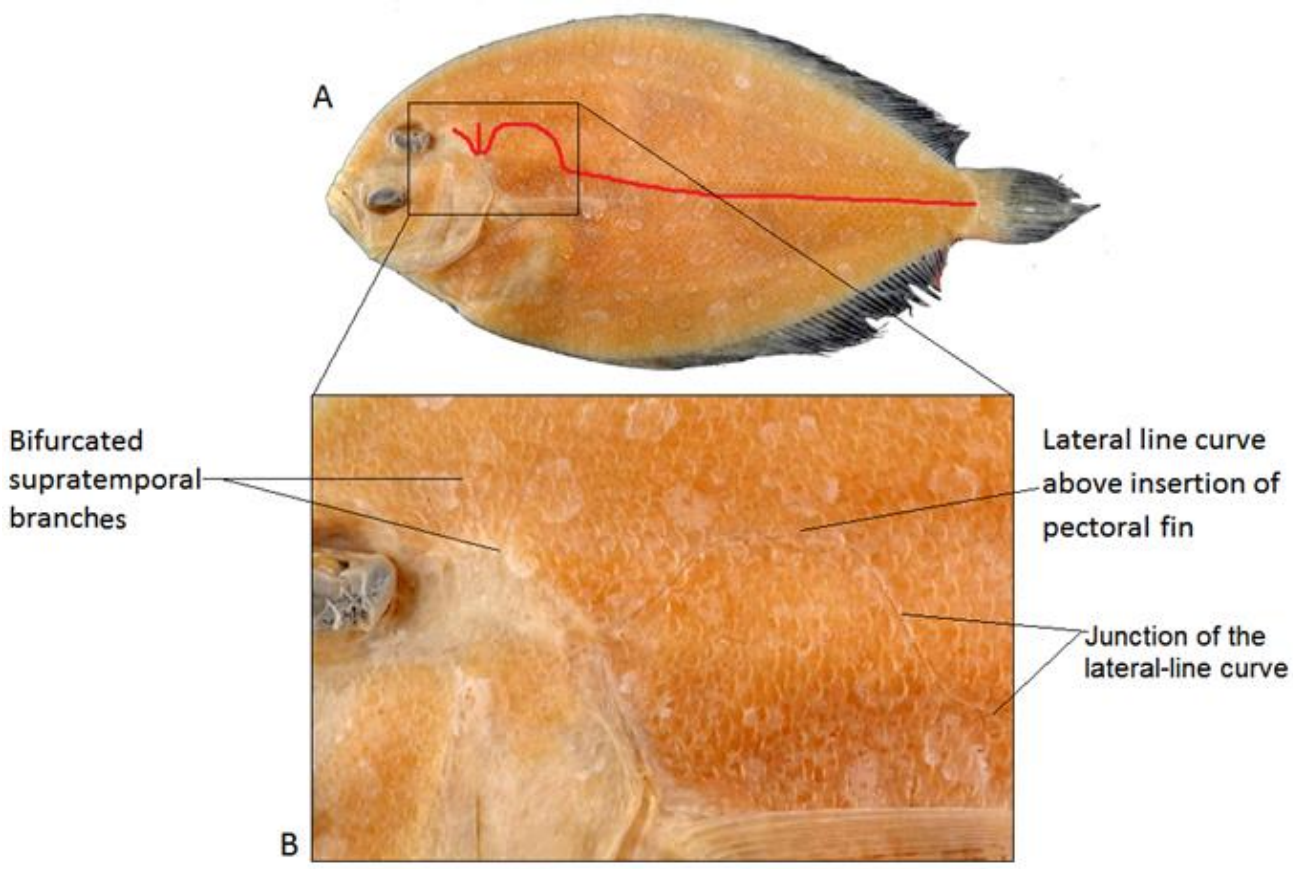


Figure 18. *Bothus pantherinus* SMF 7550 holotype, 120.08 mm SL, adult female: (A) red line highlights path of lateral line beginning at caudal and running along median of body; (B) Lateral line curves superiorly at junction (beginning of curve) of lateral line above pectoral fin, bifurcated supratemporal branches posterior to dorsal eye.

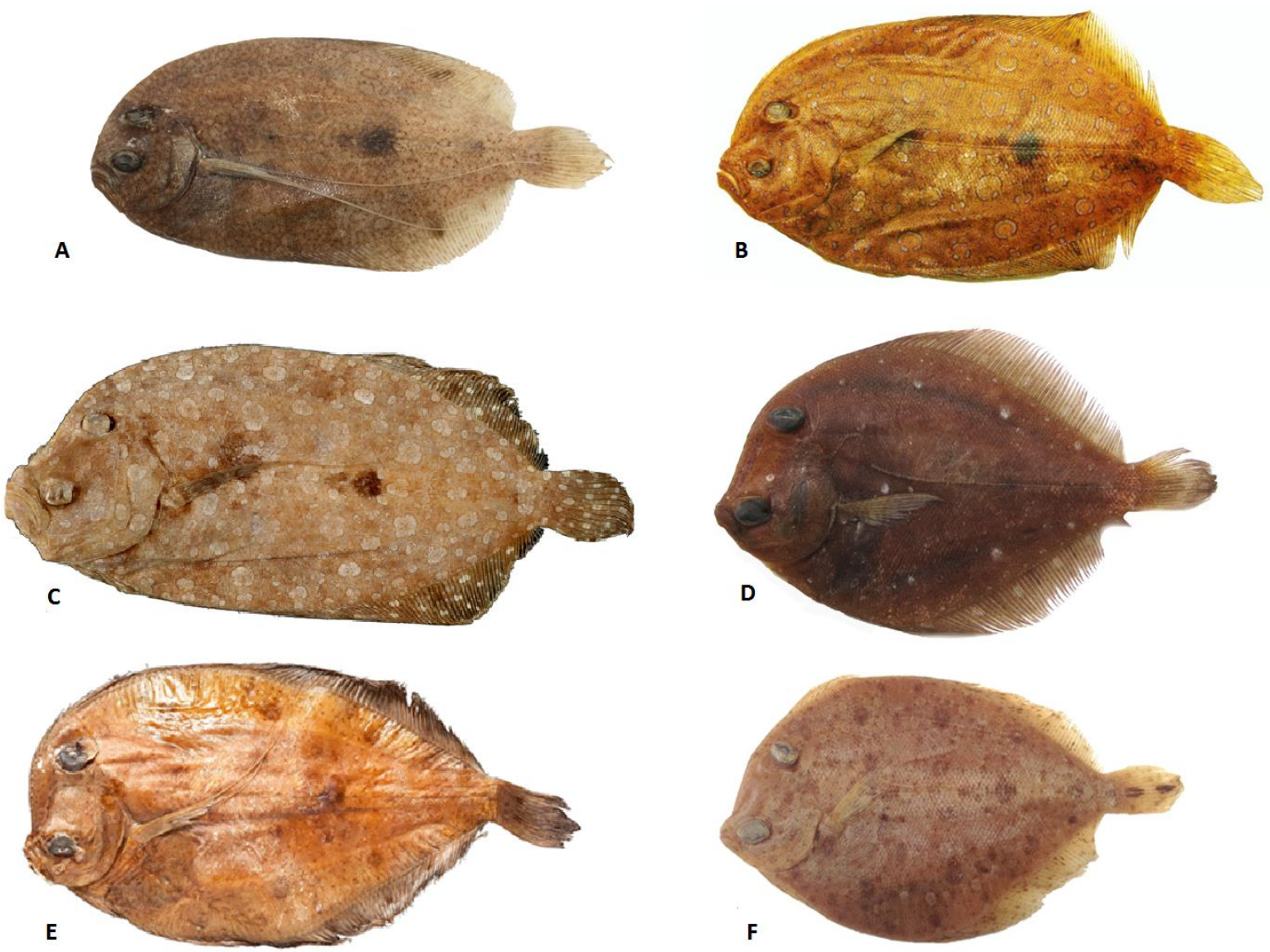


Figure 19. *Bothus guibei* MNHN 1964-0416 (**A**), *Bothus lunatus*, BMNH 1920.12.22.196 (**B**), *Bothus mancus* SMF 6002 (**C**), *Bothus* constellatus SMF 29813 (**D**), *Bothus myriaster* BMNH 1935.3.12 (**E**), *Bothus robinsi* USNM 282732 (Spc.15), 90.62 mm SL (**F**); depicting range of body pigmentation, blotch patterns, and skin colour found in *Bothus*.

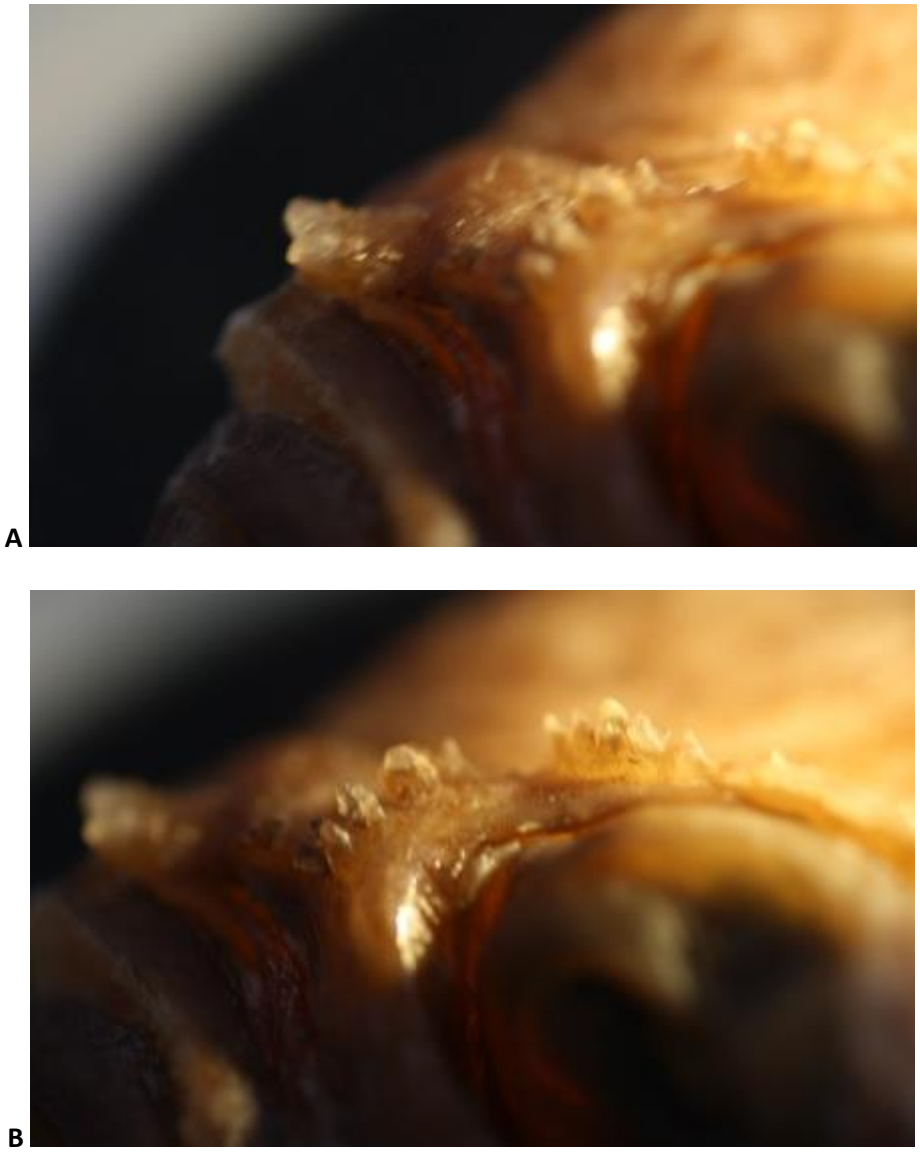


Figure 20. *Bothus guibei* MNHN 1964-438, holotype 184.17 mm SL, adult male; depicting branching spines on snout (A) and spines on anterior orbit of ventral eye (B).

Figure 21. Ocular and blind side head of *Bothus assimilis* Holotype (BMNH 2012.1.12.11), (A) and *Bothus guibei* Holotype (MNHN 1964-0438) (B); depicting concave/flat anterior profile of head with prominent notch above snout (A) and a convex anterior profile of head lacking notch (B). Distribution of *Bothus assimilis* Indo-pacific; distribution of *Bothus guibei* Mediterranean/Atlantic. Lists of structures are available in Appendix B.

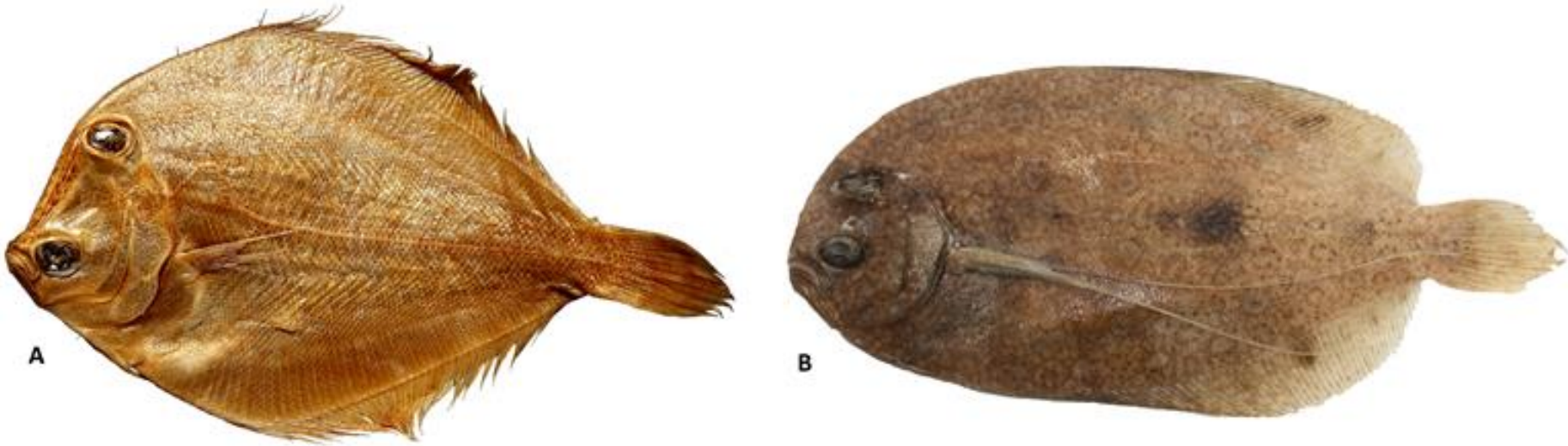


Figure 22. Ocular side lateral aspect of *Bothus assimilis* Holotype (BMNH 2012.1.12.11) (A) and *Bothus guibei* Holotype (MNHN 1964-0438) (B); depicting deeper laterally compressed body with short pectoral fin rays (A), versus lesser compressed body with elongated pectoral fin rays (B) exhibited in species of *Bothus*. Distribution of *Bothus assimilis* (A) Indo-pacific; distribution of *Bothus guibei* (B) Mediterranean/Atlantic. Lists of structures are available in Appendix B.

Key to Species of Bothus

1	Three slender appendages on the posterior margin of the dorsal and ventral eye; dark band running vertically across medial portion of body on blind side…… *Bothus tricirrhitus*	p.223
—	Appendages present or absent on eyes, when present never exactly three on both dorsal and ventral eyes; uniform colour on blind side…….	2
2	Anterior profile of head convex along interorbital distance (Fig. 21, B); no notch above snout……	3
—	Anterior profile of head concave or flat between interorbital distance (Fig. 21, A); distinct notch situated above ……..	7
3	Dorsal-fin ray count less than 102……..	4
—	Dorsal-fin ray count greater than 102……..……*Bothus ellipticus*	p.75
4	Presence of eye appendages……..	5
—	Absence of eye appendages…….. *Bothus swio*	p.206
5	Absence of dark blotches on the rays of the dorsal and anal-fin near a vertical posterior to mid-body……..	6
–	Blotches nearly equal to ventral eye size symmetrically situated on dorsal and anal-fin rays in near vertical posterior one fourth of body……..*Bothus guibei*	p.79
6	Presence of two dark diffuse blotches along margin of lateral line on ocular side; anterior blotch situated at junction of straight and curved portion of lateral line; posterior blotch situated on lateral line one fourth of SL from caudal peduncle ……*Bothus maculiferus*	p.107
–	Presence of one dark diffuse blotch, larger than ventral eye diameter, situated	

	on lateral line one fourth of SL from caudal peduncle…….*Bothus pantherinus*	p.160
7	Prominent blue incomplete rings and curved blotches outlined with dark edging greater than or equal to ventral eye diameter, randomly situated on body and fin-rays……*Bothus lunatus*	p.97
–	Absence of blue rings and curved blotches outlined with dark edging on body…	8
8	Lateral-line count less than 95……	9
–	Lateral-line count greater than or equal to 95……	16
9	White blotches or stellate blotches in random or symmetrical arrangement on the body and fin-rays……	10
–	Absence of white blotches or circular pigmentations on body……..	11
10	White blotches, larger than ventral-eye diameter, arranged randomly all over body and fin rays; large triangular protuberance on anterior of ocular-side maxillary.....*Bothus mancus*	p.115
–	lack of triangular protuberance on anterior side maxillary; variegated white blotches and greyish/light blue ocellated spots randomly assorted on head and body ……*Bothus leopardinus*	p.89
–	Symmetrically arranged stellate white blotches along dorsal and ventral margins of body, and dorsal and anal-fin rays; small protuberance above maxillary……*Bothus constellatus*	p.66
11	Presence of two dark spots, approx. equal in size or smaller than ventral eye diameter on caudal fin ……..	12
–	Absence of two dark blotches, approx. equal in size to eye diameter, in medial portion of caudal-fin ……	13
12	Two dark pigmented spots arranged horizontally on caudal fin…..*Bothus robinsi*	p.197

–	Two dark pigmented spots arranged vertically on caudal fin……*Bothus ocellatus*	p.149
13	Solid dark brown ocular-side colour, without distinct pigmentation patterns; only found at St.Helena Island……..*Bothus mellissi*	p.126
–	Light tan skin colour with distinct pigmentation patterns……..	14
14	Small dark speckles along anterior profile of head, anterior to interorbital distance ……..*Bothus assimilis*	p.61
–	No dark blotches along anterior profile of head, anterior to interorbital distance…	15
15	Frequent presence of two dark diffuse blotches along margin of lateral line on ocular side; anterior blotch situated at junction of straight and curved portion of lateral line; posterior blotch situated on lateral line one fourth of SL from caudal peduncle; geographical distribution of Atlantic and Mediterranean……..*Bothus podas*	p.174
16	Gill-rakers less than or equal to 12 on lower limb of first gill arch……	17
–	Gill-rakers greater than 12 on lower limb of first gill arch..... .....*Bothus thompsoni*	p.214
17	Presence of ocular appendages as fleshy broad flaps……..*Bothus myriaster*	p.136
–	Absence of ocular appendages in the form of flaps; prominent white ‘Y’ shaped pigmentation in center of dark blotch on lateral-line in posterior two thirds of body…….*Bothus ypsigrammus*	p.229

Table 1 (Part 1 of 2). Frequency distribution value of ocular side lateral-line scales in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (_), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Lateral line count for holotypes of *B. lunatus*, *B. ocellatus*, *B. robinsi*, *B. swio,* and *B. thompsoni* were obtained from original descriptions; the holotypes of *B. myriaster* and *B. ellipticus* are not available.

	Lateral-line count																																								
	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	n	MEAN	SD
B. assimilis																			1																		1	81.0	0.0
B. constellatus								1				1	2^	3	3^		3^	1					1														15	77.0	3.3
B. guibei																				1*				1*	1*		1										4	86.0	2.9
B. leopardinus																	2	3																			5	79.6	0.5
B. lunatus																	1	1			1		1	3	1	2		1					1				13	87.4	6.2
B. maculiferous																	2	1				1	3	2		2	1										12	84.5	3.5
B. mancus													1				2	1	1		1	2	3	2		1	1										15	83.3	3.8
B. mellissi																				1		2*	1*		2*	4*	1*		2*								13	87.1	2.7
B. myriaster																																	1		1	1	21	102.8	3.9
B. ocellatus					1			3	5	2	4	4	3			1																					24	72.0	3.4
B. pantherinus									1				1"	3*	3	3	3*	3	2	2	4	1		3		1			1								31	80.5	4.3
B. podas												1	2	2	1	2	3	5	8	4	5	7	5	5		2	1	3	1	2							59	82.9	4.3
B. robinsi		1				3	1	3	6	4	6	9	6	8	2	3	1		1		1																55	73.7	3.4
B. swio																														2							2	92.0	0.0
B. thompsoni																																					12	109.8	7.4
B. tricirrhitus																1																					1	78.0	0.0
B. ypsigrammus																																					3	115.0	10.0

Table 1 (Part 2 of 2). Frequency distribution values of ocular side lateral-line scales in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (__), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Lateral line count for holotypes of *B. lunatus*, *B. ocellatus*, *B. robinsi*, *B. swio,* and *B. thompsoni* were obtained from original descriptions; the holotypes of *B. myriaster* and *B. ellipticus* are not available.

	Lateral-line count																																					
	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	n	MEAN	SD
B. assimilis																																				1	81.0	0.0
B. constellatus																																				15	77.0	3.3
B. guibei																																				4	86.0	2.9
B. leopardinus																																				5	79.6	0.5
B. lunatus					<u>1</u>																															13	87.4	6.2
B. maculiferus																																				12	84.5	3.5
B. mancus																																				15	83.3	3.8
B. mellissi																																				13	87.1	2.7
B. myriaster	2	1		2	3	3	3	3							1																					21	102.8	3.9
B. ocellatus																																				24	72.0	3.4
B. pantherinus																																				31	80.5	4.3
B. podas																																				59	82.9	4.3
B. robinsi																																				55	73.7	3.4
B.swio																																				2	92.0	0.0
B. thompsoni					1		2	1			3	4																						<u>1</u>		12	109.8	7.4
B. tricirrhitus																																				1	78.0	0.0
B. ypsigrammus						1														<u>1</u>						1*										3	115.0	10.0

Table 2. Frequency distribution of dorsal-fin rays in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (_), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Dorsal-fin ray counts for holotypes of *B. ellipticus, B. lunatus, B. maculiferus. B. mancus, B. ocellatus, B. robinsi*, *B. swio,* and *B. thompsoni* were obtained from original species descriptions.

	Count of dorsal-fin rays																																					n	MEAN	SD
	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106						
B. assimilis														1																								1	86.0	0.0
B. constellatus															1	1^	4	6^	2		1^																	15	89.7	1.4
B. ellipticus																																1						1	104.0	0.0
B. guibei															1				1*			1*																3	90.7	3.5
B. leopardinus															1	1	2		1																				5	88.8	1.5
B. lunatus															1				2	3	2	2	1		1														12	92.6	2.5
B. maculiferus																				2	2	5	3			2													14	94.4	1.8
B. mancus															1	1				1	1	1		1	1	2	1	4	2	1	2								19	97.5	4.7
B. mellissi																			1*	2*	5*	4*	1*																13	93.2	1.1
B. myriaster														1		2		1	1	5	6	3	3		1														24	92.3	2.5
B. ocellatus						1		1	1	5	4	7	4						1	1																			25	83.4	3.6
B. pantherinus						1*		2		1"		3*	1	3		4	4	4	1	2	2	3		1			1												33	88.5	4.8
B. podas											2	1	5	6	7	7	16	4	5	3	1		1		1	1													60	88.6	2.9
B. robinsi						3	2	2	2	4	8	2	11	5	9	3	1	1		2																				55	84.5	3.2
B. swio																1		1																						2	89.0	1.4
B. thompsoni										1		1		5	4	1	1																							13	86.2	1.7
B. tricirrhitus															1																									1	87.0	0.0
B. ypsigrammus																	1			1										1*				1					6	97.0	8.1

Table 3. Frequency distribution value of anal-fin rays in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (_), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Anal-fin ray counts for holotypes of *B. ellipticus, B. lunatus, B. maculiferus. B. mancus, B. myriaster, B. ocellatus, B. robinsi*, *B. swio* and *B. thompsoni* were obtained from original descriptions.

	Count of anal-fin rays																																		
	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	n	MEAN	SD
B. assimilis										1																					1	64.0	0.0
B. constellatus											2^	3	4	1	1	2^	1	1													15	67.7	2.2
B. ellipticus																	1														1	71.0	0.0
B. guibei																	1		1*		1*										3	73.0	2.0
B. leopardinus											1	1	1	1	1																5	67.0	1.6
B. lunatus															2	1	2	1	3	1	1	2		1							14	72.9	2.7
B. maculiferus																	2	3	2	3	3		1								14	73.4	1.7
B. mancus												1	1		1				1		1	3	1	4	2	3		1			19	76.2	4.5
B. mellissi														1*	1	1*	2*	5*	1*	1*	1*										13	71.6	1.9
B. myriaster										2	5	3	3	3	1	1	3	2													24	67.6	2.6
B. ocellatus		1	2	1		2	4	7	5	1			1																		24	61.3	2.5
B. pantherinus			1			1"	1*	2	3*	3		2	3	5	2	2	4	1	2	1											33	67.0	4.2
B. podas							1	1		3	8	8	5	8	8	8	2	4	1	1	1										59	67.9	2.9
B. robinsi		2		2	2	1	8	4	13	3	13	2	3		1	1															55	63.1	2.8
B. swio																1		1													2	71.0	1.4
B. thompsoni							1	1	4	1	3	1	0	2																	13	64.3	2.1
B. tricirrhitus										1																					1	64.0	0.0
B. ypsigrammus																					1*	2		1							4	76.3	1.3

Table 4. Frequency distribution value of hourglass-shaped dorsal-fin pterygiophores in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (_), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Hourglass-shaped pterygiophore counts of holotypes *B. lunatus, B. maculiferus, B. mancus, B. myriaster, B. ocellatus, B. podas, B. robinsi,* and *B. thompsoni* are not available; counts for *B. ellipticus* and *B. swio* are not available.

	Count of hourglass-shaped dorsal-fin pterygiophores												
	4	5	6	7	8	9	10	11	12	13	n	MEAN	SD
B. assimilis						1					1	9.0	0.0
B. constellatus					3	12^					15	8.8	0.4
B. guibei					4*						4	8.0	0.0
B. leopardinus					1	3	1				5	9.0	0.7
B. lunatus				4	9						13	7.7	0.5
B. maculiferus					12	1					13	8.1	0.3
B. mancus					14	4					18	8.2	0.4
B. mellissi						8*	5*				13	9.4	0.5
B. myriaster					7	13	2				22	8.8	0.6
B. ocellatus				1	13	10					24	8.4	0.6
B. pantherinus				4"*	21	6	1				32	8.1	0.7
B. podas					17	30	8	1			56	8.9	0.7
B. robinsi					26	29	2				57	8.6	0.6
B. thompsoni						4	7				11	9.6	0.5
B. tricirrhitus						1					1	9.0	0.0
B. ypsigrammus						2	1	1*			6	9.8	0.9

Table 5. Frequency distribution value of dorsal-fin pterygiophores before first elongated neural spine of the precaudal vertebrae in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (_), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Pterygiophores count before first elongated neural spine for holotypes of *B. lunatus, B. maculiferus, B. mancus, B. myriaster, B. ocellatus, B. podas, B. robinsi,* and *B. thompsoni* are not available; counts for *B. ellipticus*, and *B. swio* are not available.

Count of dorsal-fin pterygiophores before first elongated neural spine of the first precaudal vertebrae											
	11	12	13	14	15	16	17	18	n	MEAN	SD
B. assimilis						1			1	16.0	0.0
B. constellatus				3	8	4^			15	15.1	0.7
B. guibei			4*						4	13.0	0.0
B. leopardinus				1	3	1			5	15.0	0.7
B. lunatus			4	9					13	13.7	0.5
B. maculiferus				10	2	1			13	14.3	0.6
B. mancus				3	11	4			18	15.1	0.6
B. mellissi					1	12*			13	15.9	0.3
B. myriaster				1	14	2	6		23	15.6	0.9
B. ocellatus			4	16	4				24	14.0	0.6
B. pantherinus			4"	23*	5				32	14.0	0.5
B. podas				18	30	8			56	14.8	0.7
B. robinsi			3	26	23	5			57	14.5	0.7
B. thompsoni			2	7	2				11	14.0	0.6
B. tricirrhitus					1				1	15.0	0.0
B. ypsigrammus					2	1	1*		6	15.8	0.9

Table 6. Frequency distribution value of gill rakers on lower limb of first gill arch in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (_), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Gill-raker counts on lower limb of first gill arch for holotypes of *B. robinsi* and *B. swio* were obtained from original descriptions. Counts for *B. constellatus*, *B. lunatus, B. maculiferus, B. mancus, B. myriaster,* and *B. thompsoni* holotypes are not available; Count for *B. ellipticus* is not available.

	Count of gill rakers on lower limb of first gill arch																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	n	MEAN	SD
B. assimilis						1									1	9.0	0.0
B. constellatus					1	3	6	2							12	9.8	0.9
B. guibei		1	2*	1*											4	6.0	0.8
B. leopardinus					2	1	2	1							6	9.3	1.2
B. lunatus			1	3	4	5									13	8.0	1.0
B. maculiferus				8	3	1		1							13	7.7	1.2
B. mancus			1	2	2	4	3	4	2						18	9.4	1.8
B. mellissi					1*	1	3*	4*	3*	1*					13	10.8	1.4
B. myriaster		3	10	4	5										22	6.5	1.0
B. ocellatus		1	1	5	13	5	1								26	7.9	1.0
B. pantherinus		1	8"	19	5*	1			1						35	7.1	1.2
B. podas		2	4	14	28	10	1		1						60	7.8	1.1
B. robinsi		2	17	25	12	2									58	6.9	0.9
B. swio						2									2	9.0	0.0
B. thompsoni									1	3	3	3	1		11	14.2	1.3
B. tricirrhitus				1											1	7.0	0.0
B. ypsigrammus				3	1*										6	7.3	0.5

Table 7. Frequency distribution value of gill-rakers on upper limb of first gill arch in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (_), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Gill-raker counts on upper limb of first gill arch for holotypes of *B. robinsi* and *B. swio* were obtained from original descriptions. Counts for holotypes of *B. constellatus*, *B. lunatus, B. maculiferus, B. mancus, B. myriaster, B. ocellatus,* and *B. thompsoni* are not available; count for *B. ellipticus* is not available.

	Count of gill rakers on upper limb of first gill arch												
	0	1	2	3	4	5	6	7	8	9	n	MEAN	SD
B. assimilis						1					1	5.0	0.0
B. constellatus						5	5	2			12	5.8	0.8
B. guibei	4*										4	0.0	0.0
B. leopardinus					1	2	1		1		5	5.6	1.5
B. lunatus	12		1								13	0.2	0.6
B. maculiferus	11			2							13	0.5	1.1
B. mancus	18										18	0.0	0.0
B. mellissi					1*	2*	3*	3*	3*		12	6.4	1.3
B. myriaster			2	8	6	4	2				22	3.8	1.1
B. ocellatus			1	4	4	10	5		1		25	4.7	1.3
B. pantherinus	13*		7	7"	6	2	1				36	2.0	1.8
B. podas	8		2	7	8	20	10	4	1		60	4.2	2.1
B. robinsi				3	22	25	7	1			58	4.7	0.8
B. swio	2										2	0.0	0.0
B. thompsoni						2	6	2	1		11	6.2	0.9
B. tricirrhitus	1										1	0.0	0.0
B. ypsigrammus					1	1*	2				6	5.3	1.0

Table 8. Frequency distribution value of ventral-eye appendages in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (_), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Count of ventral-eye appendages for holotypes of *B. myriaster* and *B. swio* were obtained from original descriptions. Ventral-eye appendages counts for *B. lunatus, B. maculiferus, B. mancus, B. ocellatus, B. robinsi* and *B. thompsoni* holotypes are not available; count of *B. ellipticus* is not available.

	Count of ventral-eye appendages													
	0	1	2	3	4	5	6	7	8	9	10	n	MEAN	SD
B. assimilis	1											1	0.0	0.0
B. constellatus	15^											15	0.0	0.0
B. guibei		2*	1				1*					4	2.5	2.4
B. leopardinus	6											6	0.0	0.0
B. lunatus	3	5				1	1	1	1	1		13	3.1	3.4
B. maculiferus	1	9	3									13	1.2	0.6
B. mancus	13	5										18	0.3	0.5
B. mellissi	13*											13	0.0	0.0
B. myriaster	11	12										23	0.5	0.5
B. ocellatus	26											26	0.0	0.0
B. pantherinus	18"*	13	6									37	0.7	0.7
B. podas	38	20	2									60	0.4	0.6
B. robinsi	57											57	0.0	0.0
B. swio	2											2	0.0	0.0
B. thompsoni	12											12	0.0	0.0
B. tricirrhitus				1								1	3.0	0.0
B. ypsigrammus	3*	1										6	0.3	0.5

Table 9. Frequency distribution value of dorsal-eye appendages in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (_), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Count of dorsal-eye appendages for holotypes of *B. myriaster* and *B. swio* were obtained from original descriptions. Dorsal eye appendage counts for *B. lunatus, B. maculiferus, B. mancus, B. ocellatus, B. robinsi* and *B. thompsoni* holotypes are not available; count of *B. ellipticus* is not available.

	Count of dorsal-eye appendages													
	0	1	2	3	4	5	6	7	8	9	10	n	MEAN	SD
B. assimilis	1											1	0.0	0.0
B. constellatus	15^											15	0.0	0.0
B. guibei		2*	1		1*							4	2.0	1.4
B. leopardinus	6											6	0.0	0.0
B. lunatus	3	5	1				1		1	1	1	13	3.1	3.7
B. maculiferus		9	3	1								13	1.4	0.7
B. mancus	14	2	2									18	0.3	0.7
B. mellissi	13*											13	0.0	0.0
B. myriaster	11	12										23	0.5	0.5
B. ocellatus	26											26	0.0	0.0
B. pantherinus	19"*	12	6									37	0.6	0.8
B. podas	39	19	1	1								60	0.4	0.6
B. robinsi	57											57	0.0	0.0
B. swio	2											2	0.0	0.0
B. thompsoni	12											12	0.0	0.0
B. tricirrhitus				1								1	3.0	0.0
B. ypsigrammus	3*		1									6	1.0	0.5

Table 10. Frequency distribution value of ocular-side pectoral-fin rays in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (_), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Count of ocular-side pectoral-fin rays for holotypes of *B. ellipticus, B. maculiferus. B. mancus, B. myriaster, B. ocellatus, B. robinsi*, *B. swio,* and *B. thompsoni* were obtained from original descriptions; count for *B. lunatus* holotype is not available.

	Count of pectoral-fin rays o.s.											
	7	8	9	10	11	12	13	14	15	n	MEAN	SD
B. assimilis						1				1	12.0	0.0
B. constellatus					11	4^				15	11.3	0.5
B. ellipticus					1					1	11.0	0.0
B. guibei					4*					4	11.0	0.0
B. leopardinus				1	2	3				6	11.3	0.8
B. lunatus			1	1	5	6				13	11.2	0.9
B. maculiferus				1	11	1				13	11.0	0.4
B. mancus				2	3	12	2			19	11.7	0.8
B. mellissi					1*	10*	2*			13	12.1	0.5
B. myriaster		1	12	9	2					24	9.5	0.7
B. ocellatus				11	13	1	1			26	10.7	0.7
B. pantherinus			3*	20"*	8	2				33	10.3	0.7
B. podas			1	13	41	5				60	10.8	0.6
B. robinsi		1	1	2	50	4				58	10.9	0.6
B.swio				2						2	10.0	0.0
B. thompsoni					1	9	1	1		12	12.2	0.7
B. tricirrhitus					1					1	11.0	0.0
B. ypsigrammus			1*	2	1					6	10.0	0.8

Table 11. Frequency distribution value of blind side pectoral-fin rays in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (_), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Count of blind side pectoral-fin rays for holotypes of *B. mancus, B. swio, and B. robinsi* were obtained from original descriptions. Count of blind side pectoral-fin rays for holotypes of *B. lunatus, B. maculiferus, B. myriaster, B. ocellatus,* and *B. thompsoni* are not available; count for *B. ellipticus* is not available.

	Count of pectoral-fin rays b.s.									
	7	8	9	10	11	12	13	n	MEAN	SD
B. assimilis				1				1	10.0	0.0
B. constellatus			1	10	3^			14	10.1	0.5
B. guibei				1*	3*			4	10.8	0.5
B. leopardinus			1	2	3			6	10.3	0.8
B. lunatus		1		1	7	4		13	11.0	1.1
B. maculiferus				6	7			13	10.5	0.5
B. mancus				6	4	9		19	11.2	0.9
B. mellissi		1		1*	9*	2*		13	10.8	1.0
B. myriaster		1	16	4	1			22	9.2	0.6
B. ocellatus			21	2	2			25	9.2	0.6
B. pantherinus		1	7"*	16	7	1		32	10.0	0.8
B. podas			6	45	8			59	10.0	0.5
B. robinsi		9	28	19	2			58	9.2	0.8
B. swio			2					2	9.0	0.0
B. thompsoni					2	9		11	11.8	0.4
B. tricirrhitus					1			1	11.0	0.0
B. ypsigrammus			3*	1				6	9.3	0.5

Table 12. Frequency distribution value of precaudal vertebrae in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (_), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Count of precaudal vertebrae holotypes of *B. constellatus, B. lunatus, B. maculiferus, B. mancus, B. robinsi, B. swio, and B. thompsoni* were obtained from original descriptions. Count for holotypes of *B. myriaster, B. ocellatus,* and *B. podas* are not available; precaudal vertebrae count for *B. ellipticus* is not available.

	Count of precaudal vertebrae					
	9	10	11	n	MEAN	SD
B. assimilis		1		1	10.0	0.0
B. constellatus		15^		15	10.0	0.0
B. guibei		4*		4	10.0	0.0
B. leopardinus		5		5	10.0	0.0
B. lunatus		13		13	10.0	0.0
B. maculiferus		13		13	10.0	0.0
B. mancus		16	2	18	10.1	0.3
B. mellissi		13		13	10.0	0.0
B. myriaster		23		23	10.0	0.0
B. ocellatus		23	1	24	10.0	0.2
B. pantherinus		31"*	1	32	10.0	0.2
B. podas		56	1	57	10.0	0.1
B. swio		2		2	10.0	0.0
B. robinsi	2	54	1	57	10.0	0.2
B. thompsoni		13		13	10.0	0.0
B. tricirrhitus		1		1	10.0	0.0
B. ypsigrammis		3*	1	6	10.3	0.3

Table 13. Frequency distribution value of caudal vertebrae including the urostyle in *Bothus* species. Sample size (n), mean, and standard deviation (SD) are included. Counts containing holotypes are indicated by an underscore (_), paratypes by an asterisk (*), syntypes by a caret (^) and lectotypes by a quotation mark ("). Count of caudal vertebrae holotypes of *B. constellatus, B. lunatus, B. maculiferus, B. mancus, B. robinsi, B. swio, and B. thompsoni* were obtained from original descriptions. Count of caudal vertebrae for holotypes of *B. myriaster, B. ocellatus,* and *B. podas* are not available; caudal vertebrae count for *B. ellipticus* is not available.

	Count of caudal vertebrae including urostyle									
	25	26	27	28	29	30	31	n	MEAN	SD
B. assimilis				1				1	28.0	0.0
B. constellatus			1	5^	9^			15	28.5	0.6
B. guibei					4*			4	29.0	0.0
B. leopardinus				1	4			5	28.8	0.4
B. lunatus					4	9		13	29.7	0.5
B. maculiferus					5	8		13	29.6	0.5
B. mancus		1		5	9	3		18	28.7	1.0
B. mellissi					2*	11*		13	29.8	0.4
B. myriaster			3	17		3		23	28.1	0.8
B. ocellatus	2	15	5	1	1			24	26.3	0.9
B. pantherinus	1*	4"*	2	24	1			32	27.6	0.9
B. podas				11	38	8		57	28.9	0.6
B. robinsi		4	44	9				57	27.1	0.5
B. swio					2			2	29.0	0.0
B. thompsoni			1	8	4			13	28.2	0.6
B. tricirrhitus			1					1	27.0	0.0
B. ypsigrammis			1	1		1*	1	6	29.0	1.8

DESCRIPTIONS

Bothus assimilis (Günther, 1862)

Figures 23, 24; Table 14

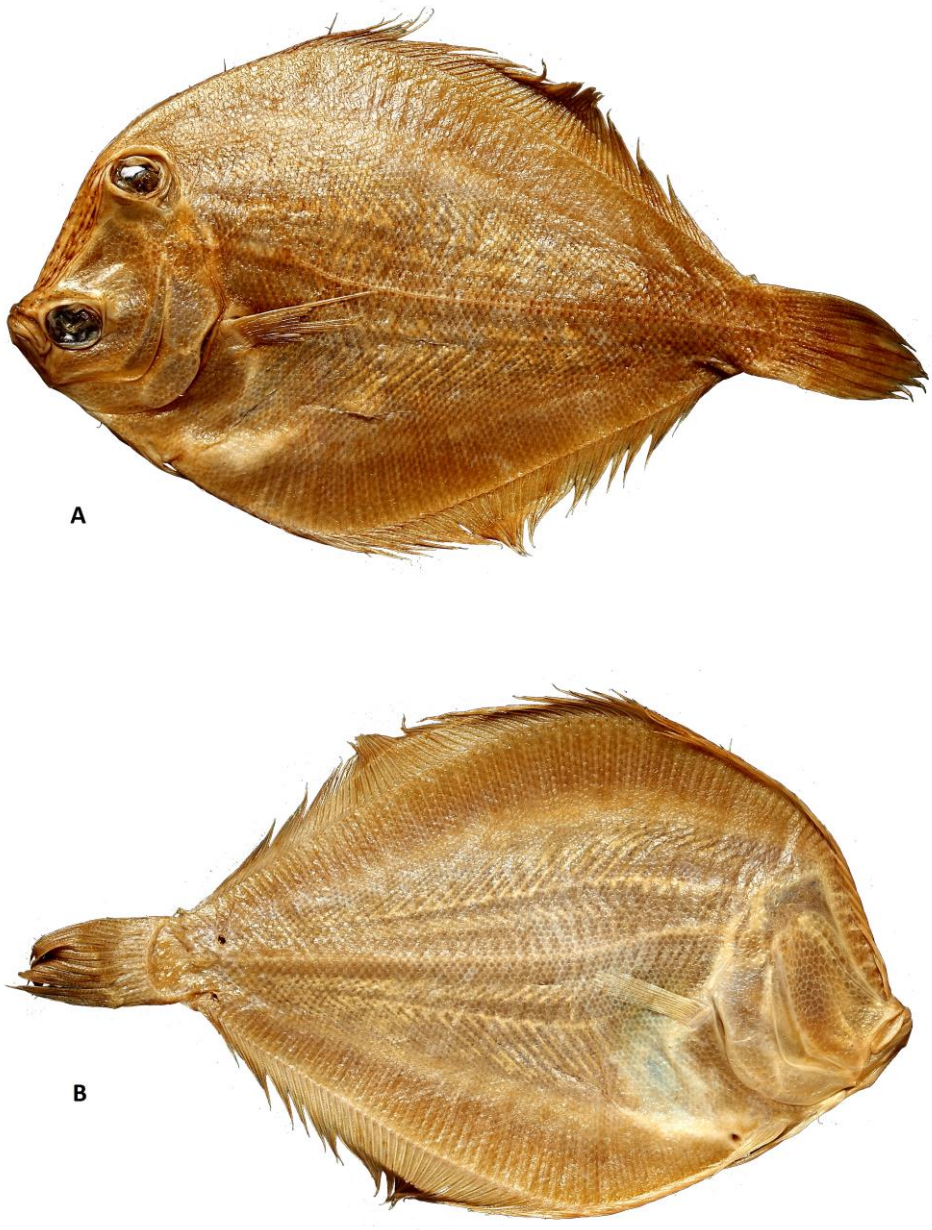


Figure 23. *Bothus assimilis* (Günther 1862), holotype BMNH 2012.1.12.11. Ocular (A) and blind (B) side of adult male, 123.03 mm SL, from Taiwan.

Synonym(s): none.

Common name(s): none.

Material examined: *Bothus assimilis,* 1 male specimen (123.03 mm).

Type material: Holotype, (123.03 mm), BMNH 2012.1.12.11 Günther (1862).

Non-type material: none.

Diagnosis: A species of *Bothus* with the following combination of characters: distinct dark speckles along the anterior crest of the inter-orbital space with no other pigmentation; body depth is 65% the length of SL; greatly expanded interorbital width, 52% of HL, no spines on orbitals (Fig. 23).

Description: A species of *Bothus* reaching the maximum 123.03 mm SL (in examined specimens). Meristic and morphometric characters are indicated in Table 14; body ovate and deep, body depth reaching 65% of SL; head length 28% of SL, head depth 54% of SL; head almost linear along length of interorbital distance; small notch above snout; interorbital distance 52% of HL; nine hourglass-shaped supracranial pterygiophores ; 16 dorsal-fin pterygiophores anterior to first neural spine; small blunt spine on snout, no spines on orbitals; ocular-side mouth one fourth in head, 22% of HL, blind side mouth slightly greater in length (24%); nine short gill-rakers on lower limb of first gill arch, five short gill-rakers on anterior part of upper arch; lateral line scales 81, ends posterior to dorsal eye in bifurcated supratemporal branch; scales cycloid with some weakly ctenoid on ocular side, cycloid on blind side; asymmetrical pectoral-fin rays with 12 and 10 on blind side; ocular-side fin rays longer (21% of SL) versus (14% of SL) on blind; 86 dorsal-fin rays, 64 anal-fin rays, 16 caudal-fin rays; 10 precaudal vertebrae, 28 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: (Fig. 23) ocular-side of body brown; blind side pale tan; anterior blotch near downward curve of lateral line system; distinct dark brown speckles along anterior ridge of interorbital distance and anterior margin of head; pectoral and pelvic fins without pigmentation; blind side without pigmentation. Holotype BMNH 2012.1.12.11 has lost some color and pigmentation during preservation.

Table 14. Meristic and morphometric values of the holotype specimen of *Bothus assimilis,* BMNH 2012.1.12.11. All measurements and abbreviations are described in Appendix B.

	B. assimilis BMNH 2012.1.12.11 holotype
Standard length	123.03
Total length	149.36
Counts	
Dorsal-fin ray	86
Anal-fin ray	64
Caudal-fin ray	16
Precaudal vertebrae	10
Caudal vertebrae including urostyle	28
Hourglass shaped pterygiophores of dorsal-fin	9
Dorsal-fin Dorsal-fin pterygiophores anterior to first elongated neural spine	16
Gill rakers on lower limb of first gill arch	9
Gill rakers on upper limb of first gill arch	5
Dorsal-eye appendage	0
Ventral-eye appendage	0
Pectoral-fin rays o.s.	12
Pectoral-fin rays b.s.	10
Pelvic-fin rays o.s.	6
Pelvic-fin rays b.s.	6
Lateral-line scales	81
Measurements	
%SL	
Body Depth	0.65
Head length	0.28
Head depth	0.54
Length of pectoral fin o.s.	0.21
Length of pectoral fin b.s.	0.14
Length of pelvic fin o.s.	0.11
Length of pelvic fin b.s.	0.12
Length of base of pelvic fin o.s.	0.11
Length of base of pelvic fin b.s.	0.04
Length of first dorsal-fin ray	0.07
Length of first anal-fin ray	0.06
Depth of caudal peduncle	0.11
%HL	
Preorbital length	0.47
Postorbital length	0.19
Predorsal distance b.s.	0.13
Dorsal eye distance from anterior edge of head	0.10
Snout length (o.s.) (o.s.)	0.15
Snout to nostril distance (o.s.) (o.s.)	0.12
Length of mouth o.s.	0.22
Length of mouth b.s.	0.24
Ventral eye diameter	0.28
Width of dorsal orbital	0.34
Interorbital Distance	0.52

Sexual dimorphism: The holotype and only known specimen of *Bothus* assimilis has a spine on the snout. Spines on the snout is a common character in *Bothus* males, thus the holotype is probably a male.

Geographic distribution: the holotype was collected in the South China Sea near Taiwan (Günther 1862).

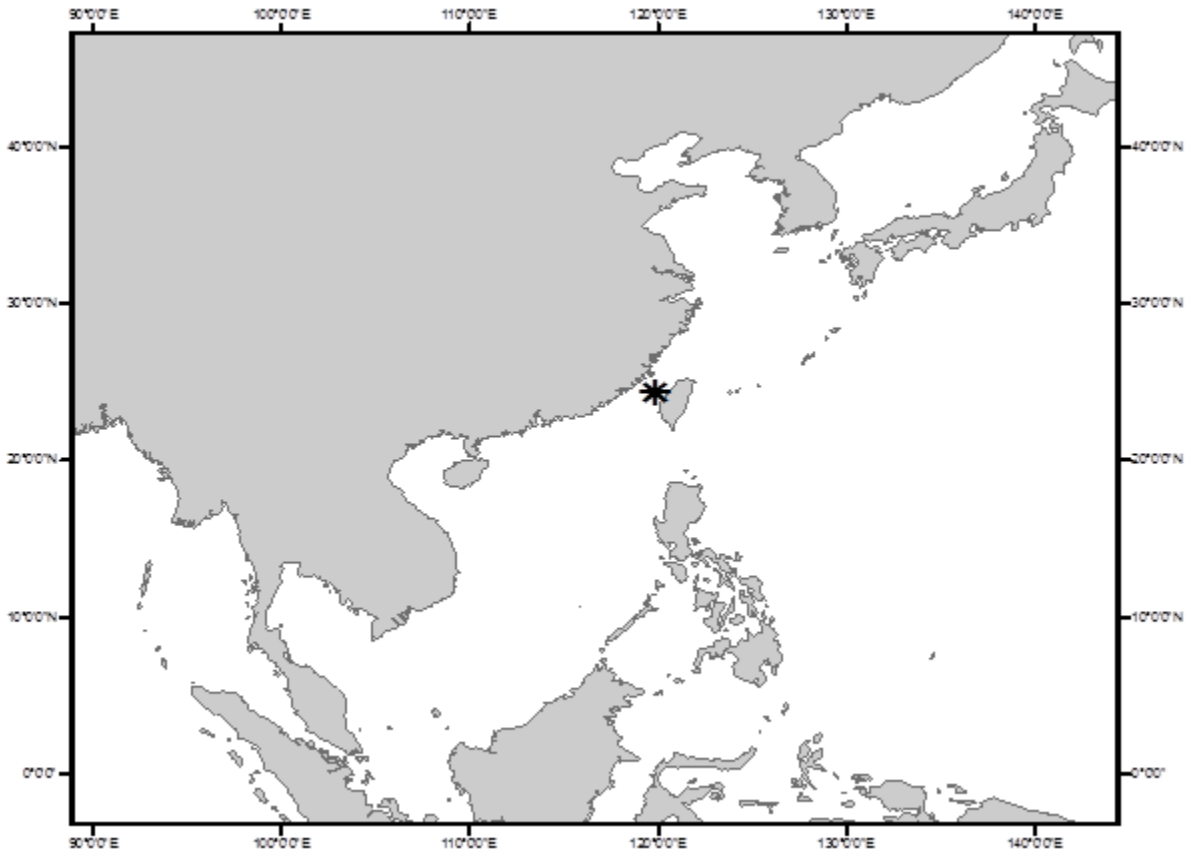


Figure 24. Geographical distribution of examined specimen of *Bothus assimilis*. Asterisk denotes the approximate locality of type material *Bothus assimilis* BMNH 2012.1.12.11.

Remarks: Norman's (1934) systematic monograph of flatfishes contains a description of *Bothus assimilis* that was first described by Günther (1862). This specimen was examined first hand by the author and was found to have conflicting counts for lateral-line scales, dorsal/anal-fin rays, and gill-rakers of the upper and lower limb of the first arch as well as morphology of ocular-side scales. The pectoral-fin rays of the ocular side are damaged on the holotype. Norman states cycloid scales on the ocular side, however this study observed both cycloid and weakly ctenoid scales on the ocular side and recorded the observation as such. Possible reasons for other discrepancies in meristics are explained on page 26.

Interestingly *B. assimilis* also has a wide interorbital distance with a short ocular-side pectoral fin. A wide interorbital distance indicates a male, however the short ocular-side pectoral-fin indicates a female within species of the genus. This is a feature sometimes seen in the Mediterranean/Atlantic species *Bothus podas* and should be explored in depth once more specimens of *B. assimilis* are collected and become available for examination.

Comparisons: *Bothus assimilis* most closely resembles *Bothus podas* based on overlapping body depth ranges at 48%–79% in *B. podas* versus 65% of SL in *B. assimilis*, ocular side pectoral-fin rays at 6%-29% of SL in *B. podas* versus 21% of SL in *B. assimilis*, and the presence of a spine on the snout in males in both species. *B. assimilis* can be differentiated from *B. podas* by the presence of unique dark speckles located along the anterior profile of the head just anterior to the interorbital space and the lack of pigmentation or blotches on ocular/blind side. Geographically *B. podas* is distributed along the west coast of Africa, whereas *B. assimilis* has only been recorded in the China Sea near Taiwan.

Bothus constellatus (Jordan, 1889)

Figures 25 - 27; Tables 15, 16

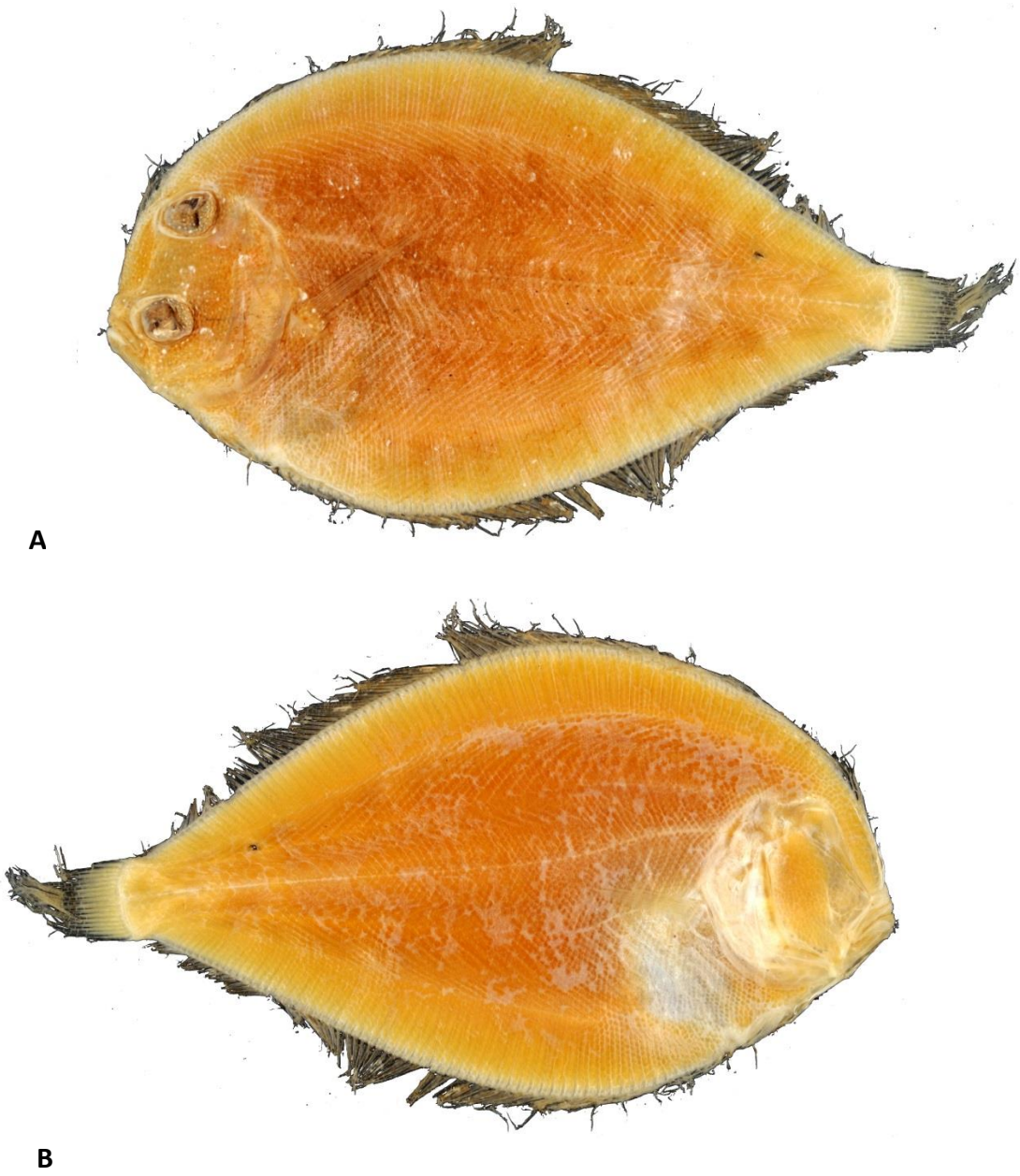


Figure 25. *Bothus constellatus* (Jordan 1889), syntype, from MCZ 11146. (A) Ocular and (B) blind side of adult male 70 mm, James Island, Galapagos.

Synonym(s): none.

Common name(s): Pacific-eyed flounder (Global).

Material examined: *Bothus constellatus,* 15 specimens (55–138.09 mm SL).

Type material: Photographs of syntypes (3) (15–70 mm SL), MCZ 11146 *Platophrys constellatus*, Galapagos.

Non-type material: SMF 29813 (4) (99.7–110.29 mm SL), Salina Cruz, Mexico, USNM 321705 (4) (63.18–73.85 mm SL), Gulf of Panama, USNM 57880 (95.99 mm SL), Cocos Island, Costa Rica, USNM 375785 (2) (68.18–90 mm SL), Galapagos, SMF 5786 (138.09 mm SL) Galapagos.

Diagnosis: Symmetrically arranged stellate white blotches along dorsal and ventral edges of body, and on dorsal and anal-fin rays; no dark blotches near lateral line (Fig. 26); slight notch on snout.

Description: A species of *Bothus* reaching a maximum standard length of 138.09 mm SL (in examined specimens). Meristic and morphometric characters are indicated in Table 15; Body semicircular, almost tear drop shaped; body depth reaching 59%–75% of SL; head length 24%– 31% of SL, head depth 42-71% of SL; profile of head convex, slight notch above snout in adults; small protuberance on snout in males, absent in females (Fig. 26); interorbital distance 24%–54% of HL; 9 hourglass-shaped supracranial pterygiophores, 14 –16 dorsal-fin pterygiophores anterior to first neural spine, no spines on orbitals; lateral line with 70–85 scales, with bifurcated supratemporal branch; scales ctenoid on ocular side, cycloid on blind side; asymmetrical pectoral-fin rays, slightly angled superiorly towards dorsal edge of body, with 11–12 on the ocular side and 9–11 on blind side; ocular-side fin rays longer at 14%–26% of SL; 87–93 dorsal-fin rays, 65–72 anal-fin rays, 17 caudal-fin rays; 10 precaudal vertebrae, 27–29 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: ocular-side of body tan brown almost orange, blind side without pigmentation; syntypes are degraded and have lost their pigmentation; non-type specimens exhibit stellate white blotches one third the size of the ventral eye, arranged symmetrically along dorsal and ventral margins of body, and dorsal and anal-fin rays (Fig. 26). Sometimes light blotches and pigmentation recorded along lateral line; pectoral and pelvic-fin rays without pigmentation.

Table 15. Meristic and morphometric data for the type and non-type specimens of *Bothus constellatus.* Measurements for *Bothus constellatus* were obtained from high definition photographs of three syntypes (MCZ 11146) and from examination of 12 non-type specimens (n=15, 8 males, 7 females). All measurements and abbreviations are described in Appendix B.

	B. constellatus syntypes (n=3)	*B. constellatus* non-type (n=12)
Standard length	55-70 (61.67;7.64)	63.18-138.09 (89.10;23.04)
Total length	67-82 (72.67;8.14)	78.87-165.03 (108.40;27.11)
Counts		
Dorsal-fin ray	88-93 (90.33;2.52)	87-91 (89.58;1.08)
Anal-fin ray	65-70(68.33;02.89)	65-72 (67.58;2.11)
Caudal-fin ray	17-17 (17;0)	17-17 (17;0)
Precaudal vertebrae	10-10 (10;0)	10-10 (10;0)
Caudal vertebrae including urostyle	28-29 (28.67;0.58)	27-29 (28.5;0.67)*
Hourglass shaped pterygiophores of dorsal-fin	9-9 (9;0)	8-9 (8.75;0.45)
Dorsal-fin pterygiophores anterior to first elongated neural spine	16-16 (16;0)	14-16(14.83;0.58)
Gill rakers on lower limb of first gill arch		8-11 (9.75;0.87)
Gill rakers on upper limb of first gill arch		5-7 (5.75;0.75)
Dorsal-eye appendage		
Ventral-eye appendage		
Pectoral-fin rays o.s.	12-12 (12;0)	11-12 (11.08;0.29)
Pectoral-fin rays b.s.	11-11 (11;0)	9-11 (10;0.43)
Pelvic-fin rays o.s.		5-6 (5.92;0.29)
Pelvic-fin rays b.s.		06-6 (6;0)
Lateral-line scales	75-79 (77;2)	70-85 (77;3.64)
Measurements		
%SL		
Body Depth	0.60-0.75 (0.65;0.08)	0.59-0.71 (0.64;0.04)
Head length	0.24-0.31 (0.26;0.04)	0.24-0.30 (0.28;0.02)
Head depth	0.51-00.71 (0.57;0.12)	0.42-0.54 (0.49;0.04)
Length of pectoral fin o.s.	0.14-0.26 (0.20;0.06)	0.14-0.25 (0.21;0.03)
Length of pectoral fin b.s.	0.07-0.13 (0.11;0.03)	0.13-0.15 (0.14;0.01)
Length of pelvic fin o.s.		0.09-0.13 (0.12;0.01)
Length of pelvic fin b.s.		0.09-0.11 (0.10;0.01)
Length of base of pelvic fin o.s.		0.11-0.14 (0.12;0.01)
Length of base of pelvic fin b.s.		0.02-0.04 (0.04;0.01)
Length of first dorsal-fin ray		0.05-0.06 (0.05;0.01)
Length of first anal-fin ray		0.05-0.08 (0.07;0.01)
Depth of caudal peduncle	0.11-0.15 (0.13;0.02)	0.11-0.12 (0.11;0..01)
%HL		
Preorbital length	0.12-0.30 (0.22;0.09)	0.34-0.48 (0.40;0.05)
Postorbital length	0.28-0.44 (0.38;0.09)	0.21-0.34 (0.27;0.04)
Predorsal distance b.s.	0.06-0.11 (0.08;0.02)	0.10-0.16 (0.13;0.02)
Dorsal eye distance from anterior edge of head	0.12-0.14 (0.12;0.01)	0.08-0.16 (0.12;0.02)
Snout length (o.s.)	0.12-0.15 (0.13;0.01)	0.16-0.48 (0.20;0.09)
Snout to nostril distance (o.s.)		0.12-0.20 (0.15;0.02)
Length of mouth o.s.		0.16-0.41 (0.21;0.07)
Length of mouth b.s.		0.18-0.24 (0.21;0.02)
Ventral eye diameter	0.28-0.32 (0.30;0.02)	0.26-0.34 (0.29;0.02)
Width of dorsal orbital	0.35-0.38 (0.36;0.02)	0.31-0.42 (0.34;0.03)
Interorbital Distance	0.28-0.32 (0.31;0.03)	0.24-0.54 (0.39;0.11)

*indicates a character could not be collected for one specimen
Blank space indicates where data could not be obtained

Sexual dimorphism: Males can be distinguished by the presence of a spine on the snout (Fig. 26).

Table 16. Morphometric comparison of males and females of *Bothus constellatus* using type and non-type material (N= 15, 8 males, 7 females). Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	B. constellatus syntypes (n=3)	*B. constellatus non-type (n=12)*	
Character	Male	Male, n=8	Female, n=7
Standard length	55-70 (61.67;7.64)	65.9-138.09 (101.17;27.11)	63.18-102.49 (80.48;16.59)
Measurements			
%SL			
Head length	0.24-0.31 (0.26;0.04)	0.24-0.30 (0.28;0.02)	0.26-0.30 (0.27;0.01)
Head depth	0.51-0.71 (0.57;0.12)	0.45-0.54 (0.48;0.04)	0.42-0.54 (0.49;0.04)
Length of pectoral-fin ray o.s.	0.14-0.26 (0.20;0.06)	0.19-0.25 (0.22;0.02)	0.14-0.24 (0.21;0.03)
%HL			
Interorbital distance	0.28-0.32 (0.31;0.03)	0.31-0.54 (0.47;0.09)	0.24-0.51 (0.33;0.09)

Blank space indicates where data could not be obtained

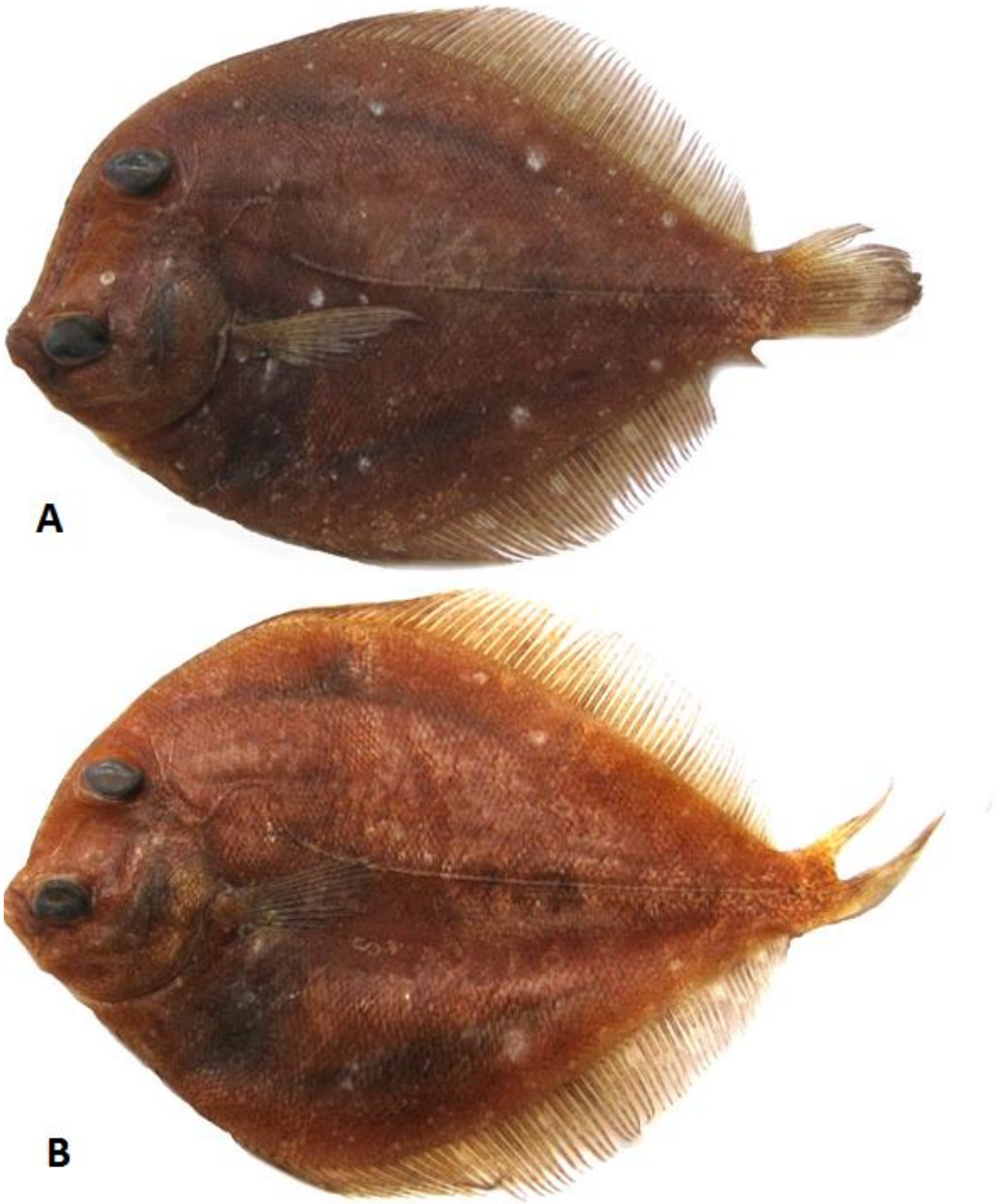


Figure 26. *Bothus constellatus* SMF 29813 male (A) depicting large interorbital distance and distinct white stellate spot pattern unique to species; USNM 375785, female (B) with distinct blotch pattern and absence of spine on nostril and smaller interorbital distance.

Geographic distribution: *Bothus constellatus* has been reported in the Galapagos Archipelago (Jordan & Goss 1889), Panama bay (Norman 1934), Western Atlantic, Canada to New York (USA), Bermuda, and northern Gulf of Mexico to southern Brazil.

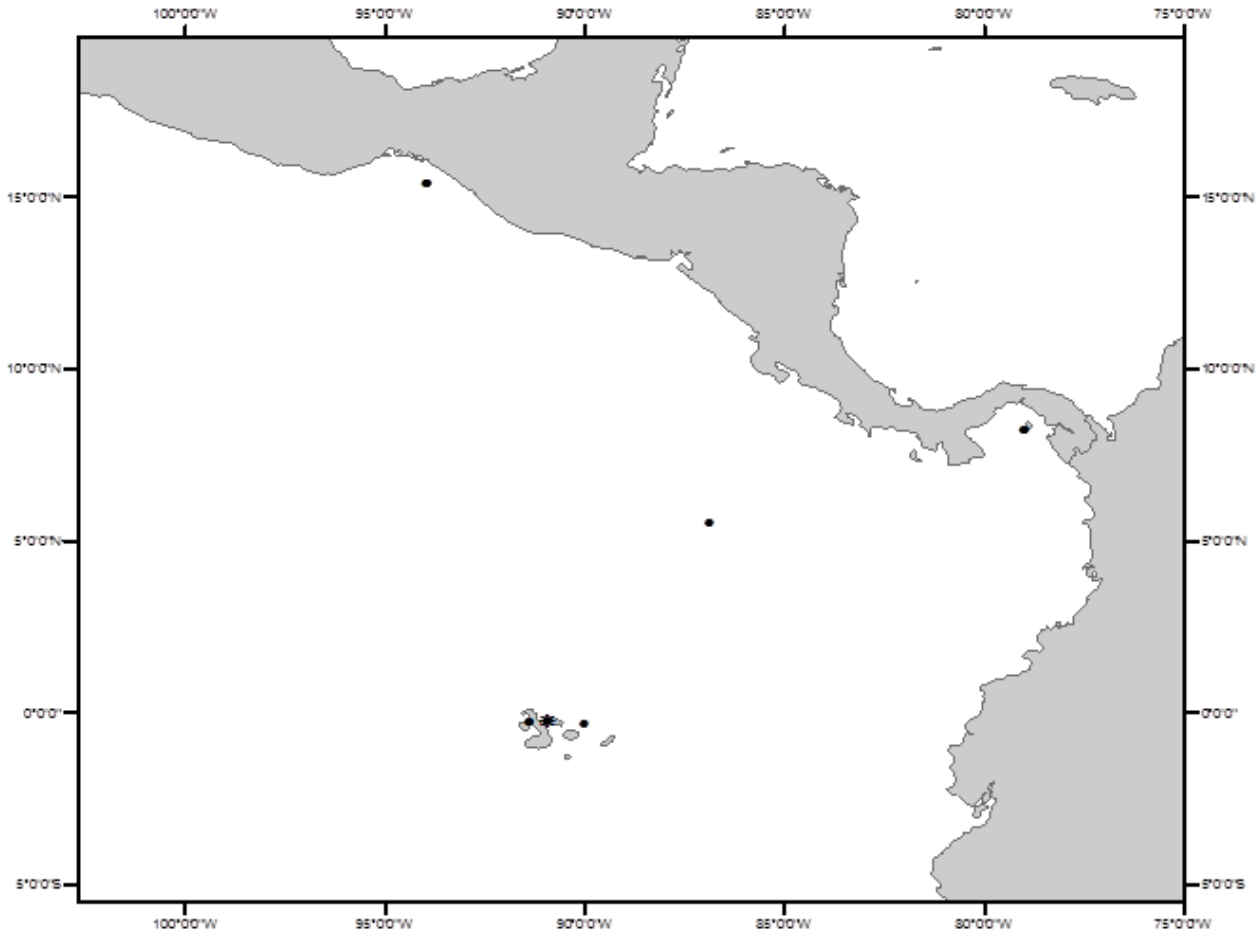


Figure 27. Geographical distribution of examined specimens of *Bothus constellatus*. Asterisk denotes the locality of syntypes (MCZ 11146).

Remarks: this species was first described as *Platophrys constellatus* by Jordan 1889 based on three syntypes (MCZ 11146). The meristics of these syntypes are similar to those of *Bothus leopardinus* (Günther 1862) compiled in this study. Jordan and Goss (1889) state that the species is different from other *Bothus* species because of its specific spot pattern and some meristic/morphometric data. Norman (1934; 234) speculated that the species were doubtfully different and suggested that *Bothus constellatus* (Jordan 1889) could be a juvenile of *B. leopardinus* (Günther 1862). Norman's (1934) identification key states that two species are separated by body in depth relation to SL, their interorbital width in relation to HL, the number of pectoral-fin rays, the shape of anterior profile of the head, and the pigmentation of the ocular side. The examination of the type material (*B. leopardinus* BMNH 1855.9.19.1250 holotype, *B. constellatus* MCZ 11146 syntypes (n=3)) for both species resulted in the validation of differences between the species. *B. constellatus* was recorded with body depths ranging from 60%–75% of the SL, interorbital distances of 28%-32% of the HL, 12 pectoral-fin rays on the ocular side, and no prominent notch above the snout. *B. leopardinus* exhibited a body depth of 0.57 % of SL, an interorbital width of 25% of HL, 10 pectoral-fin rays on the ocular side, and a prominent notch above the snout. When comparing the pigmentation of both species a key distinction can be made. Jordan in Jordan and Goss (1889:264) indicated that the presence of stellate white blotches in a distinct circular pattern were found to be unique to *B. constellatus*. The degraded condition of the type material of *Bothus constellatus* (MCZ 11146 (3)) did not allow for the depiction of pigmentation, and as such the results of the non-type material have been used to confirm the presence of symmetrical stellate white blotches in *Bothus constellatus* (Jordan 1889) (Fig. 26). The results collected in this study corroborate the appearance of this particular white stellate blotch pattern. *Bothus leopardinus* has a very vibrant and colourful pigmentation pattern in live specimens however, the arrangement of the pigmentation and presence of stellate white spots is different from that of *B. constellatus*. Another difference between the type material found in this study was the number of dorsal-fin pterygiophores before the first elongated

neural spine of the precaudal vertebrae (*B. constellatus* with 16 pterygiophores and *B. leopardinus* with 14). The difference in this osteological count is viewed as inconsequential as this character overlaps with other species of *Bothus* as well as other non-type specimens observed in the study. The difference in meristic, morphometric, and qualitative data suggest that although similar to *B. leopardinus, B. constellatus* should be designated as a valid species until further evidence is presented.

Comparisons: *Bothus constellatus* (Jordan 1889) can be distinguished from all other species of *Bothus* except *Bothus leopardinus, Bothus podas, and Bothus mellissi* by the following combination of characters: a body depth of 59%–71% of SL, a smaller interorbital distance that is 24%–54% of the head length, pectoral-fin rays extended 14%-26% of SL, 8–11 gill rakers on the lower limb of the first arch, dorsal-fin ray count of 87 –93, anal-fin ray count of 65–72, a lateral line count of 70–85, the absence spines absent on the orbitals, and the absence of dark spots on the caudal fin. *B. constellatus* is most closely related to *B. leopardinus*, based on their similar body depth (*B. constellatus* at 59%–75% of SL, *B. leopardinus* at 56%–78% of SL), head depth (*B. constellatus* at 42%–71% of HL, *B. leopardinus* at 50%–62% of HL), and lateral-line scale count (*B. constellatus* with 79–80, *B. leopardinus* with 70–85) however, it also shares similarities with *B. podas* and *B. mellissi* based on body depth (*B. podas* at 44%–63% of SL, *B. mellissi* at 60%–66% of SL) and lateral line scales counts (*B. podas* with 84–91, and *B. mellissi* with 78-101). The geographic distribution of *B. podas* and *B. mellissi* are contained to the Western Atlantic around St. Helena and the Gulf of Guinea, where as *B. constellatus* and *B. leopardinus* has is distributed in the Pacific Ocean along the western coast of South America. *B. constellatus* can be distinguished from *B. podas, B. mellissi, and B. leopardinus* by the presence of its distinct symmetrical white stellate blotches along the ventral and dorsal margins of the body and dorsal/anal-fin rays.

Bothus ellipticus (Poey, 1860)

Figure 28

Synonym(s): None.

Common name(s): None.

Material examined: None. Data taken from Poey (1860): Memorias sobra la historia natural de la Isla de Cuba, acompañadas de sumarios Latinos y extractos en Francés. Tomo 2. La Habana.

Diagnosis: Dorsal-fin ray count of 104.

Description: (Translation of original description by Poey (1860:315) as no specimen could be obtained) Sinistral, 220 mm; body oval, moderately elongated, height comprised nearly two and a half times in total length, head is one fifth of the HL; eyes located in second quarter of head, interorbital distance is equal to eye diameter; maxillary does not extend to medial portion of the orbit; articulation of the lower jaw is not prominent; Orbital spines present; spine on snout present; teeth small and compact/tight, almost in a single row; 104 dorsal-fin rays; 71 anal-fin rays, 11 pectoral-fin rays ; 6 ventral-fin rays; 17 caudal-fin rays; dorsal begins above the maxillary, dorsal longest near median of body; ventral-fins unequal in size; the first 4 ocular-side pectoral-fin rays extending up to two thirds of the body length; caudal tail rounded; scales finely ctenoid; lateral line has a short and pronounced curve.

Pigmentation of preserved specimens: (Translation from Poey 1860:316) Pale yellowish brown; light yellowish brown circles; black blotch in first one third of body with close approximation to the lateral line; whitish blotch in middle and posterior third of the body, all black dots on body bordered by a broad black band; vertical fins have some brown pigmentation.

Sexual dimorphism: The type specimen of *Bothus ellipticus* was deemed a male according to the original description of Poey, 1860.

Geographic distribution: *Bothus ellipticus* was reported in Cuba (West Indies) (Poey 1860, Jordan 1889) with no exact locality.

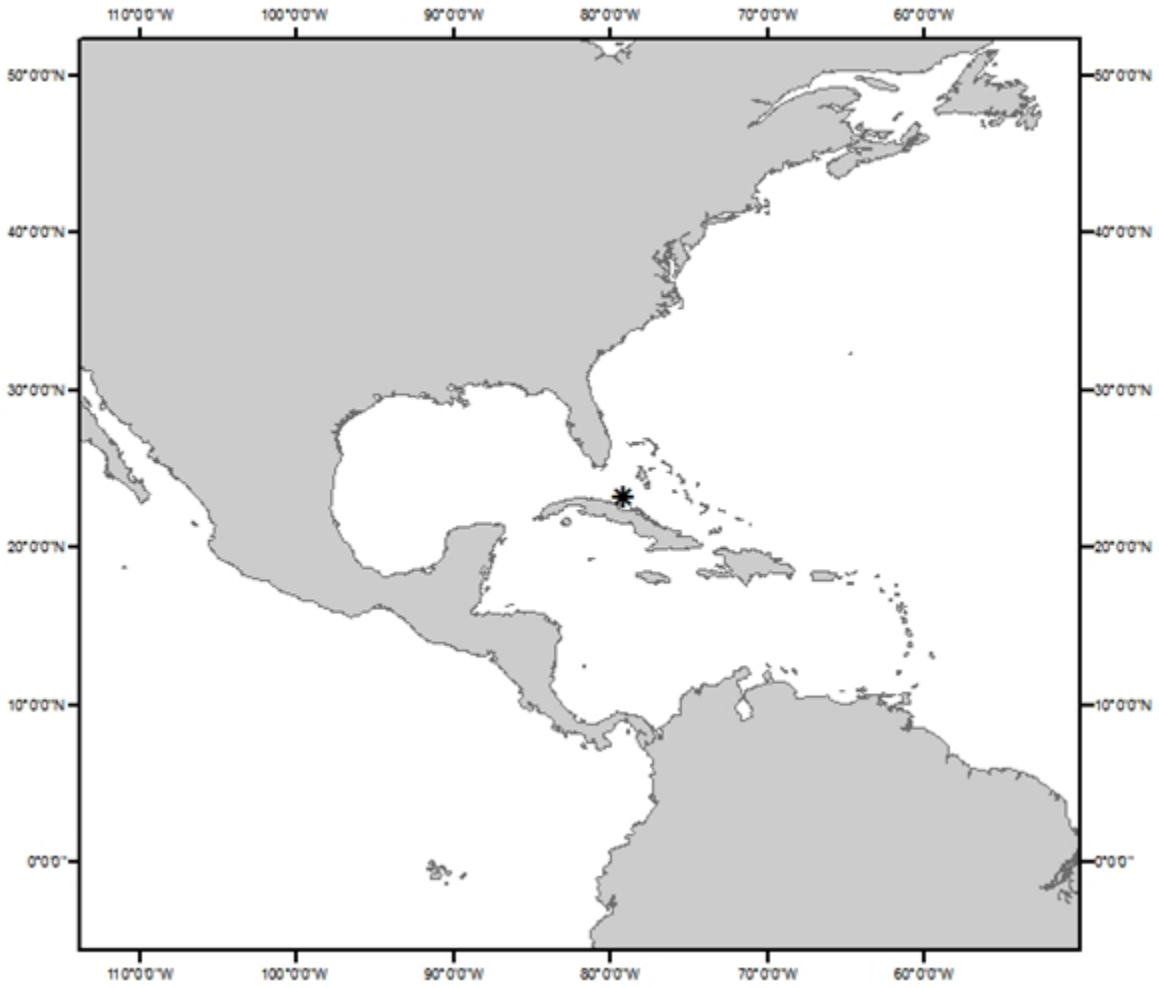


Figure 28. Geographical distribution of *Bothus ellipticus* based on recorded type locality (Cuba) in original description of Poey (1860). Asterisk denotes approximate locality.

Remarks: The location of the type specimen of *Bothus ellipticus* is not known. There are possible syntypes listed at the Museum of Comparative Zoology (Eschmeyer 2015) identified as MCZ 11188. Coincidently MCZ 11188 is also stated as the holotype of *Hippoglossus ocellatus* Poey 1860. After examining photographs of specimen MCZ 11188 it is highly unlikely to be the *B. ellipticus* specimen described by Poey (1860). Based on its shallow body depth under two and a half times the length, an interorbital distance smaller than the ventral eye diameter, and the absence of spines on the snout and orbitals contradictory to Poey`s (1860) description. In light of the observations, this double listing is likely a collection catalogue error and the whereabouts of the MCZ *B. ellipticus* syntypes are still unknown.

Poey (1860) described *Pleuronectes ellipticus* from a 220 mm specimen, which had a unique dorsal-fin ray count of 104. Jordan (1889:267) re-classified it as *Platophrys ellipticus* and offered a new description, however, there was a change in the description pertaining to: body depth at 87% of the SL, the interorbital distance to HL% (no head length is given), the number of dorsal-fin rays from 105 to 104, and the anal-fin rays from 71 to 80. The difference in body depth ratio to SL results in an extremely deep fish that is not seen in any other species of *Bothus*, likely making it an error. The conflicting anal-fin counts also suggest that Jordan did not examine the type specimen of *B. ellipticus* (Poey 1860).

Norman (1934: 229) gave a description of *B. ellipticus* in his systematic monograph of flatfishes. He noted that a specimen representing *B. ellipticus* was sent to the MCZ and was examined by an associate Colonel Tenison, who suggested that it was most likely identical to *Bothus maculiferus* (Poey 1860). The specimen examined was approximately 107.95 mm (converted from inches Norman 1934:230), thus proposing a species misidentification because of the substantial conflicting specimen data.

It is highly probable that *Bothus ellipticus* is *Bothus maculiferus* however, without any type material or other species with a matching dorsal-fin ray count to prove other wise, it should remain a valid species. Further adding to validity of the species is that Poey (1860) described both species in the same publication and distinctly identified them as separate species.

In conclusion, the status of *B. ellipticus* will remain as valid until the type specimen can be located or new specimens are collected. No species or specimens of *Bothus* examined in this study have a dorsal-fin ray count of 104, therefore I accept with doubt, that *Bothus ellipticus* be recognized as a valid species until further evidence is presented.

Comparisons: *Bothus ellipticus* is most closely related to *Bothus maculiferus* (Poey, 1860) based on pervious literature stating that they are likely the same species (Norman, 1934) and their comparable morphology. They have similar long compressed bodies (body depth at 40% of SL in *B. ellipticus*, 46%–59% of SL in *B. maculiferus*), anal-fin ray counts (*B. ellipticus* with 71, *B. maculiferus* with 71-77), ocular side pectoral-fin ray counts (*B. ellipticus* with 11, *B. maculiferus* with 10–12), and extensions of the ocular-side pectoral-fin rays (60% of SL in *B. ellipticus,* 50%–58% of SL in males of *B. maculiferus*). They also share overlapping geographic distribution of the West Indies and Cuba. They differ only in the number of dorsal-fin ray counts with *B. ellipticus* exhibiting dorsal-fin ray count of 104 and *B maculiferus* 92–98. This dorsal-fin ray count has been recorded in the only specimen known of *B. ellipticus* making it the diagnostic character, which differentiates it from *B. maculiferus* and all other congeneric species.

Bothus guibei Stauch, 1966

Figures 29 - 31; Tables 17, 18

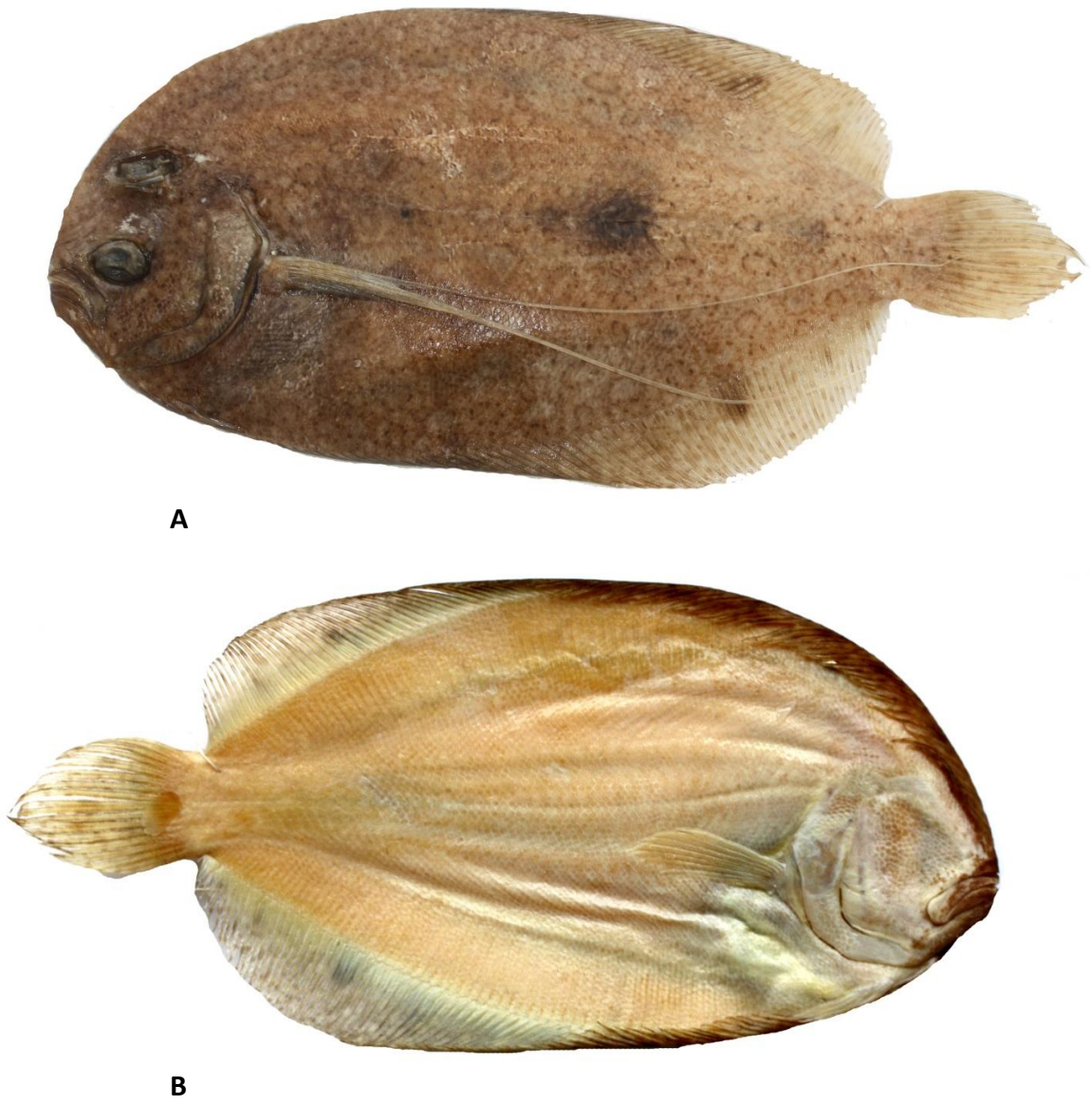


Figure 29. Photographs of *Bothus guibei* Stauch, 1966, Holotype MNHN 1964-0438, 184.17 mm SL, Annabon; (A) ocular-side and (B) blind side.

Synonym(s): *Rhombus heterophthalmus* Bennett 1831 (see remarks).

Common name(s): Guinean flounder (English).

Material examined- *Bothus guibei*, 4 specimens (165.60–190.46).

Type material: Holotype MNHN 1964-0438 (184.17 SL), paratype (3) MNHN 1964-439 (165.6, 179.22, 190.46 SL), Gulf of Guinea, Annobon.

Non-type material: None.

Diagnosis: A species of *Bothus* with the following combination of characters: 5–7 gill-rakers on lower limb of the first gill arch, absent upper limb; branching spine on snout (Fig. 30); males and females with blotches of nearly equal size situated on the dorsal-fin and anal-fin rays in posterior quarter of body (Figs. 29, 30).

Description: A species of *Bothus* reaching a maximum length of 190.46 mm SL (in examined specimens). Meristic and morphometric characters are indicated in Table 17. Body compressed; body depth 52%–54% of SL; head length 26%– 29% of SL; head depth 35%–37% of SL; anterior profile of head convex; no notch above the snout; interorbital distance moderate compared to other species 17%–21% of HL; 8 hourglass-shaped supracranial pterygiophores; 13 dorsal-fin pterygiophores before first elongated neural spine of the precaudal vertebrae; eye appendages on both posterior and anterior of eye, ventral-eye appendages 1–4, dorsal-eye appendages range 1-6 ; males with 10–11 spines on anterior margin of ventral eye orbit, 2–3 on anterior margin of dorsal-eye orbits; females with soft high ridge on ventral orbit; mouth 25%–30% of HL; blind side mouth slightly longer 31%–33%; teeth biserial; lateral line extending from posterior of dorsal-eye orbit to caudal peduncle, 82–89 scales in lateral line; lateral line ends with bifurcated supratemporal branch, scales ctenoid ocular side, cycloid blind side; 87–94 dorsal-

fin rays, originating just superior to snout on blind side; 71–75 anal-fin rays, originating posterior to base of pelvic-fin ray; asymmetrical pectoral-fin ray with 11 on ocular side; extended in males 76%–83% of SL, female 17%–18% of SL; blind side pectoral-fin rays 10–11, extends 15–19% of SL; second to third pectoral-fin ray greatest in length on ocular side; 17 caudal-fin rays; 10 precaudal vertebrae; 28 caudal vertebrae.

Pigmentation of preserved specimens: Ocular-side of body brown with blind side pale tan; male ocular-side has one or two large dark brown blotches along margin of lateral line; anterior blotch situated at junction of straight and curved portion of lateral line; posterior blotch situated in posterior fourth quarter of body near the caudal peduncle on the lateral line (Figs. 29, 30); smaller brown spots located around ventral and dorsal edges of body; brown circular pigmentations resembling ocelli all over the body in some specimens (Fig. 29); blotches nearly equal in size to ventral eye diameter, situated on rays of anal and dorsal-fin on near vertical posterior of mid-body. Two dark brown blotches symmetrically located in posterior of anal and dorsal-fin rays; speckles located randomly on body and in dorsal, anal, and caudal-fin rays; pectoral and pelvic fins pale translucent, blind side has no distinct markings or pigmentation.

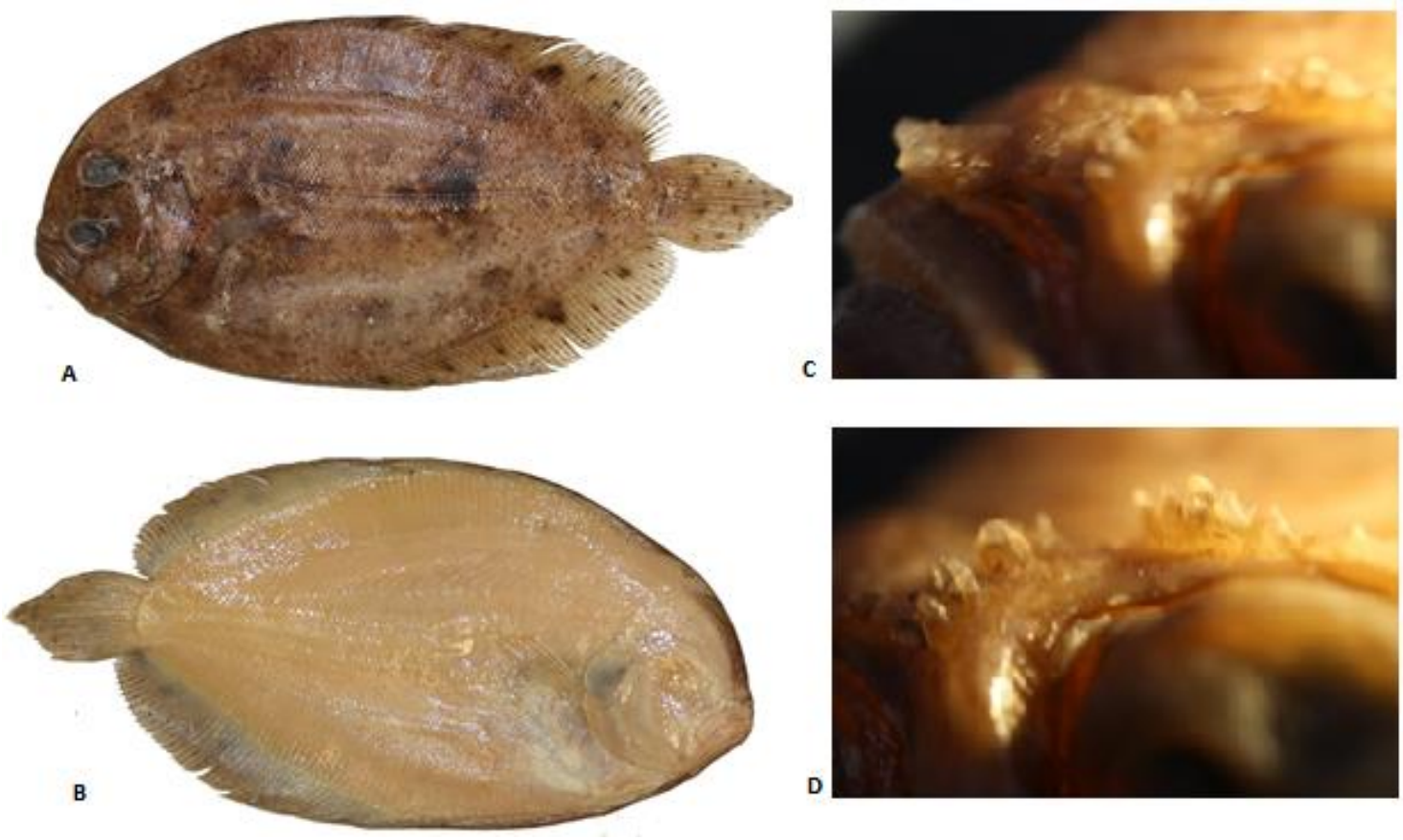


Figure 30. Photograph of *Bothus guibei* MNHN 1964-0439 paratype, Female 190.46 SL, Annabon. Ocular (**A**) and blind side (**B**); Magnified image of branching spine on snout (**C**) and branching spines on orbitals (**D**) of male *B. guibei* MNHN 1964-0438.

Table 17. Meristic and morphometric data for holotypes and paratypes of *Bothus guibei*. Holotype (male) paratypes (n=3, 1 male, 2 female). Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

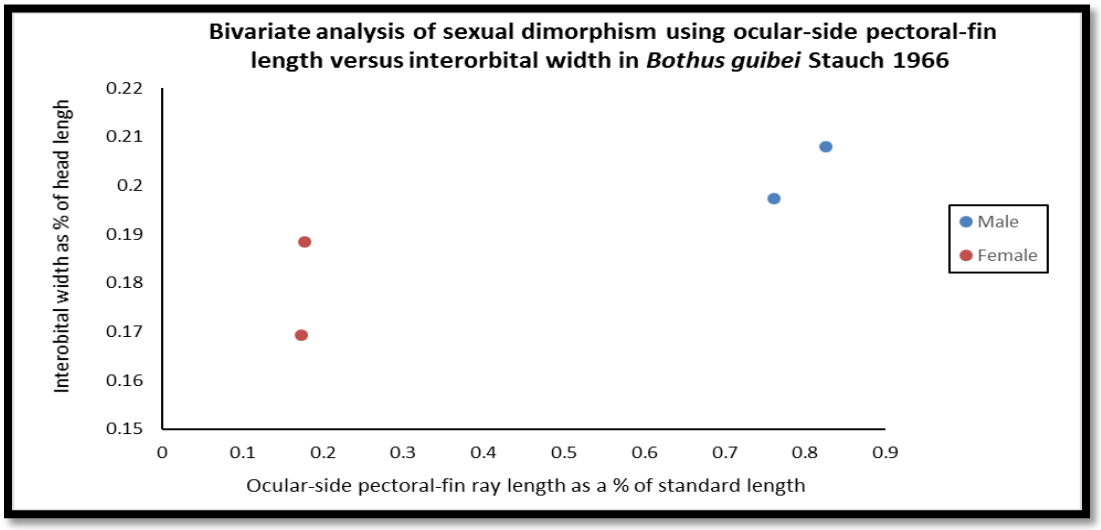
	B. guibei holotype MNHN 1964-0438	B. guibei paratypes MNHN specimens (n=3)
Standard length	184.17	165.6-190.46 (178.43;12.45)
Total length	229.1	197.6-229.3 (215.2;16.14)
Counts		
Dorsal-fin ray	87	91-94 (92.5;2.12)*
Anal-fin ray	71	73-75 (74;1.41)*
Caudal-fin ray	17	17 (17;0)
Precaudal vertebrae	10	10 (10;0)
Caudal vertebrae including urostyle	29	29 (29;0)
Hourglass shaped pterygiophores of dorsal-fin	8	8 (8;0)
Dorsal-fin pterygiophores anterior to first elongated neural spine	13	13 (13;0)
Gill rakers on lower limb of first gill arch	5	6-7 (6.33;0.58)
Gill rakers on upper limb of first gill arch	0	0 (0;0)
Dorsal-eye appendage	2	1-4 (2;1.73)
Ventral-eye appendage	2	1-6 (2.67;2.89)
Pectoral-fin rays o.s.	11	11 (11;0)
Pectoral-fin rays b.s.	11	10-11 (10.67;0.58)
Pelvic-fin rays o.s.	6	6 (6;0)
Pelvic-fin rays b.s.	6	6 (6;0)
Lateral-line scales	89	82-87 (85.;2.65)
Measurements		
%SL		
Body Depth	0.53	0.52-0.54 (0.53;0.01)
Head length	0.26	0.26-0.29 (0.28;0.02)
Head depth	0.37	0.35-0.37 (0.36;0.01)
Length of pectoral fin o.s.	0.83	0.17-0.76 (0.37;0.34)
Length of pectoral fin b.s.	0.19	0.15-0.17 (0.16;0.01)
Length of pelvic fin o.s.	0.11	0.11-0.13 (0.12;0.01)
Length of pelvic fin b.s.	0.13	0.09-0.11 (0.1;0.01)
Length of base of pelvic fin o.s.	0.11	0.08-0.11 (0.1;0.02)
Length of base of pelvic fin b.s.	0.06	0.06-0.07 (0.06;0.01)
Length of first dorsal-fin ray	0.12	0.07 (0.07;0)
Length of first anal-fin ray	0.08	0.08-0.09 (0.08;0.005)
Depth of caudal peduncle	0.12	0.11 (0.11;0)
%HL		
Preorbital length	0.26	0.26-0.31 (0.29;0.03)
Postorbital length	0.46	0.36-0.48 (0.43;0.06)
Predorsal distance b.s.	0.14	0.16-0.19 (0.17;0.01)
Dorsal eye distance from anterior edge of head	0.17	0.15-0.17 (0.16;0.01)
Snout length (o.s.)	0.23	0.22-0.23 (0.23;0.01)
Snout to nostril distance (o.s.)	0.15	0.13-0.16 (0.14;0.01)
Length of mouth o.s.	0.30	0.25-0.27 (0.26;0.01)
Length of mouth b.s.	0.32	0.31-0.33 (0.32;0.01)
Ventral eye diameter	0.26	0.2-0.27 (0.24;0.04)
Width of dorsal orbital	0.26	0.2-0.27 (0.24;0.04)
Interorbital Distance	0.21	0.17-0.2 (0.19;0.01)

*indicates a character could not be collected for one specimen

Sexual dimorphism: The sexually dimorphic characters discussed by Stauch (1966) and corroborated by this study were: males having a large grouping of orbital spines and a branching spine on the snout (Fig. 30, C, D), absent in females. Male's greater Ocular-side pectoral-fin ray length was found to be significant (t (2) =5.39, $p < 0.05$) when discriminating between males and females. Morphometric comparison table, bivariate analysis, and visual representation of sexual dimorphism found in Table 18, Fig. 29, Fig. 30 A, B.

Table 18. Morphometric comparison and bivariate analysis of males and females of *Bothus guibei* Stauch 1966 (n=4, 2 females, 2 male). Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	B. guibei holotype MNHN 1964-0438	*B. guibei* paratypes MNHN specimens (n=3)	
Character	Male	Male, n=1	Female, n=2
Standard length	184.17	179.22 (179.22;0.)	165.6-190.46 (178.03;17.58)
Count			
Number of eye appendages	4	10 (10;0)	2(2;0)
Number of spines on orbitals	14	10 (10;0)	
Measurements			
%SL			
Head length	0.26	0.28 (0.28;0)	0.26-0.29 (0.27;0.02)
Head depth	0.37	0.36 (0.36;0)	0.35-0.37 (0.36;0.02)
Length of pectoral-fin ray o.s.	0.83	0.76(0.76;0)	0.17-0.18 (0.18;0)
%HL			
Interorbital distance	0.21	0.2 (0.2;0)	0.17-0.19 (0.18;0.01)



Geographic distribution: *Bothus guibei* has been reported in the Gulf of Guinea at Annabon, and São Tomé Island (Gulf of Guinea), at a depth of 4-40 m (Stauch 1966, Afonso *et al.* 1999).

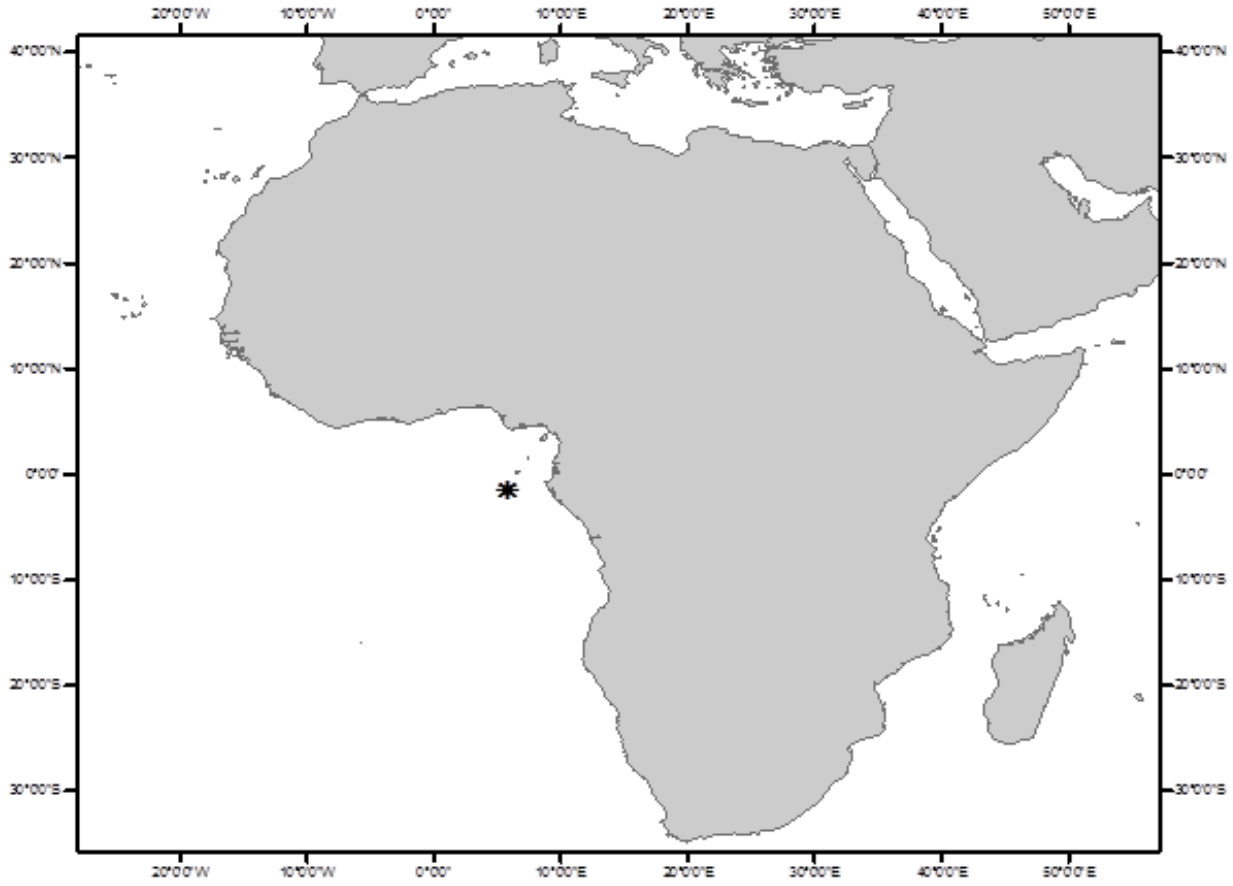


Figure 31. Geographical distribution of examined specimens of *Bothus guibei*. Asterisk denotes the locality of type material.

Remarks: Stauch (1966) described *Bothus guibei* as a new endemic species that belonged to *Bothus* based on its resemblance to other Atlantic *Bothus* species. The name 'guibei' was given as a dedication to Jean Marius René Guibé (1910-1999) of the National Museum of Natural History in Paris. There are currently one holotype and 11 paratypes listed in the NMNH, collected from the same locality (Annabon Island) and designated by Stauch (1966) in the original description. The holotype and three of the eleven paratypes designated by Stauch have been examined, as not all paratypes were available.

Reference (Eschmeyer 2015) to *Bothus guibei,* its distribution, and other *Bothus species* distributed in the same area have been made in recent texts (Wirtz, P., C. E. L. Ferreira, S. R. Floeter, R. Fricke, J. L. Gasparini, T. Iwamoto, L. A. Rocha, C. L. S. Sampaio and U. Schliewen, 2007). Authors have associated *Bothus podas* with *Bothus guibei* based on their close geographical distributions. *Bothus guibei* is distributed among small islands off the coast of Equatorial Guinea, and *B. podas* is distributed in the Mediterranean and along the west coast of Africa. Although they have semi- overlapping distributions, their morphologies do not resemble each other and are easily distinguishable. This raises the question as to why the two species have been mentioned together. The body depth, head morphology, interorbital distance, pectoral-fin ray length, body depth, spines on the snout, gill-raker counts, and pigmentation differ significantly. Therefore, it is the view of the author that the association of species has been based purely on their geographic distributions and does not enhance the analyses of *Bothus guibei*.

Rhombus heterophthalmus Bennett, 1831 is currently listed as a synonym of *Bothus podas* (Delaroche 1809). Bennett (1831) described the species as having wide set eyes, spine on the snout, a pectoral fin that runs the length of the body, and a so called 'hump' on the head. *Bothus* species exhibiting spines on the snout and extended pectoral-fin rays that run the length of the body are *Bothus guibei* (males 76%–83% of SL), *Bothus pantherinus* (45%—90% of SL), and *Bothus tricirrhitus* (75% of SL). No specimens of *Bothus podas* examined in this study exhibited a pectoral fin that runs the length of the body (*B. podas* ocular-side pectoral-fin 6%–29% of SL). The Bennett description also states that there is some relation to Pleuronectes mancus (*Bothus mancus)* however, he states it is different due to the 'bump' along the profile of the head (Bennett 1831) and the longer pectoral fin. *R. heterophthalmus* was collected in the Atlantic Ocean, whereas *B. pantherinus* and *B. mancus* are distributed in the Indian/Pacific Ocean, *B. tricirrhitus* was collected in the Red Sea, and *Bothus guibei* is distributed in the Atlantic along the African coast near Guinea. The similar long pectoral-fin rays and geographical

distribution of *R. heterophthalmus* suggests that Bennett originally described a species of *B. guibei* Stauch, 1966 when identifying *R. heterophthalmus* in 1831. However, Bennett described a species with a `hump` on its head, and no specimens of *B. guibei* observed in this study have exhibited humps on the head. Furthermore, the description of Bennett is vague and doesn`t describe pigmentation, other morphological data, or any meristics. Therefore, *R. heterophthalmus* will be deemed a synonym of *B. guibei* until further data can be accumulated or a type specimen exhibiting a noticeable hump on the head is collected.

Comparisons: *Bothus guibei* can be distinguished from all other species of *Bothus* (except *Bothus maculiferus, Bothus pantherinus,* and *Bothus tricirrhitus*) by: a body that is longer than it is deep at 52%-54% of SL, a convex head with no notch above the snout, an interorbital distance (17%–21% of HL) less than the diameter of the ventral eye, the presence of branching spines on the eye orbitals and snout, appendages on the eyes in males, and the second to sixth pectoral-fin rays extended in males 76%–83% the SL.

Bothus guibei exhibits considerable resemblance to *Bothus pantherinus* and *Bothus tricirrhitus* based on their elongated pectoral-fin rays in males at over 70% of SL. *B. tricirrhitus* can easily be distinguished as it has exactly three eye appendages on each eye whereas *B. guibei* has one to six appendages on the ventral eye and on the dorsal eye. *B. tricirrhitus* also exhibits a large dark bar running vertically across the median of the body on the blind side, whereas *B. guibei* has no pigmentation on the blind side. *B. pantherinus* can be distinguished from *B. guibei* because it lacks blotches nearly equal in size situated on the dorsal and anal-fin rays in the posterior quarter of body in both males and females. *B. guibei* also has a geographic distribution specific to the Gulf of Guinea and two islands (Annabon, São Tomé), whereas *B. pantherinus* has not been observed in the Atlantic Ocean and inhabits the Pacific, Indo-pacific, and Indian Ocean.

B. guibei most closely resembles *B. maculiferus* morphologically and has an interesting distribution geographically. *B. maculiferus* has a distribution usually located in the West Indies whereas *B. guibei* is located in the Gulf of Guinea. The distribution localities connected by the Atlantic Ocean could suggest a previous relationship between the two species, resulting in close morphological similarities. However, the following characters can distinguish the two species: *B. guibei* has 13 dorsal-fin pterygiophores anterior to the first neural spine of the caudal vertebrae, whereas *B. maculiferus* has a range of 14–16. *B. guibei* males have an extended pectoral-fin ray 76%-83% of SL, whereas *B. maculiferus* male's pectoral-fin rays range from 50–58% of SL. *B. guibei* also has a gill-raker range of 5–7 on the lower limb of the first gill arch, while *B. maculiferus* has a range of 7–11; *B. guibei* also has no gill-rakers present on the upper limb of the first gill arch whereas *Bothus maculiferus* has 0-3.

Bothus leopardinus (Günther, 1862)

Figures 32 - 34; Tables 19 - 21

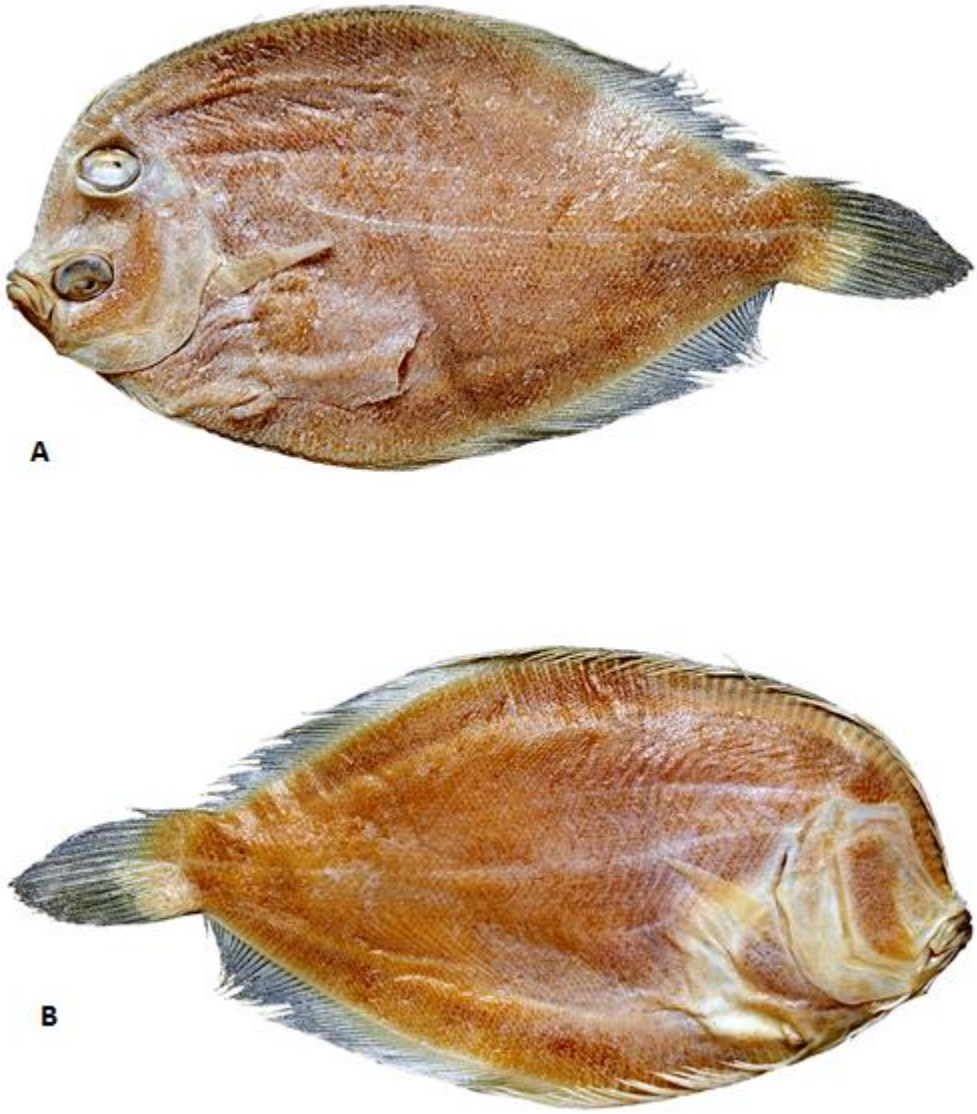


Figure 32. *Bothus leopardinus* (Günther, 1862), holotype from BMNH 1855.9.19.1250. (A) Ocular and (B) blind side of Female 120.08 mm, collection location unknown.

Synonym(s): None.

Common name(s): None.

Material examined: *Bothus leopardinus,* 6 specimens (97.6 - 139.3 mm SL).

Type material: Holotype BMNH 1855.9.19.1250 (120.08 mm SL), Haslar.

Non-type material: USNM 019218 (97.6 mm SL) Fanning Island, Kiribati; USNM 375796 (4) (124.59 - 139.3 mm SL), Columbia.

Diagnosis: A species of *Bothus* with the following combination of characters: ocular-side pectoral fin 18%–24% of SL; lack of triangular protuberance on anterior side maxillary; variegated light grey and white spots randomly assorted on head and body (Fig. 32, 33).

Description: A species of *Bothus* reaching a maximum standard length of 139.9 mm (in examined specimens). Meristic and morphometric characters are indicated in Table 19; body ovate, body depth 56%–78% of SL; head length 24%– 28% of SL, head depth 50%–62% of SL; profile of head convex, small notch above snout; dorsal eye located in nearly vertical position superior to the ventral eye, interorbital distance 21%–57% of HL; 8–10 hourglass-shaped supracranial pterygiophores, 14–16 dorsal-fin pterygiophores before first elongated neural spine; small spine on snout in males, no spines on orbitals; mouth 19%–30% of HL; blind side mouth 21%–30% of SL; teeth shape conical, biserial; 8–11 gill-rakers on lower limb of first gill arch, 4–8 on upper portion of anterior arch; lateral line with 79–80 scales, bifurcated supratemporal branch of lateral line system; scaled slightly ctenoid on ocular side, cycloid on blind side; asymmetrical pectoral-fin rays with 10–12 on the ocular side and 9–11 on the blind side; asymmetrical ocular-side rays ranging from 18%–24% of SL, blind side 7%—15% of SL; 87–91 dorsal-fin

rays, 65–69 anal-fin rays; 17 caudal-fin rays; 10 precaudal vertebrae, 28–29 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: Ocular-side of body tan brown, with blind side pale tan; no distinct dark blotch on body, or lateral line; small white/grey ocellated pigmentations distributed randomly all over the body in preserved specimens; greyish/white/aqua coloured ocelli distributed randomly all over the body and fins (in live specimens), pectoral and pelvic fins without pigmentation; blind side without (Fig. 32/33).

Figure 33. Photograph of *Bothus leopardinus* (Günther, 1862), exhibiting unique pigmentation in live specimens. Taken by Gerald Allen of Western Australian Museum - Aquatic Zoology. Specimen collection locality: Mexico.

Table 19. Meristic and morphometric data for the type and non-type specimens of *Bothus leopardinus*. Measurements for *Bothus leopardinus* BMNH 1855.9.19.1250, holotype, female and 5 non-type specimens (n=5, 3 male, 2 female). All measurements and abbreviations are described in Appendix B.

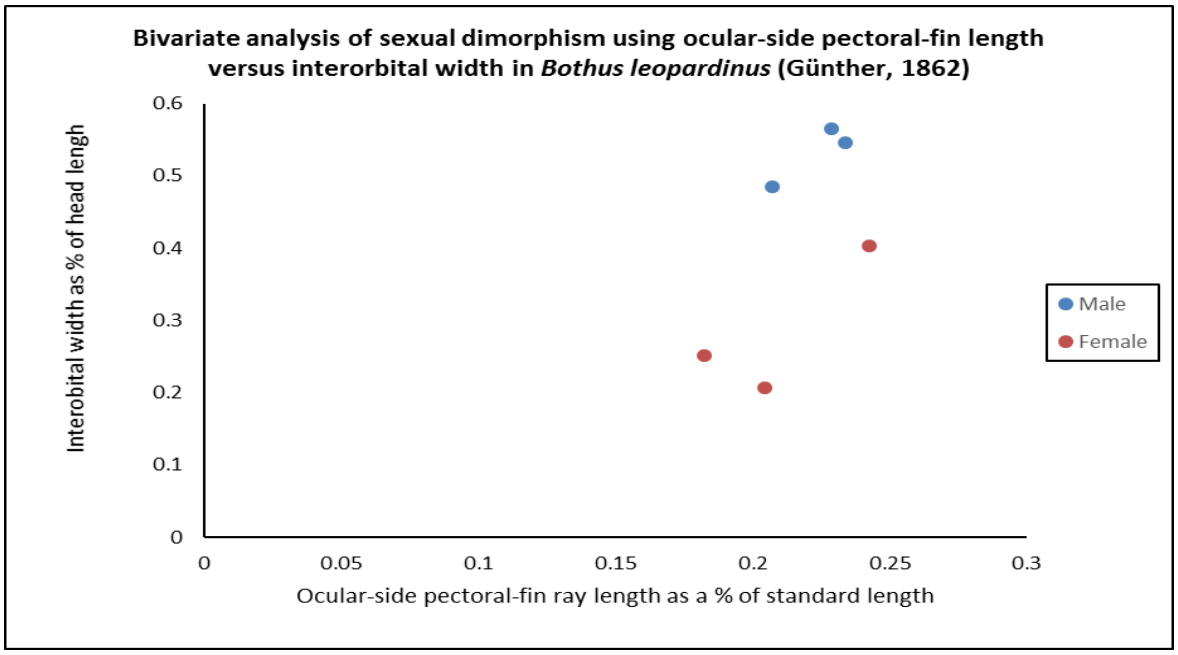
	B. leopardinus BMNH 1855.9.19.1250 holotype	*B. leopardinus* non-type specimens (n=5)
Standard length	120.08	97.6-139.3 (125.69;16.59)
Total length	147.48	111.79-168.93 (149.95;23.94)
Counts		
Dorsal-fin ray	89	87-91 (88.75;1.71)*
Anal-fin ray	69	65-68 (66.5;1.29)*
Caudal-fin ray	17	17 (17;0)*
Precaudal vertebrae	10	10 (10;0)*
Caudal vertebrae including urostyle	29	28-29 (28.75;0.5)
Hourglass shaped pterygiophores of dorsal-fin	8	9-10 (9.25;0.5)
Dorsal-fin pterygiophores anterior to first elongated neural spine	14	15-16 (15.25;0.5)
Gill rakers on lower limb of first gill arch	8	8-11 (9.6;1.14)
Gill rakers on upper limb of first gill arch	5	4-8 (5.75;1.71)
Pectoral-fin rays o.s.	10	10-12 (11.2;0.84)
Pectoral-fin rays b.s.	11	9-11 (10.2;0.84)
Pelvic-fin rays o.s.	6	6(6;0)*
Pelvic-fin rays b.s.	6	6 (6;0)*
Lateral-line scales	79	79-80 (79.75;0.5)*
Measurements		
%SL		
Body Depth	0.57	0.56-0.78 (0.66;0.08)
Head length	0.27	0.24-0.28 (0.26;0.02)
Head depth	0.5	0.52-0.62 (0.57;0.06)
Length of pectoral fin o.s.	0.18	0.2-0.24 (0.22;0.02)
Length of pectoral fin b.s.	0.07	0.13-0.15 (0.14;0.01)
Length of pelvic fin o.s.	0.1	0.1-0.14 (0.12;0.02)
Length of pelvic fin b.s.	0.11	0.-0.12 (0.08;0.05)
Length of base of pelvic fin o.s.	0.11	0.11-0.14 (0.12;0.01)
Length of base of pelvic fin b.s.	0.04	0.03-0.04 (0.04;0.002)
Length of first dorsal-fin ray	0.05	0.05-0.07 (0.06;0.01)
Length of first anal-fin ray	0.06	0.06-0.08 (0.07;0.01)
Depth of caudal peduncle	0.13	0.1-0.13 (0.11;0.01)
%HL		
Preorbital length	0.33	0.36-0.55 (0.45;0.08)
Postorbital length	0.29	0.24-0.38 (0.3;0.06)
Predorsal distance b.s.	0.12	0.1-0.13 (0.11;0.02)
Dorsal eye distance from anterior edge of head	0.12	0.11-0.14 (0.13;0.01)
Snout length (o.s.)	0.2	0.14-0.22 (0.17;0.03)
Snout to nostril distance (o.s.)	0.15	0.1-0.15 (0.13;0.02)
Length of mouth o.s.	0.2	0.19-0.3 (0.22;0.05)
Length of mouth b.s.	0.24	0.21-0.3 (0.24;0.04)
Ventral eye diameter	0.31	0.22-0.31 (0.28;0.04)
Width of dorsal orbital	0.39	0.27-0.34 (0.32;0.03)
Interorbital Distance	0.25	0.21-0.57 (0.44;0.15)

*indicates a character could not be collected for one specimen

Sexual dimorphism: Males and females can usually be distinguished by the presence of a spine on the snout, not exhibited in females. Male's greater Interorbital distance were found to be significant (t (4) =5.39, $p < 0.05$) when discriminating between males and females. Morphometric comparison table, bivariate analysis, and visual representation of sexual dimorphism found in Table 20, Fig. 32, 33.

Table 20. Morphometric comparison and bivariate analysis of males and females of *Bothus leopardinus* (Günther, 1862) of type and non-type material (n= 6, 3 males, 3 females). Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	B. leopardinus BMNH 1855.9.19.1250 holotype	*B. leopardinus* non-type specimens (n=5)	
Character	Female	Male, n=3	Female, n=2
Standard length	120.08	132.2-139.3 (135.42;3.59)	97.6-124.59 (111.1;19.08)
Count			
Measurements			
%SL			
Head length	0.27	0.24-0.25 (0.25;0)	0.28-0.28 (0.28;0)
Head depth	0.50	0.52-0.62 (0.55;0.06)	0.62 (0.62;0)
Length of pectoral-fin ray o.s.	0.18	0.21-0.23 (0.22;0.01)	0.21-0.23 (0.22;0.01)
%HL			
Interorbital distance	0.25	0.48-0.57 (0.53;0.04)	0.21-0.4 (0.31;0.14)



Geographic distribution: *Bothus leopardinus* has been reported in the Gulf of California (Jordan & Goss, 1889) to Panama, Tropical Eastern Pacific (Allen, Robertson, 1994), Galapogos Island (McCosker and Rosenblatt, 2010) Pacific coast of Mexico, Central America (Norman, 1934), Fanning Island, and Columbia.

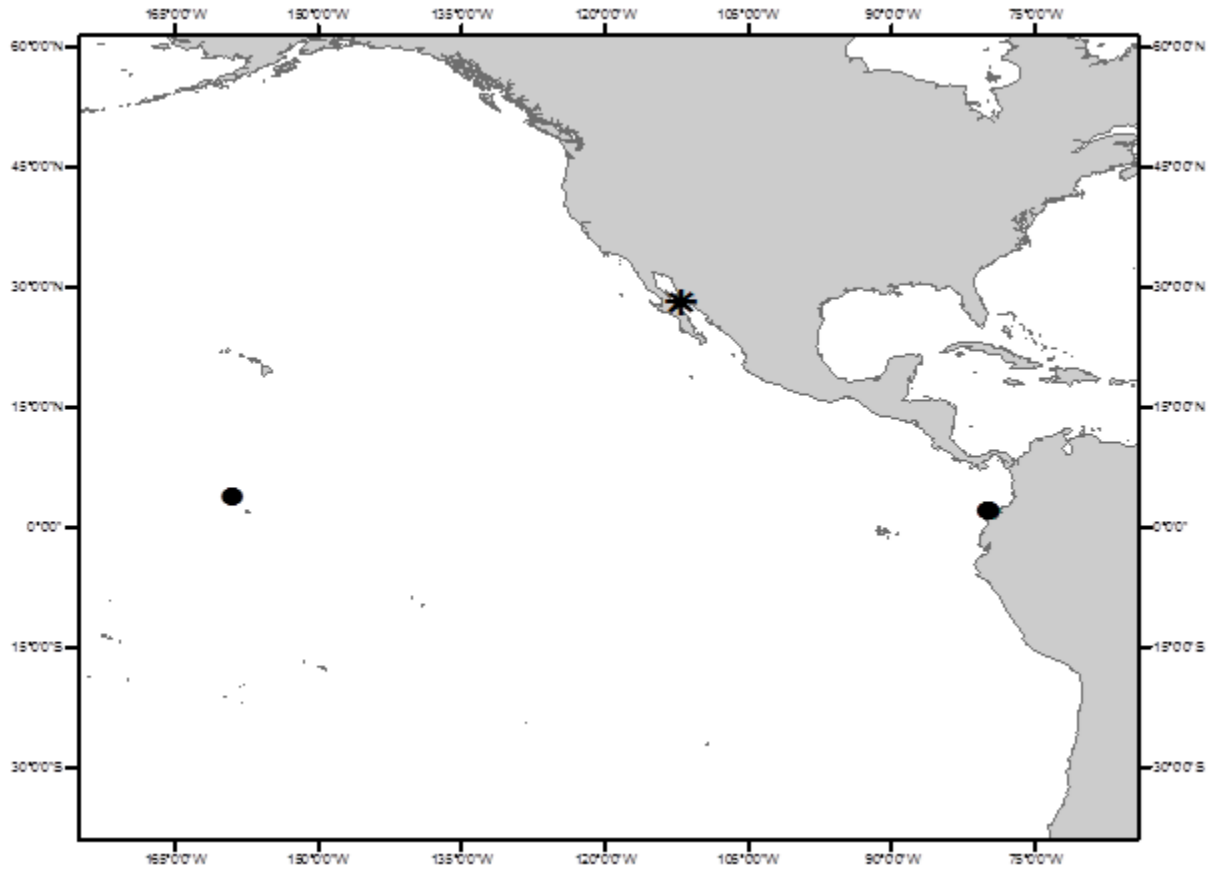


Figure 34. Geographical distribution of examined specimens of *Bothus leopardinus*. Asterisk denotes the locality of type material *Bothus leopardinus* BMNH 1855.9.19.1250 holotype.

Remarks: Günther (1862) first described this species as *Rhomboidichthys leopardinus*. It was later described as *Parophrys leopardinus* (Jordan, 1884) based on a specimen collected in Guaymas, Mexico that coincided with Günther's original description. This description also mentioned the prevalence of the variegated white spot pattern on the body. Later the species was reclassified as *Platophrys leopardinus* (Jordan and Goss, 1889) and eventually reclassified as *Bothus leopardinus* (Günther, 1862). Norman

(1934) gave a description for *B. leopardinus* however, he stated that he doubted that *Bothus constellatus* (Jordan, 1889) and *Bothus leopardinus* were distinct from one another. This study corroborates the meristic similarities between species (Table 21), however, there are distinct differences between them as the comparison conveys.

Comparisons: *Bothus leopardinus* can be distinguished from other species of *Bothus* by its deeply compressed body at 56%–78% of SL, the lack of ventral and dorsal eye appendages, a short pectoral fin of the ocular side at 18%–24% of SL, and its unique variegated pigmentation and spot pattern of the ocular side (more prominent in live specimens). *B. leopardinus* morphology and pigmentation pattern most closely resembles *Bothus lunatus, Bothus mancus,* and *Bothus constellatus. B. mancus* differs with the presence of a large triangular protuberance above the maxillary on the ocular side, the absence of gill-rakers on the upper limb of the first gill arch, and the presence of two large dark blotches on the lateral-line, all of which are absent in *B*. leopardinus. *B. lunatus* differs with a generally smaller head depth at 37%–51% of SL compared to *B. leopardinus* at 50%–62%, the presence of eye-appendages, and the presence of distinct bright blue and pigmentations in the shape of complete/incomplete rings. *B. leopardinus* was stated as doubtfully distinct from *B. constellatus* (Norman, 1934) based on morphometric observations. When comparing the type material of *B. leopardinus* and *B. constellatus* (Table 21) there are differences between size (*B. leopardinus* at 120.08 mm SL, *B. constellatus* at 55–70mm SL) and the number of dorsal-fin pterygiophores before the first elongated neural spine of the precaudal vertebrae (*B. leopardinus* with 14, *B. constellatus* with 16). However, other type and non-type specimen morphological and meristic data do exhibit overlap, giving credit to Norman's statement. Thus leaving the qualitative characters as the most reliable method for distinguishing these species. *B. constellatus* exhibits the symmetrical stellate white spots unique to the species, where as *B. leopardinus* exhibits variegated blotches and pigmentations distributed randomly all over the body. The variegated

ocellated spots of *B. leopardinus* (prominent in live specimens, Fig. 33) distinguish it from all other congeneric species.

Table 21. Meristic and morphometric variables comparing the type material *Bothus leopardinus* (BMNH 1855.9.19.1250 Holotype) and *Bothus constellatus* (MCZ 11146, n= 3 syntypes). All measurements and abbreviations are described in Appendix B.

	B. leopardinus BMNH 1855.9.19.1250 holotype	*B. constellatus* MCZ 11146 syntypes (n=3)
Standard length	120.08	55-70 (61.67;7.64)
Total length	147.48	67-82 (72.67;8.14)
Counts		
Dorsal-fin ray	89	88-93 (90.33;2.52)
Anal-fin ray	69	65-70(68.33;02.89)
Caudal-fin ray	17	17-17 (17;0)
Precaudal vertebrae	10	10-10 (10;0)
Caudal vertebrae including urostyle	29	28-29 (28.67;0.58)
Hourglass shaped pterygiophores of dorsal-fin	8	9-9 (9;0)
Dorsal-fin pterygiophores anterior to first elongated neural spine	14	16-16 (16;0)
Gill rakers on lower limb of first gill arch	8	
Gill rakers on upper limb of first gill arch	5	
Dorsal-eye appendage	0	
Ventral-eye appendage	0	
Pectoral-fin rays o.s.	10	12-12 (12;0)
Pectoral-fin rays b.s.	11	11-11 (11;0)
Pelvic-fin rays o.s.	6	
Pelvic-fin rays b.s.	6	
Lateral-line scales	79	75-79 (77;2)
Measurements		
%SL		
Body Depth	0.57	0.60-0.75 (0.65;0.08)
Head length	0.27	0.24-0.31 (0.26;0.04)
Head depth	0.50	0.51-0.71 (0.57;0.12)
Length of pectoral fin o.s.	0.18	0.14-0.26 (0.20;0.06)
Length of pectoral fin b.s.	0.07	0.07-0.13 (0.11;0.03)
Length of pelvic fin o.s.	0.10	
Length of pelvic fin b.s.	0.11	
Length of base of pelvic fin o.s.	0.11	
Length of base of pelvic fin b.s.	0.04	
Length of first dorsal-fin ray	0.05	
Length of first anal-fin ray	0.06	
Depth of caudal peduncle	0.13	0.11-0.15 (0.13;0.02)
%HL		
Preorbital length	0.33	0.12-0.30 (0.22;0.09)
Postorbital length	0.29	0.28-0.44 (0.38;0.09)
Predorsal distance b.s.	0.12	0.06-0.11 (0.08;0.02)
Dorsal eye distance from anterior edge of head	0.12	0.12-0.14 (0.12;0.01)
Snout length (o.s.)	0.20	0.12-0.15 (0.13;0.01)
Snout to nostril distance (o.s.)	0.15	
Length of mouth o.s.	0.20	
Length of mouth b.s.	0.24	
Ventral eye diameter	0.31	0.28-0.32 (0.30;0.02)
Width of dorsal orbital	0.39	0.35-0.38 (0.36;0.02)
Interorbital Distance	0.25	0.28-0.32 (0.31;0.03)

*indicates a character could not be collected for one specimen
Blank spaces indicate where data could not be collected

Bothus lunatus (Linnaeus, 1758)

Figures 35 - 38; Tables 22, 23

Figure 35. *Bothus lunatus* (Linneaus 1758), from BMNH 1967.6.16316. Ocular and blind side of adult female 87.73 mm SL, from Runaway Bay, Jamaica; (A) ocular side, (B) blind side.

Synonym(s): *Pleuronectes argus* Bloch 1783, *Pleuronectes spinosis* Bloch and Schneider 1801, *Pleuronectes pictus* Forster 1844, *Pleuronectes lunulatus* Jouan 1861, *Platotichthys chartes* Nichols 1921.

Common name(s): Peacock flounder/ Plate Fish/Sole fish (English).

Material examined: *Bothus lunatus,* 13 specimens (73.33 -313 mm SL).

Type material: No types known. Information taken from Linnaeus 1758 original description, translation from: Goode and Bean (1885).

Non-type material: ANSP 126431 (2) (215-258 mm SL), Yucatan; BMNH 1967.6.16.316-317 (73.33 mm SL), Jamaica; BMNH 1930.8.6.16 (*Platophrys lunatus*) (104.4 mm SL), Puerto Rico; ZMH 19917 (313 mm SL), Puerto Rico; ANSP 8844 (2) (225-239 mm SL), Anguilla; USNM 190528 (258 mm SL), Antigua; NMC 1968-2101 (152.67 mm SL), St. Lucia; BMNH 1920.12.22.196 (*Rhomboidichthys lunatus*) (160.91 mm SL), Trinidad; NMC 68-54 (180 mm SL), Trinidad; SMF 23378 (272 mm SL), Suriname; SMF 989 (186.8 mm SL); ANSP 124056 (*Pleuronectes lunulatus*) (67.27 mm SL), Grand Bahamas

Diagnosis: A species of *Bothus* with an abundance of complete and incomplete blue rings outlined with brown all over the body, dorsal/anal fins, pectoral fins, and caudal fin of the ocular side (prominent in live specimens, Fig. 36/37).

Description: A species of *Bothus* reaching a maximum standard length of 313 mm (in examined specimens). Meristic and morphometric characters are indicated in Table 22; body ovate, body depth reaching 46%–57% of SL; head length 23%– 31% of SL, head depth 37%–51% of SL; profile of head convex with notch above maxillary in males, notch lesser in females (Fig. 35); interorbital space deeply concave, greater in males, 16%–42% of HL; 8–10 hourglass-shaped supracranial pterygiophores, 13–14 dorsal-fin pterygiophores before first elongated neural spine; strong spine on snout present in males,

absent in females, rarely spines on orbitals; mouth 18%–33% of HL on ocular side, blind side 21%–32%; teeth shape conical, organized in two incomplete rows; 6–9 gill-rakers on lower limb of first gill arch, 0–2 gill-rakers on upper limb of first gill arch; lateral line with 79–95 scales, usually ending in bifurcated supratemporal branch of lateral line; scales slightly ctenoid on ocular side, cycloid on blind side; pectoral-fin rays asymmetrical and longer in males with 9–12 on ocular side and 8–12 on blind side; ocular-side pectoral-fin rays greatly extended 14%–60% of SL, blind side shorter 12%–14% of SL, greater in males; 91–97 dorsal-fin rays, 69–78 anal-fin rays, 16–17 caudal-fin rays; 10 precaudal vertebrae, 29–30 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: Ocular-side of body brown in preserved specimen (Fig. 35), with blind side pale tan; distinct blue incomplete rings or blotches encompassed with dark brown pigmentation, the size of eye or larger located throughout body; smaller blue blotches located on dorsal, anal and caudal fins; ocular-side pectoral fin has white/blue pigmentations present; two dark blotches on lateral line; anterior blotch located posterior to base of pectoral fin, posterior blotch located just posterior to mid-section of body but anterior to caudal peduncle (Fig. 35, 36, 37); other dark pigmentation found as symmetrical blotch patterns around edges of body ; blind side without pigmentation; important to note that pigmentation of distinct blue blotches does degrade over time in formalin (see Appendix B for definitions of pigmentation).

Figure 36. Distinct blotch pattern unique to *Bothus lunatus*, BMNH 1920.12.22.196, Adult male 160.91 mm SL: Showing distinct incomplete rings with blue pigmentation outlined with brown all over body in preserved specimen.

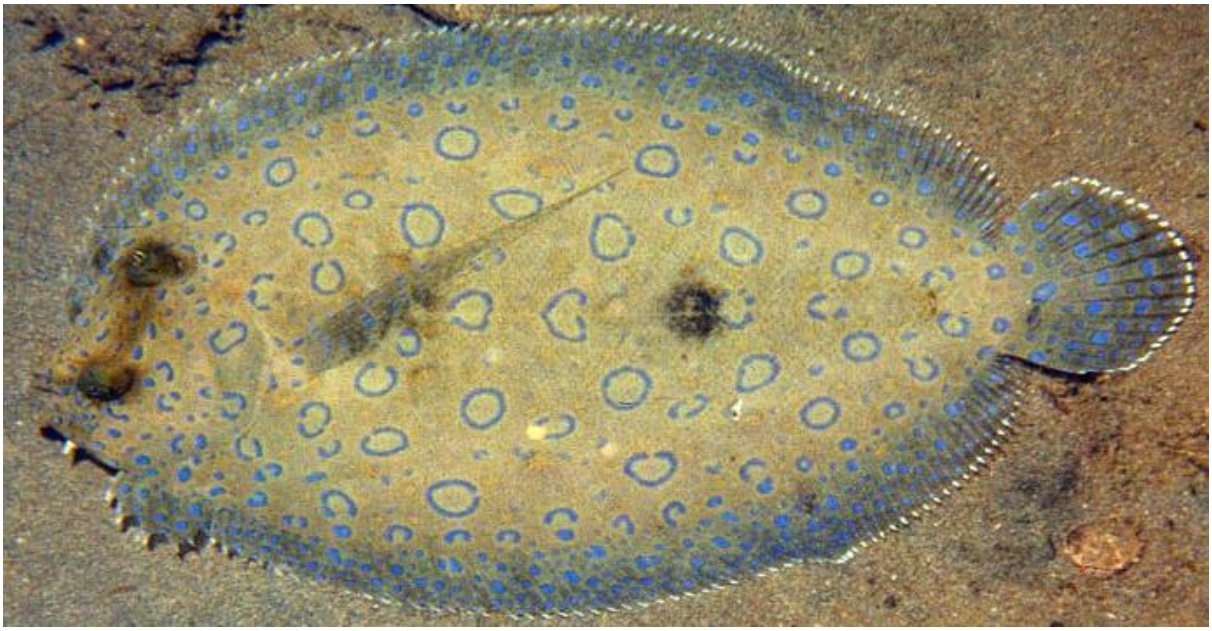


Figure 37. Photograph of live *Bothus lunatus*. Location: Crashboat Landing Pier, Puerto Rico. Taken by Richard Bejarano. Depicting distinct complete/incomplete rings with blue pigmentation outlined with brown all over body and fins in live specimens.

Table 22. Meristic and morphometric data for the type description, non-type specimens of *Bothus lunatus,* and synonym species *Pleuronectes lunulatus* ANSP 124056. Data for *Bothus lunatus* was obtained from original species description (Linneaus, 1758), and compared against non-type material (n=13, 6 male, 7 female) of *Bothus lunatus* and *Pleuronectes lunulatus*. Non-type specimen *Pleuronectes lunulatus* ANSP 124056 has been included as a junior synonym of *Bothus lunatus*. Means and standard deviations are shown in parenthesis All measurements and abbreviations are described in Appendix B.

	B. lunatus Linneaus 1758 Translated Description	*B. lunatus* non-type specimens (n=13)	*Pleuronectes lunalatus* ANSP 124056, (non-type synonym of *B. mancus*)
Standard length	245	73.33-313. (202.93;68.6)	67.27
Total length	290	87.73-371.05 (238.69;82.31)	82.36
Counts			
Dorsal-fin ray	87	91-97 (93.09;1.81)*	82
Anal-fin ray	69	69-78 (73.15;2.61)	62
Caudal-fin ray		16-17 (16.73;0.47)*	17
Precaudal vertebrae		10-10 (10;0)	10
Caudal vertebrae including urostyle		29-30 (29.69;0.48)	26
Hourglass shaped pterygiophores of dorsal-fin		7-8 (7.69;0.48)	10
Dorsal-fin pterygiophores anterior to first elongated neural spine		13-14 (13.69;0.48)	15
Gill rakers on lower limb of first gill arch	5 to 15	6-9 (8;1)	9
Gill rakers on upper limb of first gill arch		0-2 (0.15;0.55)	6
Dorsal-eye appendage		0-10 (3.08;3.73)	1
Ventral-eye appendage		0-9 (3.08;3.38)	1
Pectoral-fin rays o.s.		9-12 (11.23;0.93)	10
Pectoral-fin rays b.s.		8-12 (11;1.08)	9
Pelvic-fin rays o.s.		6 (6;0)	6
Pelvic-fin rays b.s.		6 (6;0)	6
Lateral-line scales	scales about 103	79-95 (86.08;4.27)*	66
Measurements			
%SL			
Body Depth	40% of SL	0.46-0.57 (0.51;0.03)	0.52
Head length	25% of SL	0.23-0.31 (0.25;0.07)	0.28
Head depth		0.37-0.51 (0.42;0.04)	0.47
Length of pectoral fin o.s.	slightly longer than maxillary	0.14-0.6 (0.31;0.17)	0.22
Length of pectoral fin b.s.		0.12-0.14 (0.13;0.01)	0.14
Length of pelvic fin o.s.	25% of HL	0.06-0.11 (0.09;0.01)	0.11
Length of pelvic fin b.s.		0.06-0.09 (0.08;0.01)	0.1
Length of base of pelvic fin o.s.		0.06-0.11 (0.08;0.01)	0.13
Length of base of pelvic fin b.s.		0.03-0.08 (0.05;0.01)	0.04
Length of first dorsal-fin ray		0.04-0.09 (0.06;0.01)	0.06
Length of first anal-fin ray		0.05-0.08 (0.06;0.01)	0.07
Depth of caudal peduncle		0.09-0.1 (0.1;0.004)	0.12
%HL			
Preorbital length		0.26-0.56 (0.42;0.08)	0.18
Postorbital length		0.18-0.6 (0.32;0.1)	0.19
Predorsal distance b.s.		0.09-0.31 (0.17;0.05)	0.13
Dorsal eye distance from anterior edge of head		0.13-0.2 (0.15;0.02)	0.12
Snout length (o.s.)		0.22-0.29 (0.25;0.02)	0.2
Snout to nostril distance (o.s.)		0.15-0.21 (0.18;0.02)	0.15
Length of mouth o.s.	43% of HL	0.18-0.33 (0.26;0.04)	0.24
Length of mouth b.s.		0.21-0.32 (0.29;0.03)	0.24
Ventral eye diameter		0.14-0.24 (0.19;0.03)	0.37
Width of dorsal orbital	5 and 1/3the length of the head	0.21-0.29 (0.26;0.02)	0.38
Interorbital Distance	narrow	0.16-0.42 (0.3;0.07)*	0.34

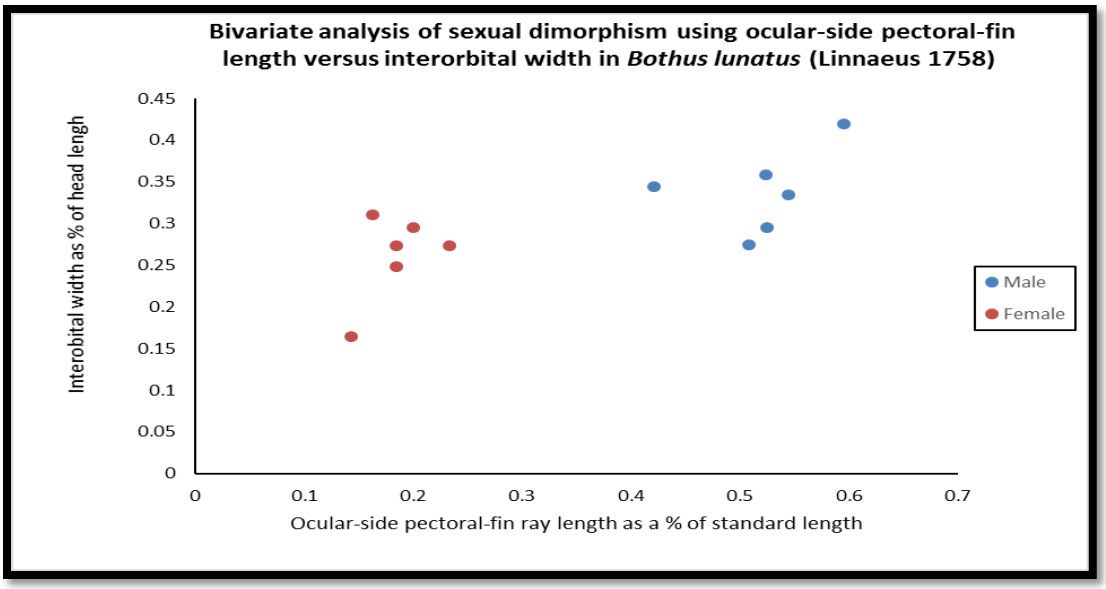
*indicates a character could not be collected for one specimen

Sexual dimorphism: Sexual dimorphism is characterized between males and females in *Bothus lunatus* (Figs. 35, 36; Table 23) by the following characters: male with prominent notch above snout, female notch less apparent; Males have strong spine on snout, females with small bump on snout; blue pigmentation more distinct in males with larger markings. Male's greater Interorbital space was found to be significant (t (11) =6.94, $p < 0.05$), whereas ocular-side pectoral-fin ray length (t (10) =7.83, $p < 0.001$) was found to be very highly significant when discriminating sex.

Table 23. Morphometric comparison and bivariate analysis of males and females of *Bothus lunatus* (Linnaeus 1758) of type and non-type material non-type material (N= 13, 6 males, 7 females), and *Pleuronectes lunulatus* ANSP 124056. Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	B. lunatus non-type specimens (n=13)		*Pleuronectes lunalatus* ANSP 124056, (newly designated synonym *of B.lunatus*)
Character	Male, n=6	Female, n=7	Male
Standard length	186.8-313 (253.76;46.26)	73.33-258 (173.81;66.49)	67.27
Count			
Number of eye appendages	7-18(14.;4.53)	0-2(1.14;1.07)	
Number of spines on orbitals	0-1(0.8;0.45)		0
Measurements			
%SL			
Head length	0.25-0.3 (0.27;0.02)	0.23-0.31 (0.27;0.02)	0.28
Head depth	0.37-0.48 (0.41;0.04)	0.37-0.51 (0.44;0.05)	0.47
Length of pectoral-fin ray o.s.	0.42-0.6 (0.51;0.06)	0.14-0.23 (0.18;0.03)	0.22
%HL			
Interorbital distance	0.27-0.42 (0.34;0.06)*	0.16-0.31 (0.26;0.05)*	0.34

*indicates a character could not be collected for one specimen



Geographic distribution: *Bothus lunatus* has been reported in North America along the Eastern Atlantic coast (Linneaus, 1758); Cuba, Sombrero, St Thomas (Jordan and Goss 1889); coast of Florida, St. Croix, Barbados, Jamaica, Tobago, West Indies (Norman 1934); as well as the Yucatan, Jamaica; Puerto Rico, Anguilla, Antigua, St. Lucia, Trinidad, Suriname, Mexico, Ascension Island (Wirtz *et al.* 2014).

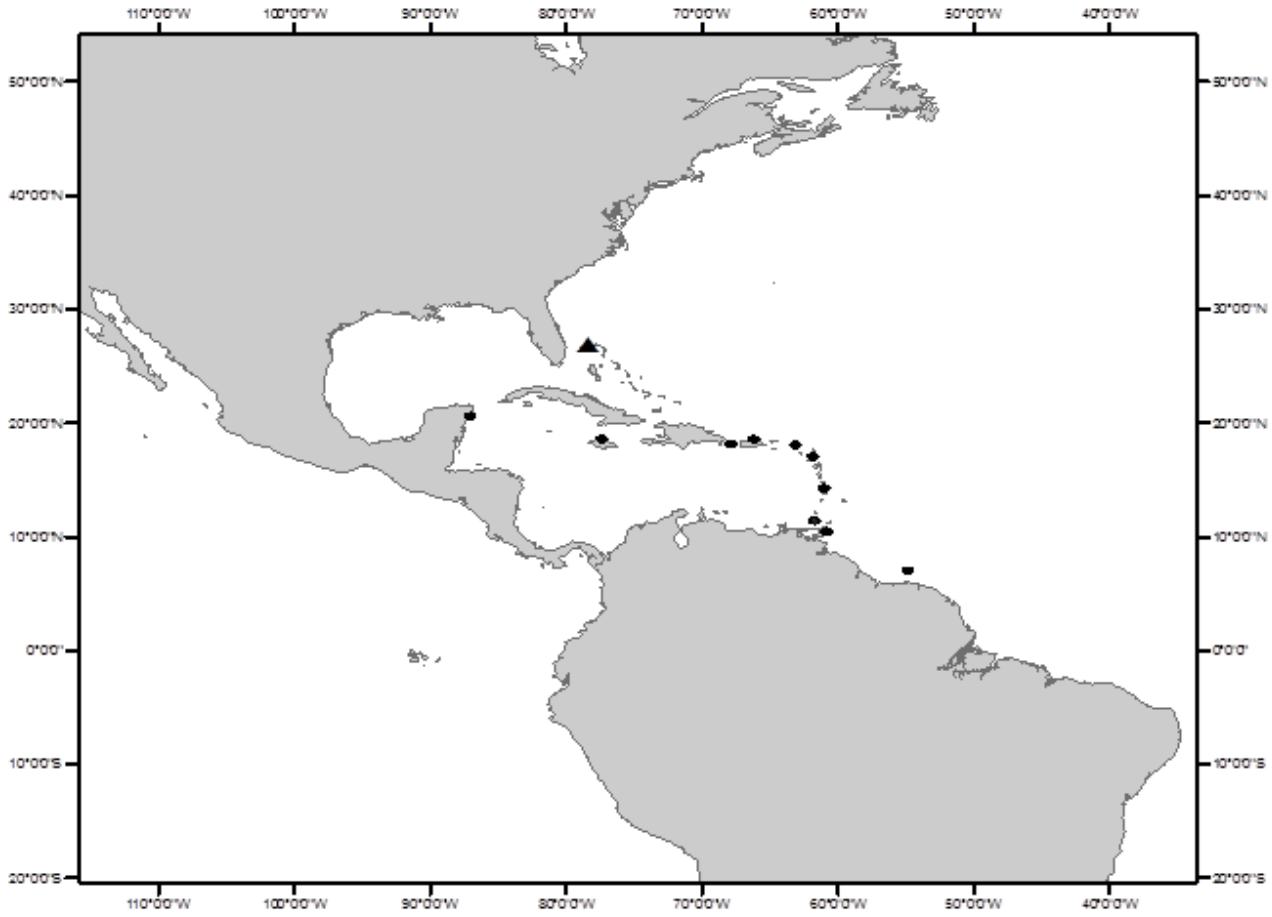


Figure 38. Geographical distribution of examined specimens of *Bothus lunatus* and *Pleuronectes lunatus* (ANSP 124056). Triangle denotes locality of examined synonym species *Bothus lunulatus* ANSP 124056. Locality of type material is stated as 'North America' with no distinct location given for the species.

Remarks: *Bothus lunatus* was first described as *Pleuronectes lunatus* Linneaus, 1758 and is currently classified as *Bothus lunatus.* Previous species believed to be synonyms of *Bothus lunatus* include *Pleuronectes surinamensis, which* was later re-classified and is now valid as *Citharichthys surinamensis* (Bloch & Schneider 1801).

Goode and Bean (1885) gave a description of *Pleuronectes lunatus* Linnaeus, 1758 based on the holotype and original specimen described of Linneaus (1758). The specimen they described matches the description of *B. lunatus* confirming that it was the holotype. The meristic and morphological data ranges from their description are consistent with species of *B. lunatus* examined in this study however, their description does not refer to the markings or pigmentations of the holotype specimen. Seeing as the obvious feature of the 'peacock flounder' (*B. lunatus*) is its unique pigmentation and blue rings, it raises questions as to how it could be missed. A possible explanation could be that they were looking at a female specimen, as markings are not as pronounced in female species of *B. lunatus*. Goode and Bean's description also notes a very close interorbital space, which is characteristic of female species of *Bothus*. This could therefore explain the absence of any pigmentation description pertaining to *B. lunatus*, as the pigmentation may have been deemed irrelevant to the description at the time.

Nichols (1921) described *Platotichthys chartes* from the Turk Islands in the Bahamas, however Norman (1934; 228) identified it as a post-larval *Bothus lunatus*. The description of *Platotichthys chartes* states a dorsal-fin ray count of 95, and an anal ray count of 73. After comparing *P. chartes* with the data compiled for *B. lunatus* in this study (Table 22), the observations show significant overlap in the dorsal and anal-fin ray counts. Therefore, *Platotichthys chartes* Nichols 1921 is deemed a junior synonym of *Bothus lunatus*.

Bloch (1783) described *Pleuronectes argus* as having "*the body blotched colorful, the tail fin round. Ocular side pectoral-fin rays 10, Blind side 8; anal-fin rays 69; caudal-fin rays 17; lateral line*

scales 79," (Bloch 1783:51). *Pleuronectes argus* has an anal-fin ray count of 69. This matches the anal-fin ray count from the description of *Bothus lunatus* (Linneaus 1758). Bloch's mention of a blotched colorful body suggests that *Pleuronectes argus* could be *Bothus lunatus* based on the presence of blue circular pigmentations throughout the body and fin rays. Jordan & Goss (1889:268) referred to *Pleuronectes argus* and state that the description is of high quality, but can only be referring to *Bothus lunatus* when comparing figures of the specimens. Therefore, *Pleuronectes argus* Bloch 1783 is deemed a junior synonym of *Bothus lunatus*.

Pleuronectes pictus Forster 1844 was stated as a synonym of *Pleuronectes spinosus* (Schneider & Forster in Bloch & Schneider, 1801), by the editor Henrico Lichtenstein (1844). *Pleuronectes pictus* is described as having 'circular blue blotches all over including the pectoral and caudal fins' which coincides with the diagnostic feature of *Bothus lunatus* (Table 22, Fig. 36, 37). Therefore, *Pleuronectes pictus* Forster, 1844 has been deemed a junior synonym of *Bothus lunatus*.

Pleuronectes lunulatus Jouan 1861 (ANSP 124056 (Tables 22, 23)), a proposed synonym of *B. mancus* is described as a species with similar characters to *Bothus mancus* and *Bothus lunatus.* Jouan does not mention any counts to help distinguish the species however, he does mention the presence of blue blotches located on the body, which is a diagnostic feature of *Bothus lunatus*. Jouan (1861) also mentions *Pleuronectes argus* in his description, which is a species that has been deemed by this study to be a synonym of *Bothus lunatus*. *Pleuronectes lunulatus* Jouan, 1861 is therefore deemed a junior synonym of *Bothus lunatus* based on the matching diagnostic features of the species (Figs. 36, 37).

Pleuronectes spinosus (Bloch & Schneider 1801:161) was described as being a synonym of *Bothus mancus*. The review of the original description revealed references to *Pleuronectes pictus* which has been designated as a synonym of *Bothus lunatus*. The original description by Bloch and Schneider describes the species as having well defined blue blotches. Therefore, based on the observations

Pleuronectes spinosis also is deemed a junior synonym of *Bothus lunatus* due to the presence of large blue blotches which match the diagnostic feature of *Bothus lunatus*.

Comparisons: *Bothus lunatus* can be distinguished from all other *Bothus* species by its distinct blue ring shape pigmentations distributed throughout the body and fins (Fig. 36). *B. lunatus* most closely resembles *Bothus mancus* based on their large body size (*B. lunatus* maximum SL of 313 mm, *B. mancus* maximum SL of 284mm), body depth (*B. lunatus* 46%–57% of SL, *B. mancus* 49%–64% of SL), and brightly coloured bodies. *B. lunatus* differs with its distinct blue pigmentations as well as the absence of a large triangular protuberance located above the maxillary, which is a key diagnostic feature of *B. mancus*. They also show a slight difference in the extension of the pectoral-fin rays in males (*B. lunatus* 42%–60% of SL, *B. mancus* 17%–38% of SL), the number of dorsal fin hourglass-shaped pterygiophores (7–8 in *Bothus lunatus,* versus 8–10 in *Bothus mancus*) and the number of dorsal-fin pterygiophores before the first elongated neural spine of the precaudal vertebrae (13–14 in *Bothus lunatus,* versus 14–16 in *Bothus mancus*). Geographically they can be distinguished as *B. lunatus* is distributed in the Atlantic Ocean, whereas *B. mancus* is distributed in the Pacific and Indian Oceans.

Bothus maculiferus (Poey, 1860)

Figures 39, 40; Tables 24, 25

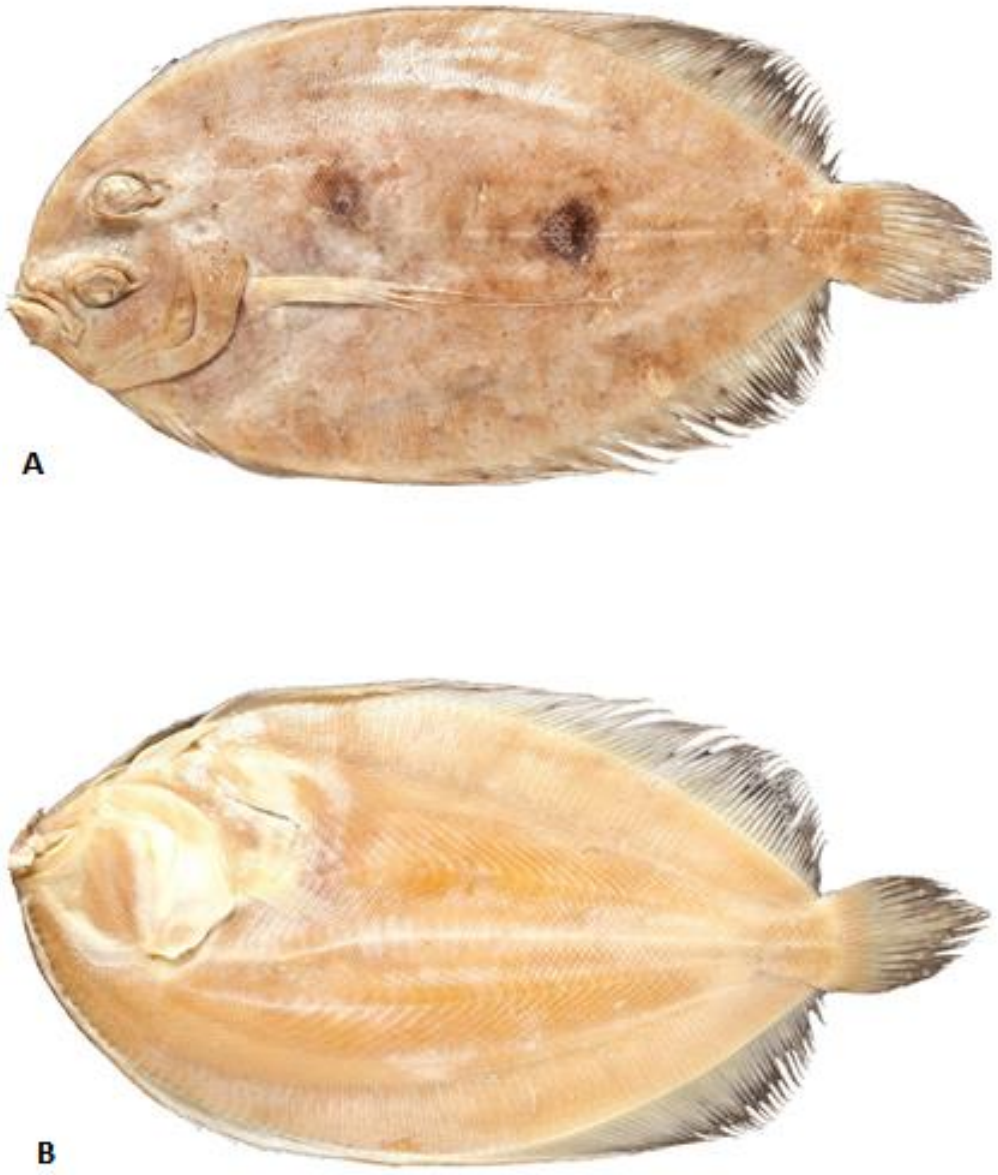


Figure 39. *Bothus maculiferus* BMNH 1931.12.5.569, non-type specimen: Adult male 183 mm SL; (A) ocular side, (B) blind side.

Synonym(s): None.

Common name(s): Maculated flounder/Mottled Flounder (English)

Material examined: *Bothus maculiferus,* 13 specimens (41.31–216 mm SL)

Type material: Syntype (2), *Pleuronectes maculiferus*, (154 mm TL), Poey (1860), Cienfuegos, Cuba: not available for examination.

Non-type material: USNM 053226 (2) (79.9-2–0.2mm SL), Bahamas, **ANSP** 126018 (108.34 mm SL), Great Bahama Bank, BMNH 1931.12.5.569 (154 mm SL), Buccoo Reef-Trinidad & Tabago, ANSP 97998 (216 mm SL), Port au Prince-Haiti, BMNH 63.8.7.15 (127 mm SL), St. Croix, USNM 081683 (144.8 mm SL), Panama, ROM 48192 (2) (57–87.1 mm SL), USNM 317341 (4) (51.77–72.14 SL), Ascension Island.

Diagnosis: A species of *Bothus* with the following combination of characters: anterior margin of the head convex with no notch above the maxillary, male pectoral-fin rays elongated 50%–58% of SL, two dark diffuse blotches along margin of lateral-line on ocular side, no distinct pigmentations on dorsal or anal-fin rays.

Description: A species of *Bothus* reaching a maximum length of 216 mm SL. Meristic and morphometric characters indicated in Table 24; Body less deep and more ovate, body depth reaching 46%–59% of SL; profile of head concave with no notch above maxillary, head length 25%– 44% of SL, head depth 28%–49% of SL; 8-9 hourglass-shaped supracranial pterygiophores; 14–16 dorsal-fin pterygiophores before first elongated neural spine; anterior edge of dorsal eye usually located above the midpoint of the ventral eye; 0–3 number of eye appendages, varying location anterior to posterior of eye; males with branching spines on anterior margin of orbitals; spine present on snout on ocular-side in males; mouth on ocular-side 17%–31% of HL, blind side mouth 19%–33% of HL; teeth shape conical, organized in two

incomplete rows; lateral line scales 78–89, ending in bifurcated supratemporal branch; ctenoid scales on ocular side, cycloid on blind side; asymmetrical pectoral-fin rays with 10–11 ocular side and 10–11 pectoral-fin rays on blind side. pectoral-fin rays longer in males, ocular-side fin rays longer 50%–58% of SL, blind side shorter 15%–26% of SL; 92–98 dorsal-fin rays, 71–77 anal-fin rays, 16–17 caudal-fin rays; 10 precaudal vertebrae, 29–30 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: Ocular-side of body brown, with blind side pale tan; presence of two dark diffuse blotches along margin of lateral line on ocular side; anterior blotch is situated at junction of straight and curved part of lateral line; posterior blotch situated on lateral line one fourth of SL from caudal peduncle (Fig. 39); brown blotches located all over the body; brown and white circular blotch patterns occurring in random location on body; dark speckles located randomly arranged, on dorsal, anal, and caudal-fin rays; pectoral and pelvic fins without pigmentation, blind side without pigmentation.

Table 24. Meristic and morphometric variables for the type and non-type specimens of *Bothus maculiferus*. Data for *B. maculiferus* holotype obtained from original species description (Poey, 1860), compared against non-type material (n=13, 4 male, 9 female). Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	B. maculiferus syntype (Poey 1860) Original Description	*B. maculiferus* non-type specimens (n=13)
Standard length	-	41.31-216 (100.62;50.72)
Total length	154	51.77-241 (118.83;56.27)
Counts		
Dorsal-fin ray	94	92-98 (94.38;01.89)
Anal-fin ray	72	71-77 (73.54;01.76)
Caudal-fin ray		17 (17;0)
Precaudal vertebrae		10 (10;0)
Caudal vertebrae including urostyle		29-30 (29.62;0.51)
Hourglass shaped pterygiophores of dorsal-fin		8-9 (8.08;0.28)
Dorsal-fin pterygiophores anterior to first elongated neural spine		14-16 (14.31;0.63)
Gill rakers on lower limb of first gill arch		7-11 (7.69;1.18)
Gill rakers on upper limb of first gill arch		0-3 (0.46;1.13)
Dorsal-eye appendage		1-3 (1.38;0.65)
Ventral-eye appendage		0-2 (1.15;0.55)
Pectoral-fin rays o.s.	12	10-11 (10.92;0.29)*
Pectoral-fin rays b.s.		10-11 (10.54;0.52)
Pelvic-fin rays o.s.	6	6 (6;0)
Pelvic-fin rays b.s.		6 (6;0)
Lateral-line scales		79-89 (84.5;3.45)
Measurements		
%SL		
Body Depth	Over half the total length	0.46-0.59 (0.55;0.03)
Head length	Over one fourth of the total length	0.25-0.44 (0.30;0.04)*
Head depth		0.28-0.49 (0.44;0.06)
Length of pectoral fin o.s.		0.15-0.58 (0.29;0.17)
Length of pectoral fin b.s.		0.11-0.21 (0.14;0.02)
Length of pelvic fin o.s.		0.09-0.14 (0.11;0.01)*
Length of pelvic fin b.s.		0.08-0.12 (0.10;0.01)*
Length of base of pelvic fin o.s.		0.10-0.12 (0.11;0.006)*
Length of base of pelvic fin b.s.		0.04-0.06 (0.05;0.01)*
Length of first dorsal-fin ray		0.06-0.09 (0.07;0.01)*
Length of first anal-fin ray		0.05-0.12 (0.08;0.02)*
Depth of caudal peduncle		0.09-0.12 (0.11;0.01)
%HL		
Preorbital length		0.20-0.36 (0.30;0.05)
Postorbital length		0.24-0.42 (0.31;0.05)
Predorsal distance b.s.		0.02-0.13 (0.09;0.03)
Dorsal eye distance from anterior edge of head		0.06-0.20 (0.15;0.05)
Snout length (o.s.)		0.14-0.27 (0.22;0.03)
Snout to nostril distance (o.s.)		0.11-0.17 (0.15;0.02)
Length of mouth o.s.		0.17-0.31 (0.26;0.04)
Length of mouth b.s.		0.19-0.33 (0.27;0.04)
Ventral eye diameter	One fourth of the head length	0.18-0.28 (0.24;0.04)
Width of dorsal orbital		0.20-0.37 (0.31;0.05)
Interorbital Distance	Equal to eye diameter	0.12-0.20 (0.16;0.03)

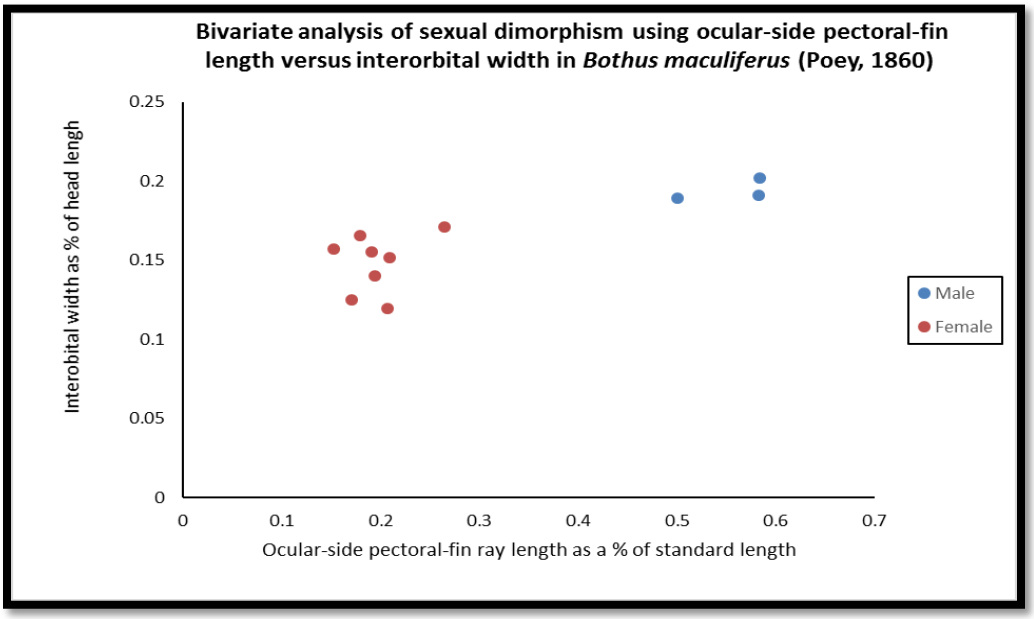
*indicates a character could not be collected for one specimen

Sexual dimorphism: Males and females of *Bothus maculiferus* (Table 25, Fig. 39) exhibit ventral-eye appendages, spines on the snout, and wide interorbital distances. Male's larger interorbital space (t (11) =6.94, $p < 0.001$), and ocular-side pectoral-fin ray lengths (t (10) =7.83, $p < 0.001$) were both found to be very highly significant when discriminating sexes.

Table 25. Morphometric comparison and bivariate analysis of males and females of *Bothus maculiferus* (Poey 1860) of non-type specimens (n=13, 9 female, 4 male). Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	B. maculiferus non-type specimens (n=13)	
Character	Male, n=4	Female, n=9
Standard length	57.02-216 (142.96;65.44)	41.31-127 (81.8;30.96)
Count		
Number of eye appendages	1-3.00 (2;0.82)	1-2 (1.11;0.33)
Number of spines on orbitals	3-7 (5;2)	
Measurements		
%SL		
Head length	0.25-0.32 (0.28;0.03)	0.29-0.44 (0.31;0.05)
Head depth	0.41-0.48 (0.45;0.04)*	0.28-0.49 (0.43;0.06)*
Length of pectoral-fin ray o.s.	0.50-0.58 (0.56;0.05)	0.15-0.26 (0.20;0.03)*
%HL		
Interorbital distance	0.19-0.20 (0.19;0.01)	0.12-0.17(0.16;0.03)

*indicates a character could not be collected for one specimen



Geographic distribution: *Bothus maculiferus* has been reported in the western Atlantic Ocean in the West Indies (Norman 1934), Caribbean Sea, Atlantic coast of South America near Brazil (Gutherz 1967), Cuba (Poey 1860), Caribbean Coast of Central America (Weinstein, M.P., Heck, K.L., Davis, R.W. 1980), Curaçao (Munroe 2003), Belize (Smith *et al.* 2003) Haiti, Trinidad & Tobago, and Panama at depth of 1-45 m.

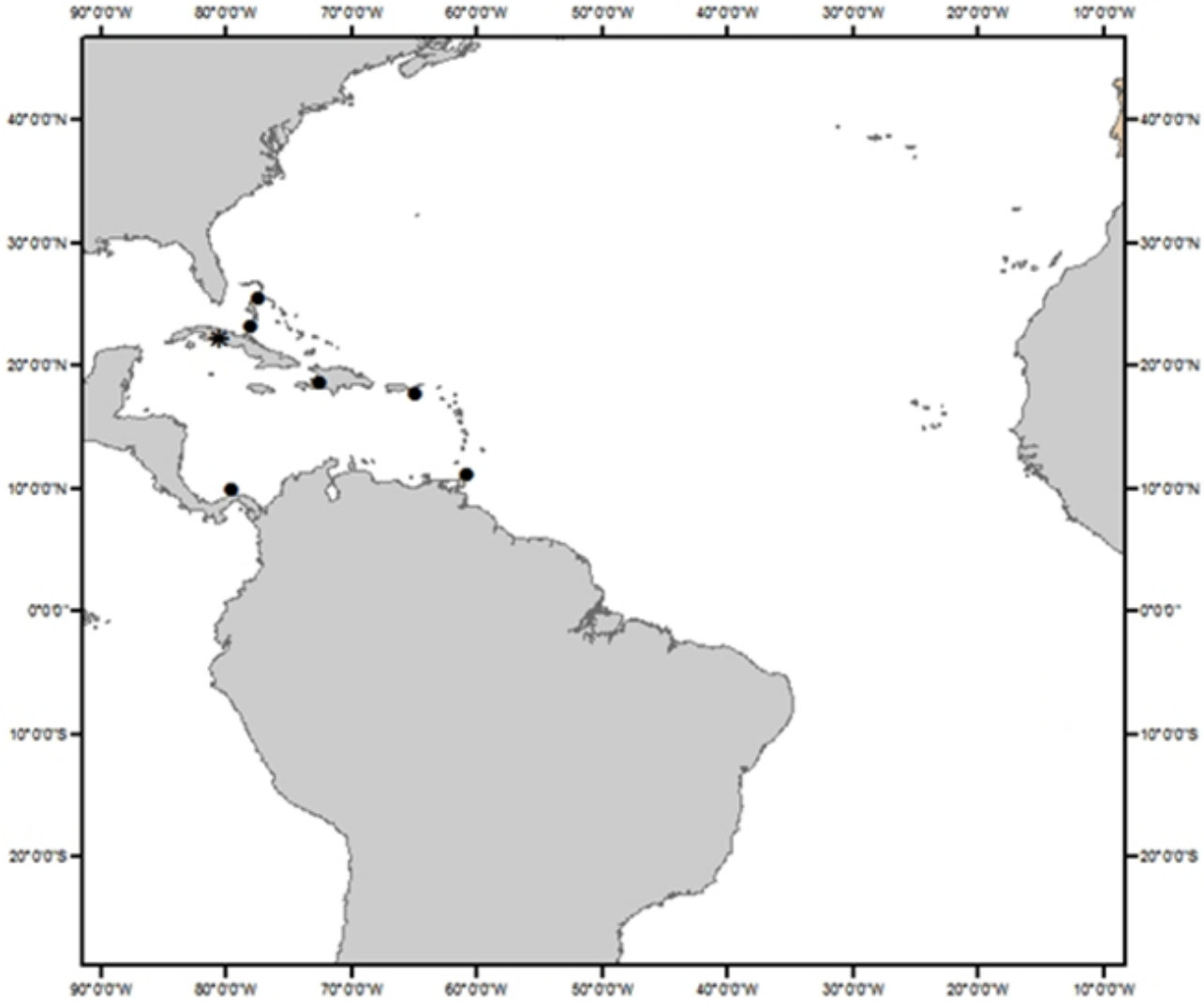


Figure 40. Geographical distribution of examined specimens of *Bothus maculiferus*. Asterisk denotes the locality of type material (*Bothus maculiferus* syntype Poey 1860, not available for examination).

Remarks: *Pleuronectes maculiferus* Poey 1860, is described as having an interorbital distance equal to the diameter of the ventral eye. It should be noted that in examined specimens the interorbital distance

is less than the ventral eye diameter (Table 24). Poey (1868) reassigned his species *Pleuronectes maculiferus* in the genus *Rhomboidichthys* where it was later redesignated as *Platoprhys maculiferus* (Jordan, 1889) before adopting its final designation by Norman (1934) as *Bothus maculiferus* (Poey, 1860).

Norman also lists *Rhomboidicthys ellipticus* as a synonym of *Bothus maculiferus* based on Jordan (Jordan 1889) with the type specimen exhibiting a dorsal-fin ray count of 104. Only *Bothus ellipticus* was recorded having 104 dorsal-fin rays according to literature and the specimens examined in this study. With the whereabouts of the type specimens unknown and no non-type specimens available, I reluctantly deem the species valid based on the dorsal-fin ray count of 104. Therefore, *Rhomboidichthys ellipticus* has been designated *Bothus ellipticus* (see description of *Bothus ellipticus*).

In Norman's (1934) monograph of flatfishes, he states that in certain specimens there was the presence of sky blue pigmentation. No specimens of examined in this study exhibited blue pigmentation, however various brown and light white/greyish spots and blotches were recorded which could explain what Norman was referring to. There is also the possibility that Norman was examining a misidentified specimen of *Bothus lunatus*.

Comparisons: *Bothus maculiferus* can be distinguished from all other species of *Bothus* by the following characters: a convex head with no notch above snout, the pectoral-fin rays in males are 50% of SL, the presence of two dark diffuse blotches along margin of lateral line on ocular side, the presence of slender eye appendages, and two large dark blotches on the lateral line of the body.

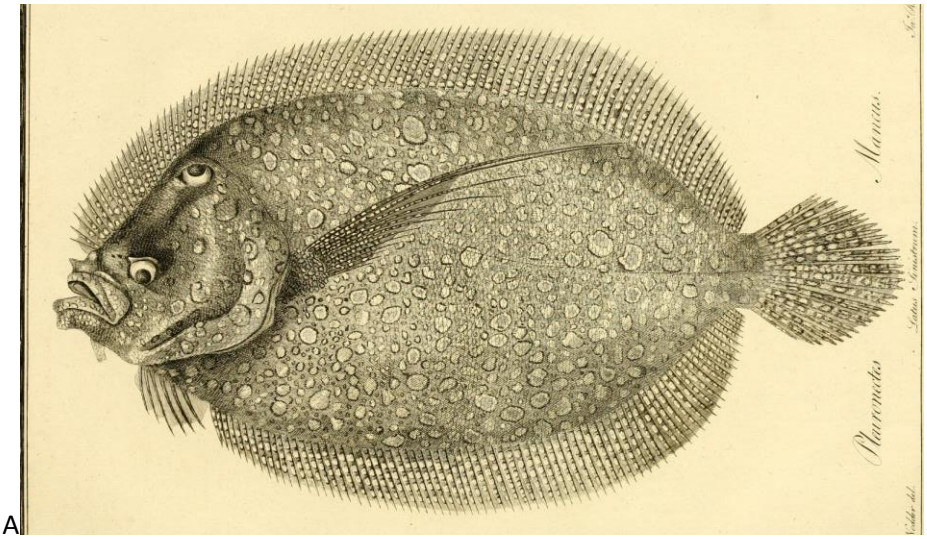
B. maculiferus most closely resembles *Bothus guibei* based on the convex anterior profile of the head with no notch above the snout, presence of spines on the snout, the body depth (*B. maculiferus* at 46%–59% of SL, *B. guibei* at 52%–54% of SL), the extended pectoral-fin ray of the ocular side, and the

presence of two diffuse blotches on the lateral line in the posterior of the body. Stauch (1966) also made reference to the close resemblance between *B. maculiferus* and *B. guibei*. As stated by Stauch (1966) the main difference between *B. maculiferus* and *B. guibei* is the number of gill-rakers on the lower limb of the first gill arch. The data observed agrees with difference in number of gill-rakers on the lower limb of the first gill arch, with *B. maculiferus* ranging from 7–11, and *B.* guibei ranging from 5–7 gill-rakers. The count of gill-rakers on the upper limb of the first gill arch also shows *B. maculiferus* having a range of 0–3 gill-rakers, while *B. guibei* has no gill-rakers. *B. maculiferus* and *B. guibei* exhibit differences in ocular-side pectoral-fin length in males with *B. maculiferus* exhibiting pectoral-fin ray ranges from 50%–58% of SL, whereas in *B. guibei* ranges from 76%–83% of SL. The most apparent difference in the morphology is the presence of two large spots in the posterior one fourth of the body on the dorsal and anal-fin rays present in *B. guibei* and absent in. The geographic distribution of the two species differs with distributed along the West Indies, whereas *Bothus guibei* is distributed along the west coast of Africa near Guinea.

Bothus mancus (Broussonet, 1782)

Figures 41 -44; Tables 26, 78

A



B

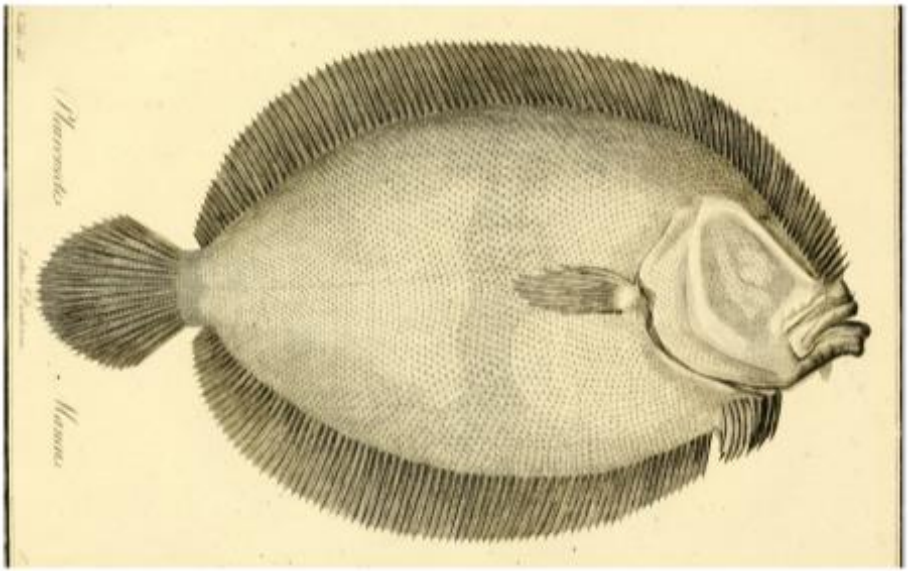


Figure 41. Original plate of *Pleuronectes mancus* Broussonet 1782 holotype, from 'Ichthyologia, sistens piscium descriptiones et icons 1782. Decas I. London. 49 unnum, pgs. 23, 25'. Depicting morphology and blotch pattern of original type specimen. Adult male from Ulietea, French Polynesia, (A) ocular side, (B) blind side.

Synonym(s): *Rhombus macropterus* Quoy & Gaimard 1824, *Rhombus parvimanus* Bennett 1832, *Rhombus pavo* Bleeker 1855, *Platophrys smithi* Rendahl 1921, *Pleuronectes barffi* Curtiss 1944

Common name(s): Flowery Flounder/ Manray flatfish/Tropical flounder/Peacock flounder (English)

Material examined: *Bothus mancus,* 20 specimens (39.93 - 284 mm SL),

Type material: None. Type lost at BMNH. Analyses based on original description: Broussonet 1782, Ichthyologia, sistens piscium descriptiones et icones. Decas I. London. 49 unnum. pages, incl. i-iv., Unnum. Pls. 1-11.

Non-type material: USNM 012684 (130.39 mm SL), Madeira; USNM 280219 (39.93 mm SL), Hawaii; ANSP 91834 (208 mm SL), Hawaii; ANSP 114274 (4) (74.98 - 79.04 mm SL), Saipan; SMF 6002 (204 mm SL), Marshall Islands; SMF 19902 (97.38 mm SL) , Nikobar Islands; SMF 5995 (264 mm SL), Sri Lanka; USNM 282625 (2) (133.1-205 mm SL), Howland Island; ROM 40488 (2) (150.12-178 mm SL), Maldives; ANSP 82858 (101.52 mm SL), Hensley (1937), French Polynesia; BPBM 10734 (55.52 mm SL), Vanuata; ROM 38220 (2) (41.7 - 46.61 mm SL), Cook Islands; BPBM 39164 (60.96 mm SL) Randall (1985), Easter Island.

Diagnosis: A species of *Bothus* with the following combination of characters: large triangular protuberance on anterior of ocular-side maxillary; white blotches generally larger than ventral eye diameter with some smaller arranged randomly all over body and fins (Fig. 42).

Description: A species of *Bothus* reaching a maximum standard length of 284 mm (in examined specimens). Meristic and morphometric characters indicated in Table 26; body ovate, almost tear rhomboidal, body depth reaching 49%–64% of SL; head depth 25%–32% of SL, profile of head slightly convex, anterior profile of head with large notch above snout, larger in males, lesser in females (Figs. 42,

43 A); spine on snout in some males, bump on snout on males and females; interorbital distance large and concave, 14%–32% of HL; ventral eye well in advance of dorsal eye; spine present on orbitals in some males; ventral eye diameter 8%–37% of H; 8–9 hourglass-shaped supracranial pterygiophores, 14–16 dorsal-fin pterygiophores before first elongated neural spine; mouth ocular-side 23%–33% of HL, blind side 24%—32% of HL; small bony protrusion on medial region of lower jaw; teeth shape conical, oriented medially, organized in two incomplete rows; 6–12 gill-rakers on lower limb of first gill arch, 0–4 gill-rakers on upper limb of first gill arch; lateral line with 75–99 scales, extending from base of caudal-fin ending posterior to dorsal eye orbit, ending in trifurcated or bifurcated supratemporal branch of lateral line system; scales slightly ctenoid on ocular side, cycloid on blind side; asymmetrical pectoral-fin rays with 10–13 on ocular side and 10–12 on blind side; ocular-side pectoral-fin rays greatly extended and filamentous at 17%–38% of SL (in specimens observed in this study), or extended to caudal peduncle (Fig. 42) , blind side shorter 12%–15% of SL; 87–103 dorsal-fin rays, 66–82 anal-fin rays, 16–18 caudal-fin rays; 10–11 precaudal vertebrae, 28–30 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: Ocular-side of body light brown tan (Fig. 42), with blind side pale white; white blotches with encompassing dark pigmentation distributed throughout body, usually the size of the ventral eye; smaller white blotches located on dorsal, anal, and caudal fins; two dark brown blotches in lateral line, anterior blotch located at junction of lateral line curve, posterior blotch located in posterior one third (Fig. 42); blind side without pigmentation. Live specimens exhibit wide range of colours from red, blue, green, yellow and white.

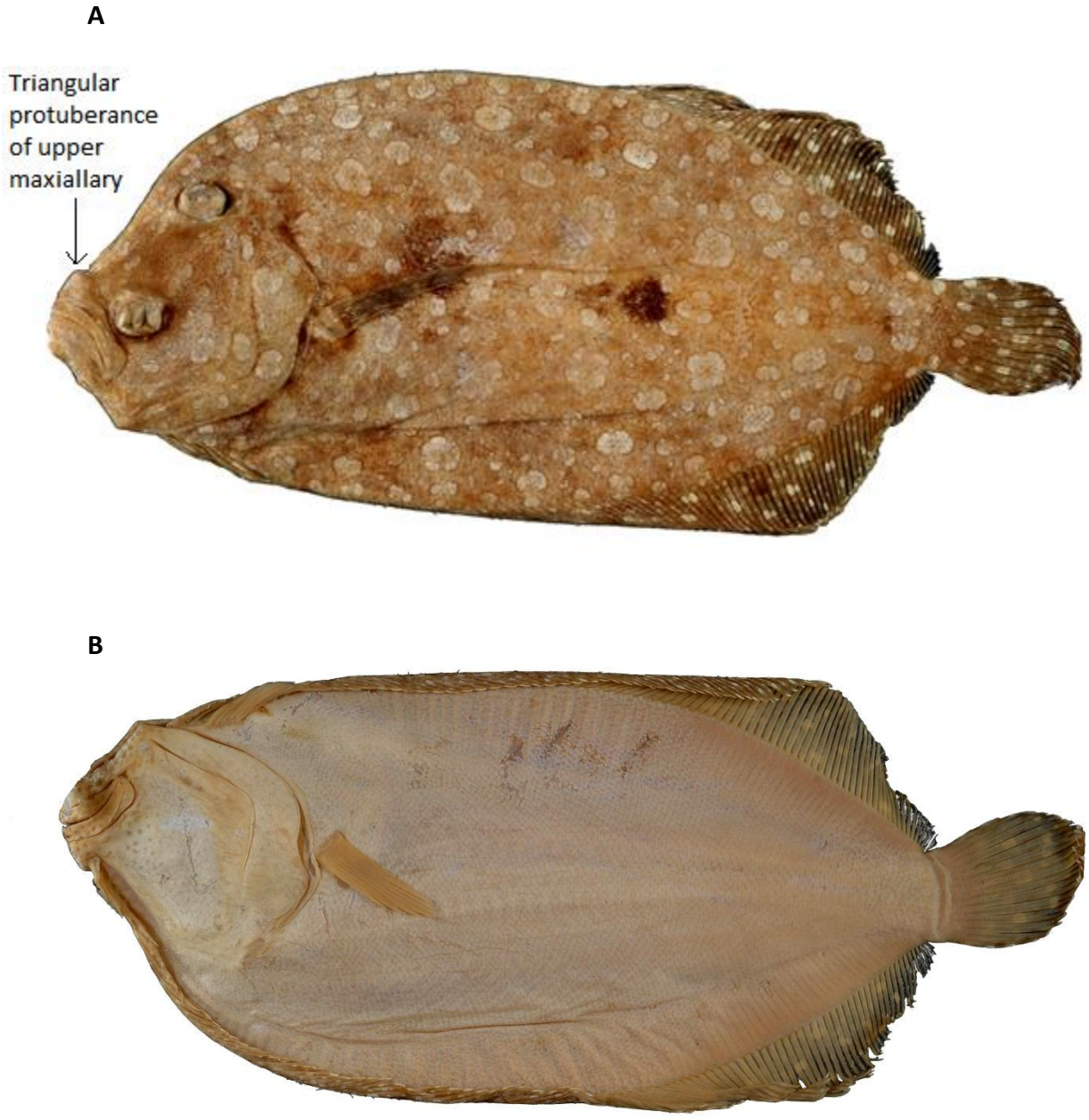


Figure 42. *Bothus mancus* (Broussonet 1782) from SMF 6002 non-type specimen. Adult male, 204 mm SL, from Pacific Marshall Islands, Bikini Atoll, Nama Inlet; (A) ocular side, exhibiting triangular protuberance of upper maxillary unique to *B. Mancus*, (B) blind side.

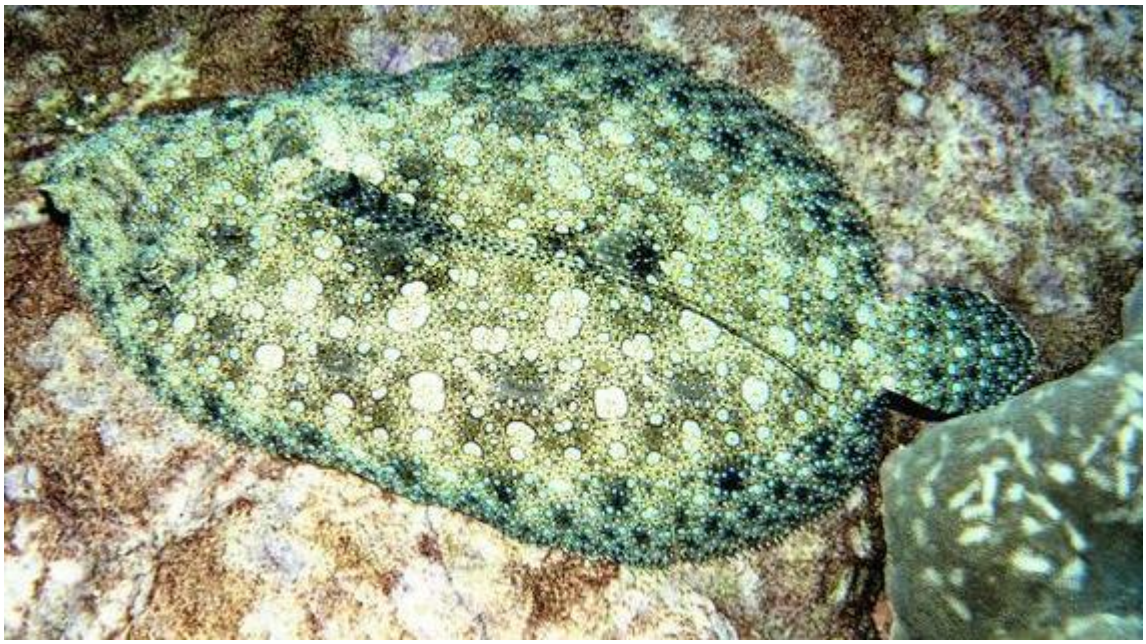


Figure 43. Female *Bothus mancus* (SMF 6000-2) (**A**); Image of live *Bothus mancus* exhibiting colourful pigmentation pattern and greatly extended filamentous pectoral-fin rays of the ocular side (**B**). Photo from Gerald Allen, taken at Clipperton Island off the West Coast of Mexico.

Table 26. Meristic and morphometric data for the type description and non-type specimens of *Bothus mancus*. Data for *Bothus mancus* was obtained from original species description (Broussonet 1782), and compared against non-type material (n=19, 5 male, 14 female). All measurements and abbreviations are described in Appendix B.

	Broussonet 1782 original description	*B. mancus* non-type specimens (n=19)
Standard length		39.93-284 (118.2;69.57)
Total length		40.13-350 (139.04;86.4)
Counts		
Dorsal-fin ray	94	87-103 (97.67;4.77)*
Anal-fin ray	80	66-82 (75.94;4.49)*
Caudal-fin ray	17	16-18 (17;0.34)
Precaudal vertebrae		10-11 (10.12;0.33)*
Caudal vertebrae including urostyle		28-30 (28.88;0.7)*
Hourglass shaped pterygiophores of dorsal-fin		8-9 (8.22;0.43)*
Dorsal-fin pterygiophores anterior to first elongated neural spine		14-16 (15.06;0.64)*
Gill rakers on lower limb of first gill arch		6-12 (9.44;1.76)*
Gill rakers on upper limb of first gill arch		0(0;0)*
Dorsal-eye appendage		0-2 (0.33;0.69)*
Ventral-eye appendage		0-1 (0.28;0.46)*
Pectoral-fin rays o.s.	13	10-13 (11.67;0.77)*
Pectoral-fin rays b.s.	12	10-12 (11.11;0.9)*
Pelvic-fin rays o.s.	6	6 (6;0)*
Pelvic-fin rays b.s.		6 (6;0)*
Lateral-line scales		75-89 (83.27;3.79)*
Measurements		
%SL		
Body Depth		0.49-0.64 (0.56;0.03)
Head length		0.25-0.32 (0.29;0.02)
Head depth		0.36-0.55 (0.45;0.05)*
Length of pectoral fin o.s.		0.17-0.38 (0.21;0.06)
Length of pectoral fin b.s.		0.12-0.15 (0.14;0.01)
Length of pelvic fin o.s.		0.08-0.15 (0.1;0.02)*
Length of pelvic fin b.s.		0.07-0.11 (0.09;0.01)*
Length of base of pelvic fin o.s.		0.08-0.12 (0.1;0.01)*
Length of base of pelvic fin b.s.		0.03-0.06 (0.05;0.01)*
Length of first dorsal-fin ray		0.04-0.08 (0.06;0.01)*
Length of first anal-fin ray		0.06-0.08 (0.07;0.01)*
Depth of caudal peduncle		0.05-0.12 (0.11;0.01)
%HL		
Preorbital length		0.11-0.44 (0.37;0.08)
Postorbital length		0.11-0.44 (0.32;0.08)
Predorsal distance b.s.		0.05-0.18 (0.14;0.03)
Dorsal eye distance from anterior edge of head		0.05-0.19 (0.15;0.03)
Snout length (o.s.)		0.07-0.27 (0.22;0.04)
Snout to nostril distance (o.s.)		0.03-0.2 (0.17;0.04)
Length of mouth o.s.		0.23-0.33 (0.28;0.02)
Length of mouth b.s.		0.24-0.32 (0.29;0.02)
Ventral eye diameter		0.08-0.29 (0.21;0.05)*
Width of dorsal orbital		0.09-0.33 (0.26;0.05)*
Interorbital Distance		0.14-0.32 (0.23;0.07)*

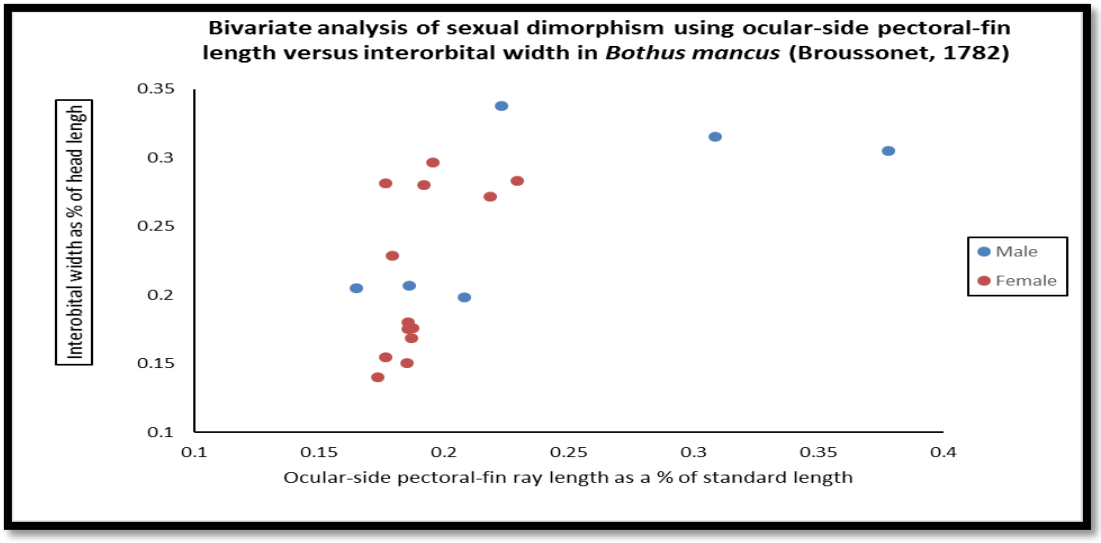
*indicates a character could not be collected for some specimens
Blank space indicates where data could not be obtained

Sexual dimorphism: Sexual dimorphism is characterized between males and females in *Bothus mancus* (Table 27) by the following characters; some males with spine snout; some males with spines on anterior of orbits, pigmentation more distinct in males. Neither interorbital distance or ocular side pectoral fin-ray length were found to be significant when discriminating sex of the species in this study, as the sample size was too small, compounded by the presence of juveniles (overlapping male/female plots presented on the bivariate analysis). Males do exhibit more pronounced sexual dimorphism as maturity progresses and can be acknowledged by the male plots (outliers) with larger interorbital lengths and extended pectoral fins in the bivariate analysis. Images of male specimens with elongated ocular-side pectoral-fins are located in Fig. 42, 43).

Table 27. Morphometric comparison and bivariate analysis of males and females of *Bothus mancus* (Broussonet 1782) of non-type material (N= 19, 5 males, 14 females). Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	B. mancus non-type specimens (n=19)	
Character	Male, n=5	Female, n=14
Standard length	79.04-284 (149.19;80.72)	41.7-208 (110.77;59.98)
Count		
Number of eye appendages	0-3 (1.2;1.3)	0-2 (0.38;0.77)
Number of spines on orbitals	0	
Measurements		
%SL		
Head length	0.28-0.31 (0.3;0.01)	0.25-0.99 (0.34;0.19)
Head depth	0.38-0.44 (0.41;0.02)*	0.36-0.55 (0.46;0.05)*
Length of pectoral-fin ray o.s.	0.17-0.38 (0.25;0.09)*	0.17-0.23 (0.19;0.02)*
%HL		
Interorbital distance	0.2-0.32 (0.25;0.06)*	0.05-0.3 (0.2;0.08)*

*indicates a character could not be collected for one specimen



Geographic distribution: *Bothus mancus* has a wide distribution in the Pacific Ocean, Indian Ocean, and Red Sea. It has been specifically reported in: French Polynesia (Broussonet, 1782); Chins, Samoa, Tahiti, Loyalty Islands, Ponape, Christmas Island, West Coast of Mexico (Norman 1934); Okinawa Islands, Japan (Amaoka), New Caledonia (Fricke, R. and M. Kulbicki, 2006), East Indies (Allen and Erdmann, 2012), Indonesia (Allen and Adrim, 2003), Galapagos Archipelago (McCosker and Rosenblatt 2010), Tonga (Randall, *et al.* 2004), China- Beijing (Li and Wang 1995), Mozambique Channel (Fricke, Darville, Bernarda, Borza, Mouthed, and P. Cabinet 2013), Chaos Archipelago (Winterbottom, Emery, and E. Holm 1989).

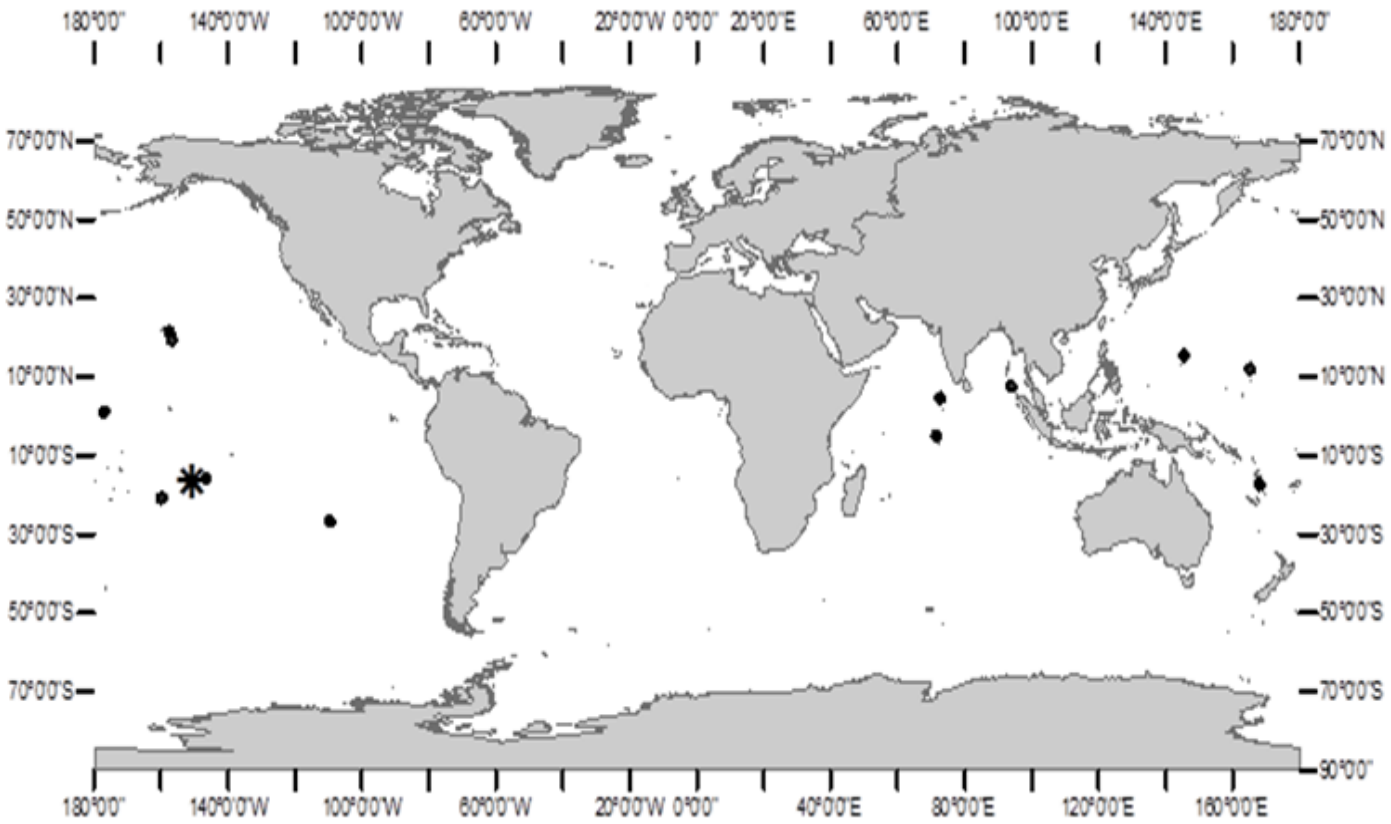


Figure 44. Geographical distribution of examined specimens of *Bothus mancus*. Asterisk denotes the locality of type material of *Bothus mancus* Holotype from Broussonet 1782.

Remarks: *Bothus mancus* was first described from a specimen taken from the Pacific Ocean. Broussonet (1782) described a new species based on several specimens that were later transferred to MNHN and are now lost (Desoutter, Chapleau, Munroe, Chanet, and Beaunier, 2001). The holotype specimen is depicted on plates three and four of Broussonnet (1782) 'Ichthyologia*, sistens piscium descriptiones et icones. Decas I*' (Fig. 41).

Bothus mancus was first described as *Pleuronectes mancus* Brousonnet 1782. Previous reclassifications, divisions, and designations of *Pleuronectes*, *Rhombus*, *Platophrys*, and *Rhomboidichthys* leave the original *Pleuronectes mancus* as *Bothus mancus* (Brousonnet 1782). The current synonym species are as follows: *Pleuronectes barffi* Curtis 1944; *Rhombus macropterus* Quoy & Gaimard 1824; *Rhombus parvimanus* Bennett 1832; *Rhombus pavo* Bleeker 1855; *Platophrys smithi* Rendahl 1921. *Pleuronectes lunulatus* Joaun 1861 and *Pleuronectes* spinosus were both previously designated as synonyms of *Bothus mancus* however, they have been deemed junior synonyms of *Bothus lunatus* (see pg. 106).

Pleuronectes barfii Curtiss, 1944 was based on a specimen having 101 dorsal-fin rays and a total length of 317.5 mm, which is larger than most specimens examined however, the counts are still consistent with the ranges found within the specimens of this study (Table 26). *P. Barffi* has also been listed as a synonym of *Bothus mancus* in Hensley & Amaoka (2001) however, they do not define why. Therefore, *Pleuronectes barfii* is classified as a synonym *Bothus mancus* until further evidence is presented.

Rhombus macropterus Quoy & Gaimard 1824 was described as having extended pectoral-fin rays comparable to that of *B. mancus*. *R. macropterus* was stated as being distinct from *B. mancus* because of its more oval body shape like that of a sole, and the smooth anterior profile of the head contrasting the more circular and notched profile of *B. mancus*. Lastly, *R. macropterus* was described as

have a blue hue with irregular round spots on the back. This could be describing a species of *Bothus lunatus* because of blue ring shaped pigmentations unique to the species however, the description does not state whether there are distinct blue rings or just a blue hue to the skin. Some live specimens of *B. mancus* do exhibit a blueish hue however, they do not exhibit defined blue rings. This specimen was also collected off the East coast of Malasia where as *B. lunatus* is distributed in the West Indies. These differences suggest that the species being described is not *B. lunatus*. *R. macropterus* was also described as exhibiting 40 dorsal-fin rays and slightly over 30 anal-fin rays, which is not seen in any other species of *Bothus*. The specimen was stated as lost in the text and was described from a photo, which is no longer available. Thus, based on current knowledge, *Rhombus macropterus* Quoy & Gaimard 1824 should be deemed a synonym of *Bothus mancus.*

Rhombus parvimanus Bennett, 1832 was described as sinistral with a deep and wide interorbital distance, having 10 dorsal-fin rays, and grey pigmentation spots all over it. The pectoral-fin ray count and the pigmentation coincide with the current meristic values (Table 26) and pigmentation characters (Fig 42) used to describe *Bothus mancus* in this study. Therefore, I conclude that *Rhombus parvimanus* be deemed a junior synonym of *Bothus mancus*.

Rhombus pavo Bleeker, 1855 was described a species with a body depth of two and one fifths in the SL; gill-rakers on lower limb of first gill arch 6; dorsal-fin ray count of 99, anal-fin ray count of 76; ocular-side pectoral ray count of 12, blind side 11; 100 scales in LL. The morphometric and meristic data from the original description coincide with the results observed in the current study (Table 26); therefore, based on the observations I deem *Rhombus pavo* Bleeker, 1855 a junior synonym of *Bothus mancus*.

Platophrys smithi (Rendahl 1921) was based on a literature description of *Platophrys mancus* in Smith and Swain (1882:142). The description of *Platophrys mancus* in Smith and Swain (1882) state a

triangular protuberance on the anterior to the maxillary on the ocular side, a grey mottled pigmentation pattern, an elongated pectoral fin, 98 dorsal-fin rays, 78 anal-fin rays, and 95 scales in the lateral line which coincide with the designated values and pigmentation description of *Bothus mancus* (Broussonet 1782). Therefore, *Platophrys smithi* Rendahl, 1921 is deemed as a junior synonym of *Bothus mancus*.

Comparisons: *Bothus mancus* can be distinguished from all other species of *Bothus* with the presence of a large triangular protuberance above the maxillary on the ocular side, greatly extended filamentous pectoral-fin rays of the ocular side, its white blotches equal to that of ventral eye diameter, and its extremely colourful pigmentation in live specimens (Fig. 43, B). It most closely resembles *Bothus lunatus* based their similar large body size (*B. mancus* maximum SL of 284mm, *B. lunatus* maximum SL of 313 mm), body depth (B. lunatus 46%–57% of SL, B. mancus 49%–64% of SL), and brightly coloured bodies. *Bothus mancus* can be differentiated from *Bothus lunatus* with the presence of a large triangular protuberance on anterior of the ocular-side maxillary, 8–9 hourglass-shaped pterygiophores in *B. mancus* versus 7–8 pterygiophores in *B. lunatus*, the number of dorsal-fin pterygiophores before the first elongated neural spine of the precaudal vertebrae is 14–16 in *B. mancus* versus 13–14 in *B. lunatus*, and *B. mancus* is covered with distinct white or grey pigmentation scattered throughout the body and fin rays, where *Bothus lunatus* has well defined blue rings in most cases. Finally, the geographic distribution of both species is well documented and differs significantly. *B. lunatus* is distributed in the Atlantic Ocean from the coast of Florida through the West Indies and into the East Coast of Suriname, whereas *B. mancus* has been documented in the Pacific, Indian, East Indian Ocean, Red Sea, and French Polynesia but never in the Atlantic.

Bothus mellissi Norman, 1931

Figures 45 - 48; Tables 28, 29

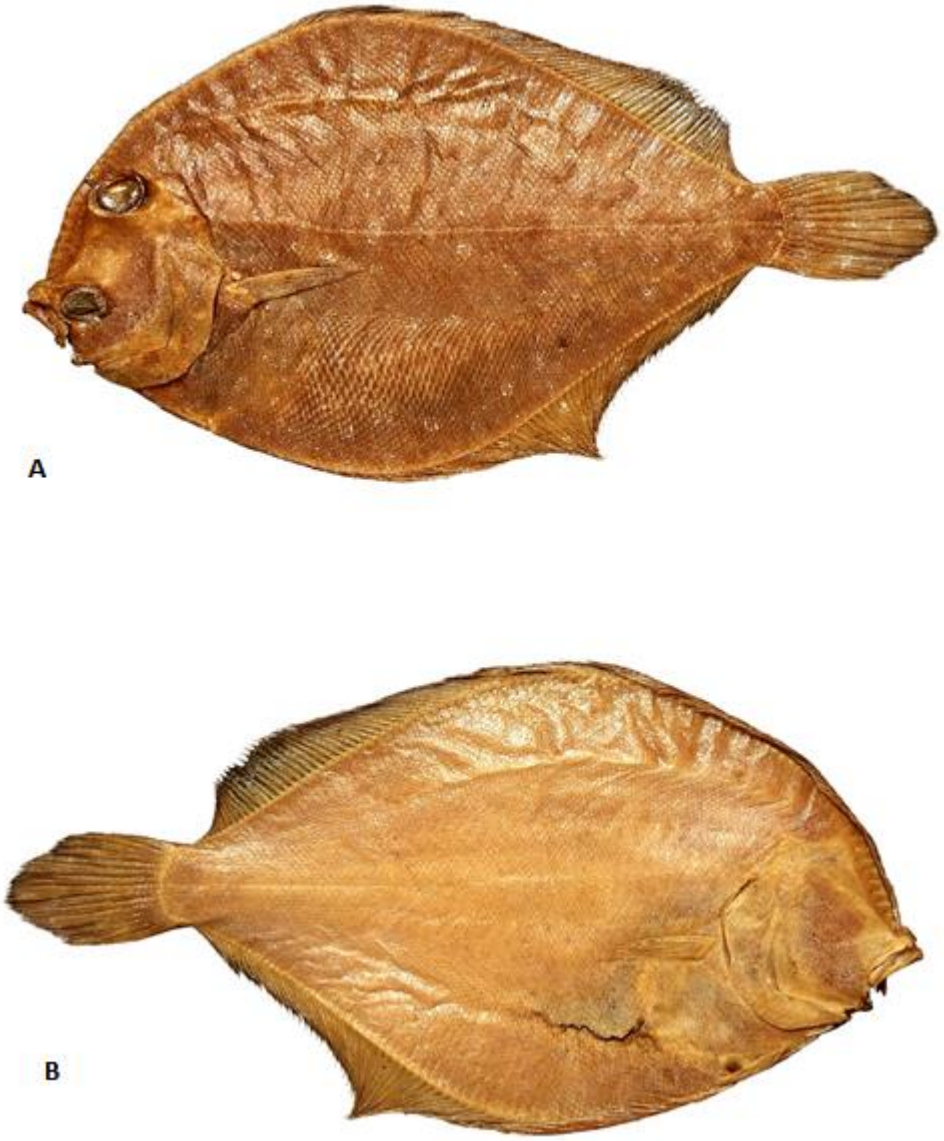


Figure 45. *Bothus mellissi* Norman 1931, BMNH 1867.10.8.52-4 holotype. (A) Ocular and (B) blind side of adult female, 179 mm SL, from Ascension Islands, St. Helena.

Synonym(s): None.

Common name(s): St. Helena Flounder

Material examined: *Bothus mellissi,* 13 specimens (134.36 - 187.21 mm SL)

Type material: Holotype BMNH 1867.10.8.52-4 (179 mm SL), Ascension Island; Paratype BMNH 1908.7.24.15 (171.13 mm SL), Ascension Island; BMNH 1867.10.8.52-4 (3) (149.38-163.54 mm SL), Ascension Island; BMNH 1910.9.9.22-8 (7) (134.36-178 mm SL), Ascension Island.

Non-type material: USNM 267877 (187.21 mm SL), St. Helena.

Diagnosis: A species of *Bothus* with the following combination of characters: body depth 60–66% of SL, Short pectoral fins 12%–17%of SL; uniform dark brown/black skin colour with little to no pigmentation on ocular-side (Fig. 46).

Description: A species of *Bothus* reaching a maximum standard length of 187.21 mm (in examined specimens). Meristic and morphometric characters indicated in Table 28; body moderately ovate, body depth reaching 60%–66% SL; head length 27%– 54% of SL, head depth 47%–54% of SL; anterior profile of head slopes sharply, with strong notch above snout in males, slope not as steep in females (Fig. 45,46); males with spine on snout, females with small bump; interorbital distance concave; 31%–52% of HL; spine present on orbitals of some males 0–1; ventral eye diameter 25%–28% of HL, no appendages located on either eye; 9–10 hourglass-shaped supracranial pterygiophores, 15–16 dorsal-fin pterygiophores before first neural spine; mouth ocular-side 20%–27% of HL, curving inferior to anterior edge of ventral eye, blind side mouth about the same; teeth shape conical, oriented medially, biserial; 8–13 gill-rakers on lower limb of first gill arch, 0–8 gill-rakers on upper portion of anterior arch; lateral line with 82–91 scales, ending in trifurcated or bifurcated supratemporal branch; scales ctenoid on

ocular side, cycloid on blind side; asymmetrical pectoral-fin rays with 11–13 on ocular side and 8–12 on blind side; ocular-side fin rays longer 13%–19% of SL, blind side 12%—17%, no rays greatly extended; 91–95 dorsal-fin rays, 68–75 anal-fin rays, 17 caudal-fin rays; 10 precaudal vertebrae, 29–30 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: Ocular-side of body tan, dark brown or black (Figs. 45, 46), with blind side pale yellowish; sometimes minute rings of small white speckles on body, anal, dorsal, and caudal rays; small white speckles located on fringes of ventral and dorsal eyes; species proposed to have extremely dark bodies due to the volcanic substrate in which they inhabit at St. Helena and Ascension Islands (Cunningham 1910); blind side pectoral fins and body without pigmentation.

Table 28. Meristic and morphometric data for the type and non-type specimens of *Bothus mellissi*. Data for *Bothus mellissi* was obtained from original species description (Broussonet 1782), and compared against non-type material (n=13, 6 male, 7 female). All measurements and abbreviations are described in Appendix B.

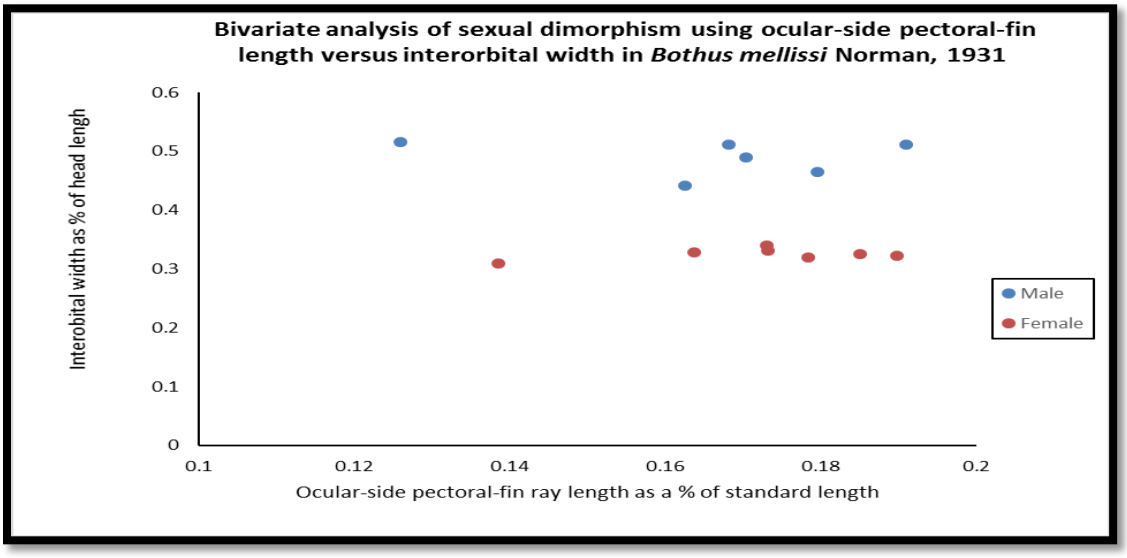
	B. mellissi	*B.mellissi*	*B. mellissi*
	BMNH 1867.10.8.52-4 holotype	paratypes specimens (n=11)	non-type specimen
Standard length	179	134.36-178 (160.24;14.51)	187.21
Total length	224	151.21-215 (195.03;20.6)	224.52
Counts			
Dorsal-fin ray	93	91-95 (93.27;1.1)	92
Anal-fin ray	72	68-75 (71.82;1.89)	69
Caudal-fin ray	17	17 (17;0)	17
Precaudal vertebrae	10	10 (10;0)	10
Caudal vertebrae including urostyle	30	29-30 (29.82;0.4)	30
Hourglass shaped pterygiophores of dorsal-f	9	9-10 (9.45;0.52)	9
Dorsal-fin pterygiophores anterior to first el	16	15-16 (15.91;0.3)	16
Gill rakers on lower limb of first gill arch	9	8-13 (10.91;1.38)	11
Gill rakers on upper limb of first gill arch	6	4-8 (6.4;1.43)	7
Pectoral-fin rays o.s.	12	11-13 (12.09;0.54)	12
Pectoral-fin rays b.s.	11	8-12 (10.82;1.08)	11
Pelvic-fin rays o.s.	6	6 (6;0)	6
Pelvic-fin rays b.s.	6	6 (6;0)	6
Lateral-line scales	88	84-91 (87.45;2.42)	82
Measurements			
%SL			
Body Depth	0.65	0.6-0.66 (0.63;0.02)	0.62
Head length	0.28	0.24-0.29 (0.26;0.01)	0.26
Head depth	0.5	0.48-0.54 (0.5;0.02)	0.47
Length of pectoral fin o.s.	0.17	0.13-0.19 (0.17;0.02)	0.17
Length of pectoral fin b.s.	0.15	0.12-0.17 (0.14;0.01)	0.15
Length of pelvic fin o.s.	0.10	0.08-0.11 (0.09;0.01)	0.09
Length of pelvic fin b.s.	0.09	0.07-0.11 (0.09;0.01)	0.09
Length of base of pelvic fin o.s.	0.1	0.08-0.11 (0.1;0.01)	0.1
Length of base of pelvic fin b.s.	0.04	0.03-0.04 (0.03;0.004)	0.03
Length of first dorsal-fin ray	0.04	0.04-0.05 (0.05;0.01)	0.03
Length of first anal-fin ray	0.07	0.05-0.08 (0.06;0.01)	0.05
Depth of caudal peduncle	0.1	0.11-0.13 (0.12;0.01)	0.12
%HL			
Preorbital length	0.4	0.14-0.44 (0.34;0.09)	0.42
Postorbital length	0.28	0.26-0.37 (0.3;0.03)	0.27
Predorsal distance b.s.	0.16	0.12-0.19 (0.15;0.02)	0.18
Dorsal eye distance from anterior edge of he	0.12	0.09-0.14 (0.11;0.01)	0.12
Snout length (o.s.)	0.16	0.16-0.21 (0.18;0.02)	0.22
Snout to nostril distance (o.s.)	0.15	0.13-0.18 (0.15;0.02)	0.18
Length of mouth o.s.	0.21	0.2-0.27 (0.23;0.02)	0.2
Length of mouth b.s.	0.27	0.23-0.29 (0.26;0.02)	0.25
Ventral eye diameter	0.25	0.25-0.28 (0.26;0.01)	0.25
Width of dorsal orbital	0.3	0.3-0.34 (0.33;0.01)	0.32
Interorbital Distance	0.33	0.31-0.52 (0.41;0.09)	0.34

Sexual dimorphism: the following characters: males generally with spine on snout; males generally with spines on anterior of orbits. Sexual dimorphism is characterized between males and females in *Bothus mellissi* (Table 29, Figs. 45, 46). Male's larger interorbital space was found to be very highly significant (t (11) =7.23, $p < 0.001$) when discriminating sex.

Table 29. Morphometric comparison and bivariate analysis of males and females of *Bothus mellissi* Norman 1931 of type and non-type material (N=13, 6 males, 7 females). Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	B. mellissi BMNH 1867.10.8.52-4 holotype (FISH 3)	*B. mellissi paratypes specimens (n=13)*		*B. mellissi* non-type specimen
Character	Female	Male, n=6	Female, n=7	Male
Standard length	179	149.38-178 (167.59;9.96)	134.36-165 (151.42;14.98)	187.21
Count				
Number of eye appendages		0-1 (0.83;0.41)		
Number of spines on orbitals				
Measurements				
%SL				
Head length	0.28	0.26-0.27 (0.26;0.01)	0.24-0.29 (0.26;0.02)	0.26
Head depth	0.50	0.48-0.54 (0.5;0.02)	0.49-0.52 (0.51;0.01)	0.47
Length of pectoral-fin ray o.s.	0.17	0.13-0.19 (0.17;0.02)	0.14-0.19 (0.17;0.02)	0.17
%HL				
Interorbital distance	0.33	0.44-0.52 (0.49;0.03)	0.31-0.33 (0.32;0.01)	0.34

Blank space indicates where data could not be obtained



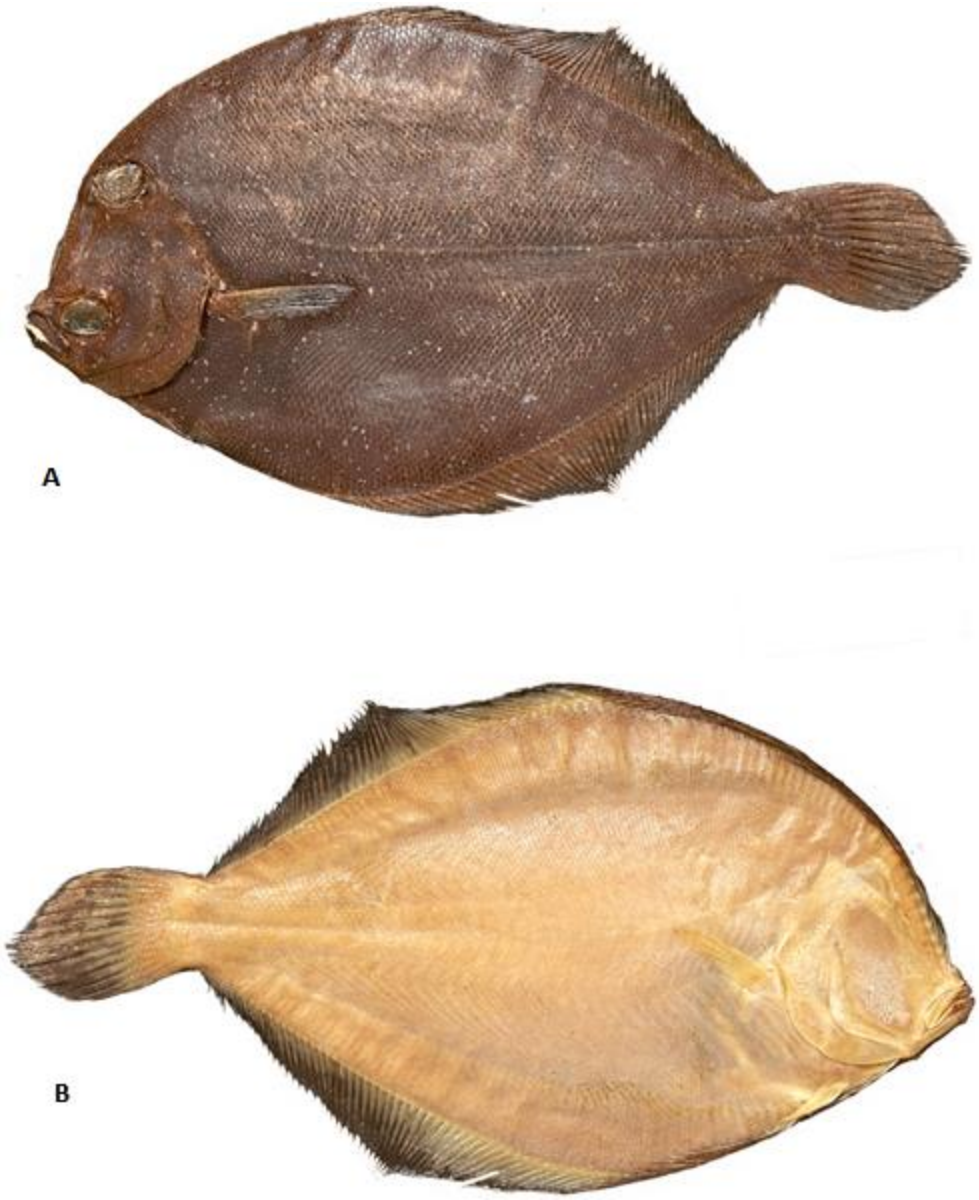


Figure 46. Morphology of male *Bothus mellissi* Norman 1931 from BMNH 1910.9.9.22-8, Paratype (specimen 3). (A)Ocular and (B) blind side of adult male 166 mm SL, from St. Helena. Depicting unique dark brown colouration of skin unique to species of *B*. *mellissi*.

Geographic distribution: *Bothus mellissi* has a specific distribution in the Atlantic Ocean specifically at St. Helena and Ascension Island.

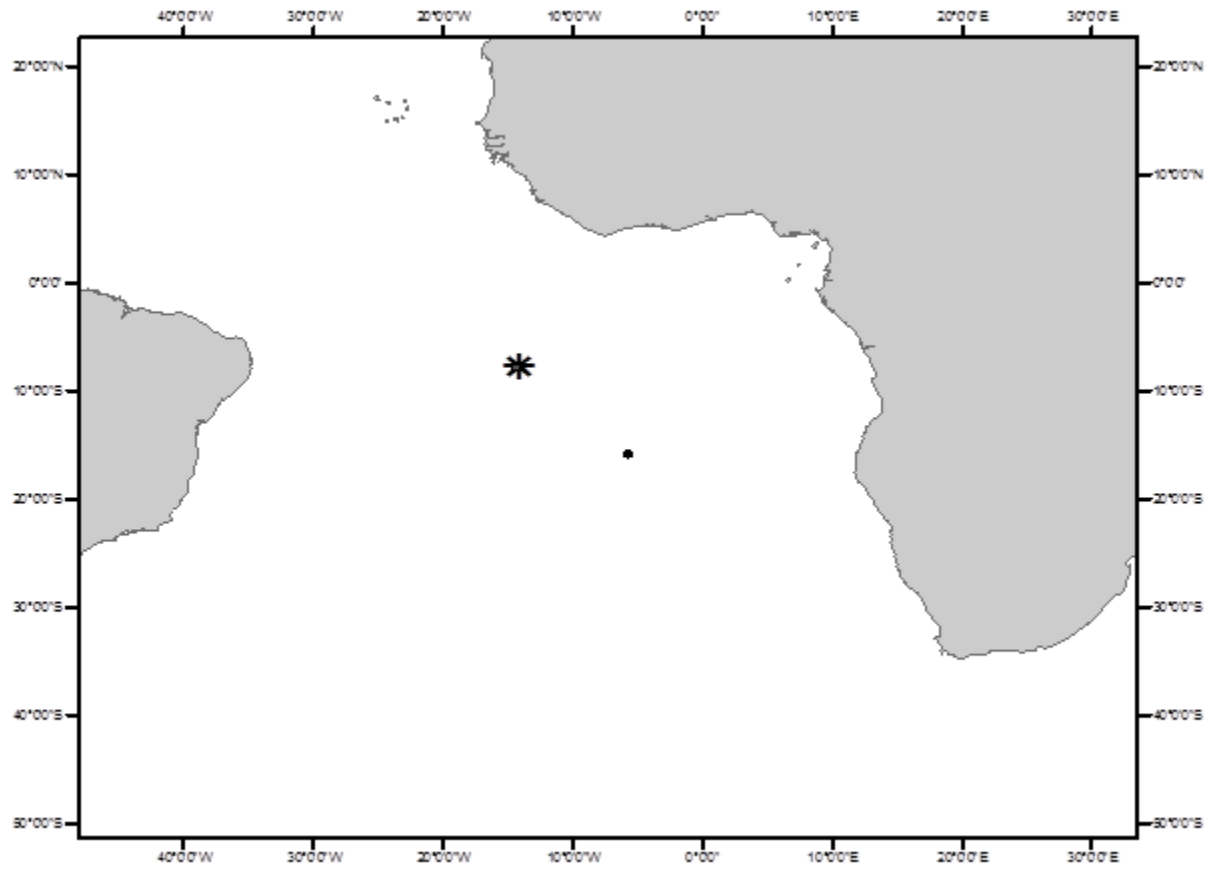


Figure 47. Geographical distribution of examined specimens of *Bothus mellissi*. Asterisk denotes the locality of type material of *Bothus mellissi* Holotype from Norman (1931); depth of 27 meters (Cunningham 1910).

Remarks: *Bothus mellissi* was first introduced by J.C. Melliss (Melliss, 1875: 109) as *Rhomboidichthys sp.* where he stated that the fish was of unimportance but was peculiar to the island of St. Helena. Cunningham (1910) then gave a full description of the *Rhomboidichthys sp.* and reclassified it as *Platophrys podas* from (Jordan and Goss, 1889) based on its resemblance to the genus at that time. Norman (1931) then clarified that the species was in fact distinct from members of *Bothus podas* due to its larger body depth (*B. mellissi* with 60%-66% of SL, *B. podas* with 44%-63% of SL), smaller eye width

(*B. mellissi* with 25%–28% of HL, *B. podas* with 8%–29% of HL), larger interorbital distance (*B. mellissi* with 31%–52% of SL, *B. podas* with 10%–67% of SL), and the dark skin colouration. With the exception of body depth, the morphological differences proposed by Norman (1934) to differentiate the species *B. mellissi* and *B. podas* present significant overlap when examining the data compiled in this study. The overlap in meristic and morphological data may be explained by species misidentification however, considering *B. mellissi* is only distributed in waters around St. Helena and Ascension Island, it is hard to believe that specimens of *B. podas* could have been misidentified as *B. mellissi* when they were collected from the West Coast of Africa or the Mediterranean. Therefore, the only real differentiating character of *B. mellissi* is the dark colouration of the skin that is supposedly unique and developed from the black volcanic substrate that the species inhabits. Taking this into account *B. mellissi* will remain as a valid species based on its larger body depth and dark, almost black skin colouration.

Of the *Bothus mellissi* paratypes listed in the collection at the BMNH, one specimen (BMNH 1908.7.24.15, labelled *Rhomboidichthys ocellatus*) exhibits curious bluish white ocelli accompanied by a vibrant blotch pattern (Fig 48). When comparing pigmentation to other paratypes of the group it is apparent that they are not the same species and resembles *Bothus lunatus*. Cunningham (1910:114) states that this curious species belongs within the genus and when comparing this specimen with meristic data of the other *B. mellissi* paratypes, they are congruent. Cunningham also states that *Rhomboidichthys sp.* and *B. mellissi* share overlapping features with other species of the genus such as *Rhombus ocellatus* Agassiz 1831 and *Pleuronectes podas* Delaroche 1809, but are still distinct because of its larger size, angle of the head profile, pigmentation, and the locality of the distribution. Based on the observations made on specimens I conclude that this specimen is a unique specimen of *B. mellissi.* The meristic data is undoubtedly congruent with *B. mellissi* species however; the greatly exaggerated pigmentation patterns are unique to this specimen. It is possible that this could be a unique species

however, the fact that *Bothus* have the ability to change skin pigmentations based on their surroundings could explain the presence of a pigmentation pattern.

Figure 48. Morphology of specimen labelled '*Rhomboidichthys ocellatus* (specimen 3), BMNH 1908.7.24.15. (A)Ocular and (B) blind side of adult male 171 mm SL, from Ascension Island. Depicting peculiar blueish rings and ocellated spot pattern.

Comparisons: *Bothus mellissi* can be distinguished from all other species of *Bothus* by its deeply ovate body at a body depth of 60–66% of SL, short pectoral-fin rays at 12%–17% of the SL, and its dark brown/black body with little to no pigmentation. *Bothus mellissi* most closely resembles *Bothus assimilis,* males of *Bothus constellatus,* males of *Bothus leopardinus,* Bothus *ocellatus,* males of *B. robinsi, and Bothus podas* based on the similar steep notched anterior profile of the head, wide interorbital distance (*B. assimilis* at 52% of HL*, B. constellatus* at 44%–52% of HL*, B. leopardinus* 48–57% of HL*,* and *B. ocellatus* of 18%–59% of HL, *B. robinsi* at 21%–69%, *B. podas* 10%–67% of HL), and general appearance. *Bothus ocellatus* and *Bothus robinsi* can be differentiated by their presence of two large horizontal (*B. robinsi*) or vertical (*B. ocellatus*) spots in the caudal fin, which is absent on *B. mellissi*. *B. ocellatus* and *B. robinsi* are also distributed along the Southern Coast of North America near Florida, whereas *B. mellissi* only inhabits the waters around St. Helena and the Ascension Islands. *B. constellatus* and *B. leopardinus* can both be distinguished by their vibrant colours and pigmentation patterns (see *B. constellatus* pg. 68, *B. leopardinus* pg. 91), whereas *B. mellissi* is generally void of colour or pigment on the ocular side. Their geographic distributions are also different with that of *B. constellatus*/*B. leopardinus* distributed in the Pacific Ocean versus the Atlantic in *B. mellissi*. *B. podas* shares the closest resemblance to *B. mellissi* and can be differentiated with by its generally smaller body depth at 44%–63% of SL, the presence of large dark spots or pigmentations on the lateral line, and the brighter skin colour. Lastly, they can be distinguished with the assistance of their geographical distribution. *B. podas* is located along the coast of Western Africa and the Mediterranean, whereas *B. mellissi* has a strict geographic distribution of St. Helena and the Ascension Islands.

Bothus myriaster (Temminck & Schlegel, 1846)

Figures 49- 55; Tables 30, 31

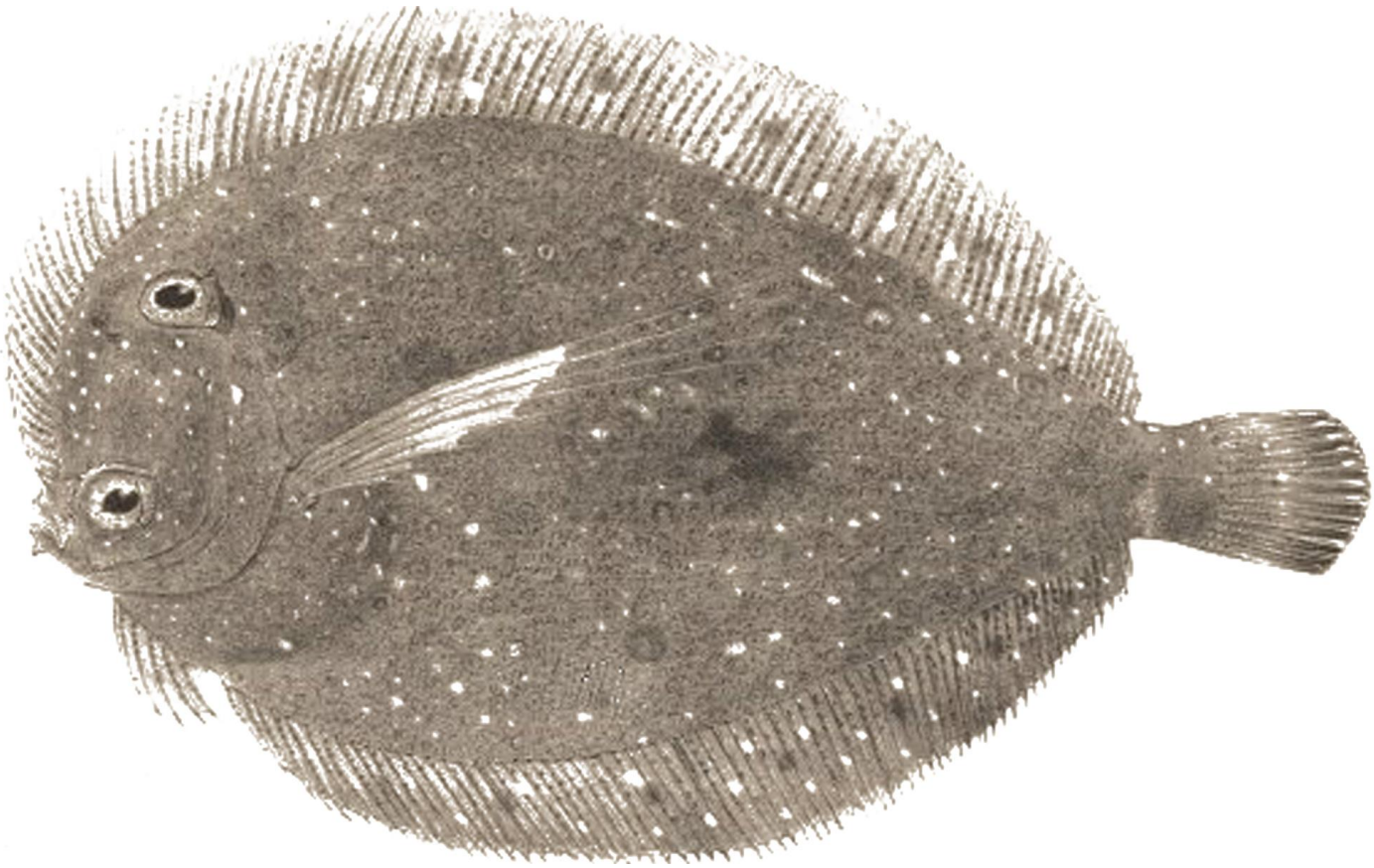


Figure 49. Original plate of *Rhombus myriaster* Temminck & Schlegel, 1846, Holotype RMNH 3523, Nagasaki, Japan.

Synonym(s): *Bothus bleekeri* (Steindachner 1861), *Citharichthys aureus* Day 1877, *Platophrys circularis* Regan 1908, *Platophrys ovalis* Regan 1908,

Common name(s): Diskus-botvis (Afrikaans), Disc flounder (English), Discoid flounder (English), Flounder (English), Indo-Pacific oval flounder (English), Oval flounder (English)

Material examined: *Bothus myriaster,* 17 specimens (81 - 161 mm SL), *Platophrys ovalis* BMNH 1908.3.23.127-9 Holotype (78.15 SL), BMNH 1908.33.23.128,129 Paratypes (2) (41.37,45.31 SL), Amirates; *Platophrys circularis* BMNH 1908.3.23.130 Holotype (31.05 SL) Amirates.

Type material: Holotype, *Bothus myriaster* RMNH 3523, Nagasaki, Japan (not examined). Diagram of holotype examined-Plate #92 '*Pisces. In: Fauna Japonica, sive descriptio animalium quae in itinere per Japoniam suscepto annis 1823-30 collegit, notis observationibus et adumbrationibus illustravit P. F. de Siebold',* 1843).

Non-type material: BMNH 1933.6.12.4 (96.73 mm SL), Taiwan; ROM 39366 (11) (94.04-137 mm SL), Taiwan; BMNH 1935.3.12.3 (161 mm SL), Vietnam; USNM 260475 (81.54 mm SL), Tanzania; ZMH 19919 (2) (115.26 - 135.52 mm SL), Zanzibar, Tanzania; BMNH 1928.3.22.17-21 (96.16–46.24 mm SL), Palk Bay, Ceylon; BMNH 1984.1.1.104 (104 mm SL), Indonesia.

Diagnosis: A species of *Bothus* with the following combination of characters: males with large fleshy flap like appendage on posterior of each eye (Figs. 49, 50, 51); usually a small dark ocelli area adjacent to posterior of lateral line curve (Fig. 53, A); numerous light to dark thin wavy bands running vertically across median of body from dorsal to ventral edge (Fig. 50, B).

Description: A species of *Bothus* reaching a maximum standard length of 161 mm (in examined specimens); meristic and morphometric characters in Table 30; body wide ovate, body depth reaching

57%–69% SL; head length 23%–30% of SL, head depth 46%-60% of SL; anterior profile of head descends steeply, almost vertical, with notch above snout; spine on snout in some males, absent in females; interorbital distance concave, 26%–57% of HL; spines present on orbitals in males, absent in females; ventral eye diameter 24%–32% of HL; 8–10 hourglass-shaped supracranial pterygiophores, 14–16 dorsal-fin pterygiophores before first elongated neural spine; ocular-side mouth 17 %–25% of HL, blind side mouth 20%—26%; teeth shape conical, bisereal; 5–8 gill-rakers on lower limb of first gill arch, 2–6 gill-rakers on upper limb of first gill arch; lateral line with 90–113 scales; bifurcated supratemporal branch; scales cycloid on ocular-side except ctenoid around ventral and dorsal edges, cycloid on blind side; asymmetrical filamentous pectoral-fin rays with 8–11 on the ocular side and 8–11 pectoral-fin rays on blind side; ocular-side fin rays longer and elongated in males 31%–59% of SL, 19%—42% of SL in females , blind side 13%—18% of SL in both males and females; 88–95 dorsal-fin rays, 64–72 anal-fin rays, 17 caudal-fin rays; 10 precaudal vertebrae, 27–30 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: Ocular-side of body light brown tan or pale yellow with blind side pale yellow; dark diffuse blotch located in posterior one fourth of body along lateral line system; usually a dark brown ocelli smaller than the ventral eye located posterior to the curve of lateral line above the pectoral fin (Fig. 53, A); smaller dark pigmentations arranged around edges of body; ocular-side pectoral fin has small light and dark speckles present; small dark speckles on blind side anal and dorsal-fin rays; blind side with dark wavy bands running vertically across median of body, from dorsal to ventral edge (Fig. 50, B).

Table 30. Meristic and morphometric data for the type description and non-type specimens of *Bothus myriaster* (Temminck & Schlegel 1846) and *Platophrys ovalis* Regan 1908, *Platophrys circularis* Regan 1908. Data for *Bothus myriaster* type description (Amaoka,1969) were compared with type material of *Platophrys* ovalis (BMNH 1908.3.23.127-9 Holotype, Paratype (2)), *Platophrys circulairs* (BMNH 1908.3.23.130 Holotype), non-type material of *Bothus* myriaster, (n= 17; 11 male, 8 female) and non-type material of *Bothus bleekeri* BMNH 1928.3.22.17-21(n=2). All measurements and abbreviations are described in Appendix B.

	B. myriaster Temminck & Schlegel 1846 description image	*B. myriaster* non-type specimens (n=17)	*Bothus ovalis* BMNH 1908.3.23.127-9	*Platophrys circularis* BMNH 1908.3.23.130 holotype	*B. ovalis* paratypes 1908.3.23.127-9 paratypes specimens (n=2)	*B. bleekeri* BMNH 1928.3.22.17-21, non-type specimens (n=2)
Standard length		81.54-161 (116.45;20.42)	78.15	31.05	41.37-45.31 (43.34;2.79)	46.24-96.19 (71.22;35.32)
Total length		99.25-191 (136.42;24.2)	93.96	34.07	47.6-54.84 (51.22;5.12)	54.2-116.91 (85.56;44.34)
Dorsal-fin ray	90	88-95 (92.65;1.87)	93	93	86-88 (87.;1.41)	93-97 (95;2.83)
Anal-fin ray	70	64-72 (66.94;2.46)	72	71	66-67 (66.5;0.71)	67-71 (69;2.83)
Caudal-fin ray		17 (17;0)	17	17	17 (17;0)	17 (17;0)
Precaudal vertebrae		10 (10;0)	10	10	10 (10;0)	10 (10;0)
Caudal vertebrae including urostyle		27-28 (27.82;0.39)	30	28	30 (30;0)	28 (28;0)
Hourglass shaped pterygiophores of dorsal-fin		8-10 (9;0.5)	8		8 (8;0)	8 (8;0)
Dorsal-fin pterygiophores anterior to first elongated neural spine		14-16 (15.06;0.43)	17	17	17 (17;0)	17 (17;0)
Gill rakers on lower limb of first gill arch		5-8 (6.24;0.97)	8		7 (7;0)	7-8 (7.5;0.71)
Gill rakers on upper limb of first gill arch		2-6 (3.76;1.25)	4		4-5 (4.5;0.71)	3-4 (3.5;0.71)
Dorsal-eye appendage	1	0-1 (0.71;0.47)	0		0 (0;0)	0 (0;0)
Ventral-eye appendage	1	0-1 (0.71;0.47)	0		0 (0;0)	0 (0;0)
Pectoral-fin rays o.s.	9	8-11 (9.53;0.8)	10	10	9 (9;0)	9-10 (9.5;0.71)
Pectoral-fin rays b.s.		8-11 (9.25;0.68)*	10	9	9 (9;0)	9 (9;0)
Pelvic-fin rays o.s.		6-6 (6.;0.)*	6		6 (6;0)	6 (6;0)
Pelvic-fin rays b.s.		6-6 (6.;0.)	6		6 (6;0)	6 (6;0)
Lateral-line scales		99-113 (104.19;3.12)*	103		98-99 (98.5;0.71)	95-97 (96.;1.41)
Measurements						
%SL						
Body Depth	0.57	0.57-0.69 (0.62;0.04)	0.69	0.83	0.71-0.73 (0.72;0.01)	0.62-0.65 (0.63;0.02)
Head length	0.24	0.23-0.3 (0.27;0.02)	0.28	0.25	0.31-0.32 (0.32;0.002)	0.27-0.31 (0.29;0.03)
Head depth		0.46-0.6 (0.53;0.04)	0.59	0.75	0.64-0.67 (0.65;0.02)	0.59 (0.59;0)
Length of pectoral fin o.s.		0.19-0.59 (0.43;0.11)	0.40	0.14	0.36-0.45 (0.41;0.06)	0.24-0.26 (0.25;0.02)
Length of pectoral fin b.s.		0.13-0.18 (0.15;0.01)	0.12	0.08	0.16-0.17 (0.17;0.0049)	0.14-0.15 (0.15;0.01)
Length of pelvic fin o.s.		0.08-0.13 (0.1;0.01)	0.13		0.1-0.13 (0.11;0.02)	0.1-0.12 (0.11;0.01)
Length of pelvic fin b.s.		0.07-0.12 (0.1;0.01)	0.11		0.11-0.15 (0.13;0.03)	0.09-0.1 (0.1;0.0049)
Length of base of pelvic fin o.s.		0.08-0.14 (0.1;0.01)	0.10		0.16-0.17 (0.17;0.01)	0.12-0.13 (0.12;0.01)
Length of base of pelvic fin b.s.		0.03-0.07 (0.05;0.01)	0.06		0.05 (0.05;0)	0.04-0.06 (0.05;0.01)
Length of first dorsal-fin ray		0.03-0.08 (0.06;0.01)	0.05		0.05-0.06 (0.05;0)	0.06-0.07 (0.06;0.01)
Length of first anal-fin ray		0.04-0.1 (0.07;0.02)	0.08		0.06-0.1 (0.08;0.02)	0.08-0.09 (0.08;0.0036
Depth of caudal peduncle		0.09-0.11 (0.1;0.01)	0.10	0.11	0.09 (0.09;0)	0.09 (0.09;0)
%HL						
Preorbital length		0.35-0.53 (0.41;0.05)	0.40		0.26-0.34 (0.3;0.05)	0.36-0.39 (0.37;0.03)
Postorbital length		0.19-0.35 (0.26;0.04)	0.25		0.26-0.34 (0.3;0.06)	0.26-0.29 (0.27;0.02)
Predorsal distance b.s.		0.12-0.2 (0.14;0.02)	0.17		0.15-0.18 (0.16;0.02)	0.15-0.17 (0.16;0.01)
Dorsal eye distance from anterior edge of head		0.13-0.24 (0.2;0.03)	0.20		0.14-0.17 (0.15;0.02)	0.16-0.18 (0.17;0.01)
Snout length (o.s.)		0.17-0.25 (0.21;0.03)	0.21	0.21	0.21-0.23 (0.22;0.01)	0.19-0.21 (0.2;0.01)
Snout to nostril distance (o.s.)		0.12-0.19 (0.15;0.02)	0.17	0.12	0.16-0.17 (0.16;0.002)	0.15-0.16 (0.15;0.01)
Length of mouth o.s.		0.17-0.24 (0.21;0.02)	0.17	0.20	0.18-0.19 (0.19;0.01)	0.2-0.22 (0.21;0.01)
Length of mouth b.s.		0.2-0.26 (0.23;0.02)	0.23	0.20	0.21-0.22 (0.21;0.01)	0.25-0.26 (0.25;0.01)
Ventral eye diameter		0.24-0.32 (0.3;0.02)	0.35	0.25	0.31-0.36 (0.33;0.03)	0.29-0.34 (0.32;0.04)
Width of dorsal orbital		0.31-0.42 (0.36;0.03)	0.40	0.25	0.36-0.38 (0.37;0.01)	0.38-0.39 (0.38;0.01)
Interorbital Distance	0.45	0.26-0.57 (0.41;0.08)*	0.33	0.31	0.2-0.25 (0.22;0.03)	0.22-0.34 (0.28;0.09)

*indicates a character could not be collected for one specimen

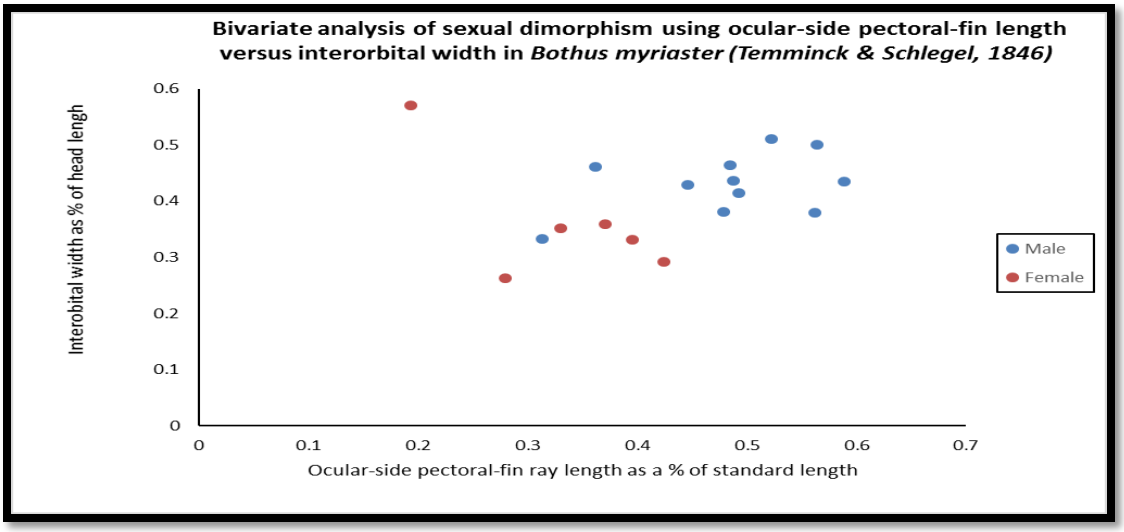
Blank space indicates where data could not be obtained

Sexual dimorphism: Sexual dimorphism is characterized in *Bothus myriaster* (Table 31) by the following characters: males generally have large flap shaped ocular appendage which are also present in some females; males generally with spines on snout, absent in females; some males with spine on anterior of ventral orbit; male pigmentation patterns more apparent. Male's greater Interorbital space was found to be significant ($t(18) = 2.44$, $p < 0.05$), and ocular-side pectoral-fin ray length was found to be highly significant ($t(19) = 3.42$, $p < 0.01$) when discriminating sex.

Table 31. Morphometric comparison and bivariate analysis of males and females of *Bothus myriaster* (Temminck & Schlegel 1846) non-type material (n=17, 11 male, 8 female); *Platophrys ovalis* holotype and paratypes (2) (n=3, 3 males); and *Bothus bleekeri* non-type (n=2, 1 male, 1 female). Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	B. myriaster non-type specimens (n=19)		*Platophrys circularis* BMNH 1908.3.23.130 holotype	*B. ovalis* paratypes 1908.3.23.127-9 (n=2)	*B. ovalis* BMNH 1908.3.23.127-9 holotype	*B. bleekeri* BMNH 1928.3.22.17-21, non-type specimens (n=2)	
Character	Male, n=11	Female, n=8	Male	Male	Male	Male	Female
Standard length	81.54-161 (118.57;22.85)	94.04-137 (112.56;16.19)	31.05	41.37-45.31 (43.34;2.79)	78.15	46.24 (46.24;0)	96.19 (96.19;0)
Count							
Number of eye appendages	0-2 (1.82;0.6)	0-2 (0.67;1.03)	0	0 (0;0)	0	0 (0;0)	0 (0;0)
Number of spines on orbitals	0-7 (2.8;1.99)	0	0	0 (0;0)	0	0 (0;0)	0
Measurements							
%SL							
Head length	0.23-0.3 (0.26;0.02)	0.26-0.29 (0.28;0.01)	0.25	0.31-0.32 (0.32;0.002)	0.28	0.31 (0.31;0)	0.27 (0.27;0)
Head depth	0.46-0.6 (0.52;0.04)	0.47-0.58 (0.55;0.04)	0.75	0.64-0.67 (0.65;0.02)	0.59	0.59 (0.59;0)	0.59
Length of pectoral-fin ray o.s.	0.31-0.59 (0.48;0.08)	0.19-0.42 (0.33;0.08)	0.14	0.36-0.45 (0.41;0.06)	0.40	0.26 (0.26;0)	0.24 (0.24;0)
%HL							
Interorbital distance	0.33-0.51 (0.43;0.05)*	0.26-0.57 (0.36;0.11)	0.31	0.2-0.25 (0.22;0.03)	0.33	0.22 (0.22;0.)	34.43 (34.43;0)

*indicates a character could not be collected for one specimen



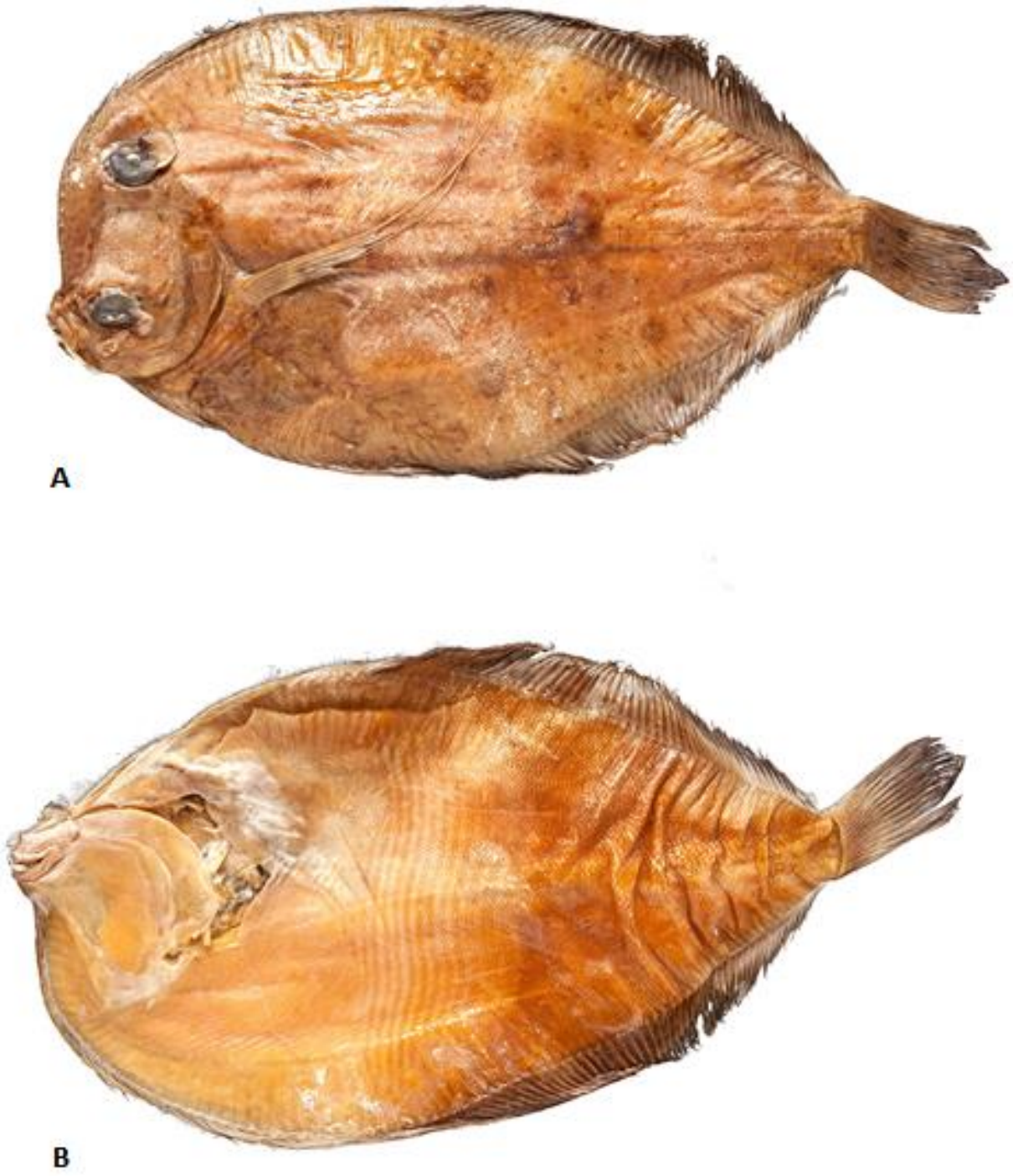


Figure 50. *Bothus myriaster* (Temminck and Schlegel 1846) BMNH 1935.3.12, 161 mm SL, French Indo-China. Ocular (A)and blind side (B) of adult male. Depicting body morphology: large flap shaped ocular appendage on posterior of each eye; dark wavy bands traversing vertically across blind side of body.

Geographic distribution: *Bothus myriaster* has been reported specifically in the: Japanese seas (Temminck & Schlegel 1846), Chagos archipelago (Regan 1908), Amirates (Norman 1934), Japan (Amaoka 1969), Lord Howe, Norfolk, and Kermadec Island, southwest Pacific Ocean (Francis 1993), Red Sea (Goren and Dor 1994), South China Sea (Randall, J. E. and K. K. P. Lim 2000), Korea (Youn 2002), Arabian Sea (Manilo and Bogorodsky 2003), Pondichery and Karaika (Mishra and Krishnan 2003), Mauritian Island of Rodrigues (Heemstra, E., P. C. Heemstra, M. J. Smale, T. Hooper and D. Pelicier 2004), Kagoshima- Japan (Ohashi, Y. and H. Motomura 2011).

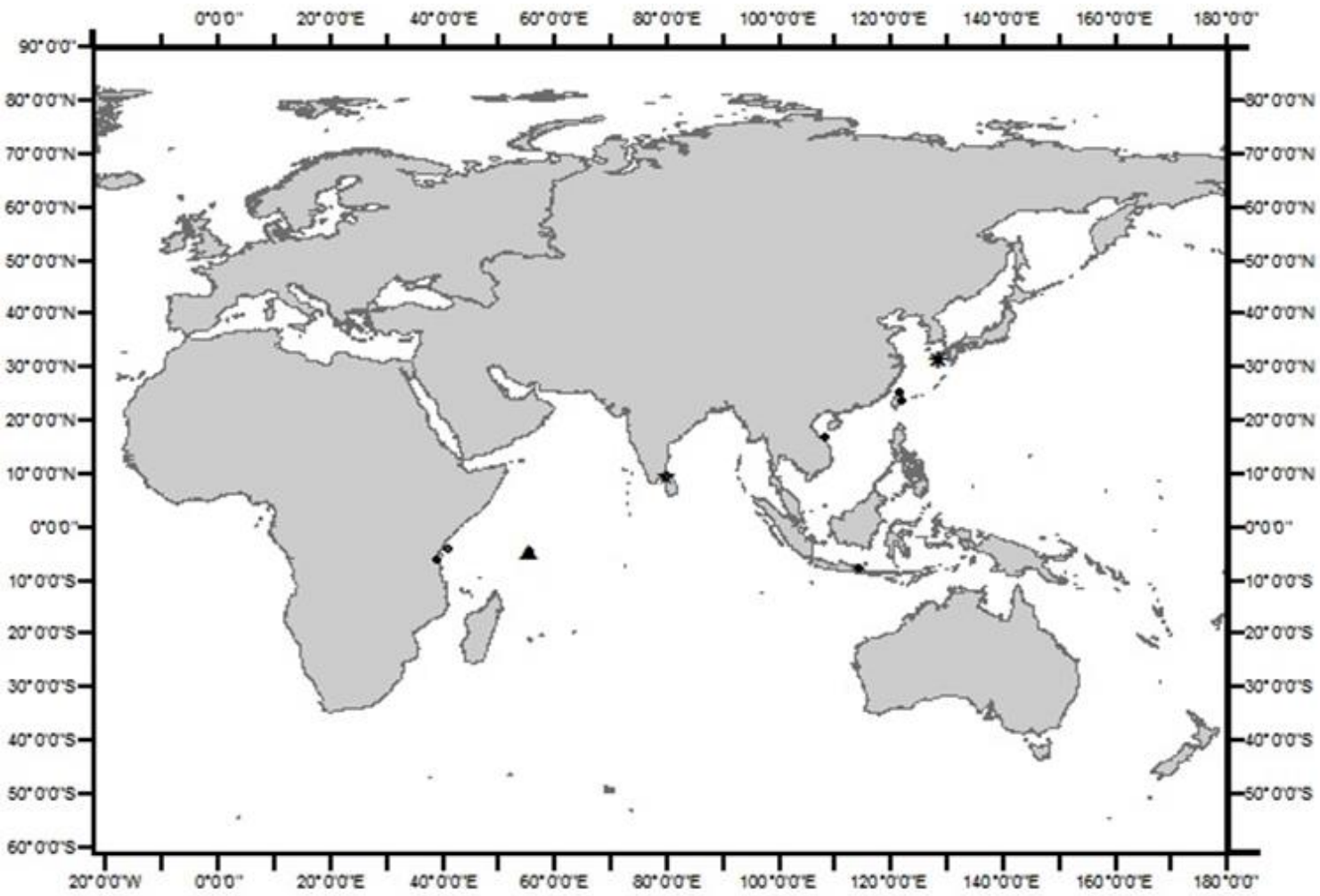


Figure 51. Geographical distribution of examined specimens of *Bothus myriaster*. Asterisk indicates locality of type specimen. Triangle denotes type specimens of *Platophrys ovalis, Platophrys circularis*; star denotes locality of non-type *Bothus bleekeri*.

Remarks: *Bothus myriaster* is the only species to exhibit large fleshy flap-like appendages on the posterior of each eye and numerous dark wavy bands running vertically across median of body, from dorsal to ventral edge. There are other species of *Bothus* (*Bothus tricirrhitus*) that exhibit pigmentation in the shape of bars running vertically across the blind side of the body, however no other species have eye appendages similar to *Bothus myriaster.* All other eye appendages in species of *Bothus* are slender and pointed; this character is only seen in *B. myriaster*.

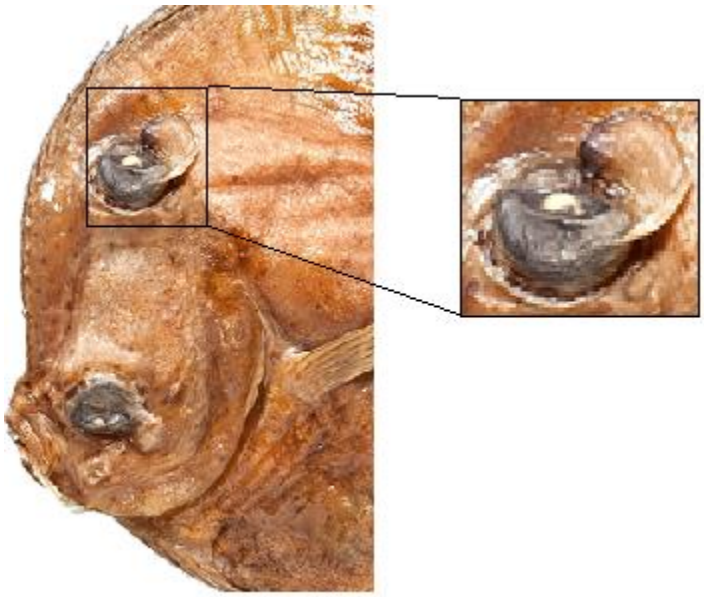


Figure 52. *Bothus myriaster* (Temminck and Schlegel 1846) BMNH 1935.3.12, 161 mm SL, French Indo-China. Magnification of large flap shaped ocular appendage on posterior of eye.

Bothus myriaster (Temminck & Schlegel, 1846) was first described as *Rhombus myriaster* Temminck & Schlegel 1846. The current synonym species of *Bothus myriaster* are: *Platophrys ovalis* Regan 1908*, Platophrys circularis* Regan 1908*, Bothus bleekeri*, and *Citharicthys aureus* Day 1877.

Bothus bleekeri Steindachner, 1861 is listed as a valid species in Norman (1934). Norman (1934) also mentions that *B. bleekeri, Bothus myriaster* (Temminck & Schlegel 1846) and *Bothus ovalis* (Regan

1908) are likely all the same species. In Amaoka's (1969: 98) revision of Japanese flounders *B. bleekeri* was removed due to a misidentification of the type larval specimen and as such it was stated that *B. bleekeri* could be more closely related to *Taeniopsetta ocellata* (Günther 1880). Steindacher's (1861) original species description proposes that *B. bleekeri* is related to *Rhombus myriaster* due to their similar body morphologies and the presence of the ocelli behind the junction of the lateral line curve. Steindachner (1861) indicated 88–89 rays in the dorsal fin and 67–68 rays in the anal fin. These values are congruent within the description of *B. myriaster* type and non-type data observed. The only discrepancy within the data is the lack of eye appendages, which is possibly the result of the description being based on a larval specimen, as a juvenile specimen would not have fully developed eye appendages until later in ontogeny (Schreiber 2013). The similar morphology of *B. bleekeri* and *B. myriaster* (Fig. 53, Table 30, 31) suggests that they are the same species. Based on the observations made on specimens I conclude that *B. bleekeri* Steindacher 1861 should be considered a junior synonym of *B. myriaster*.

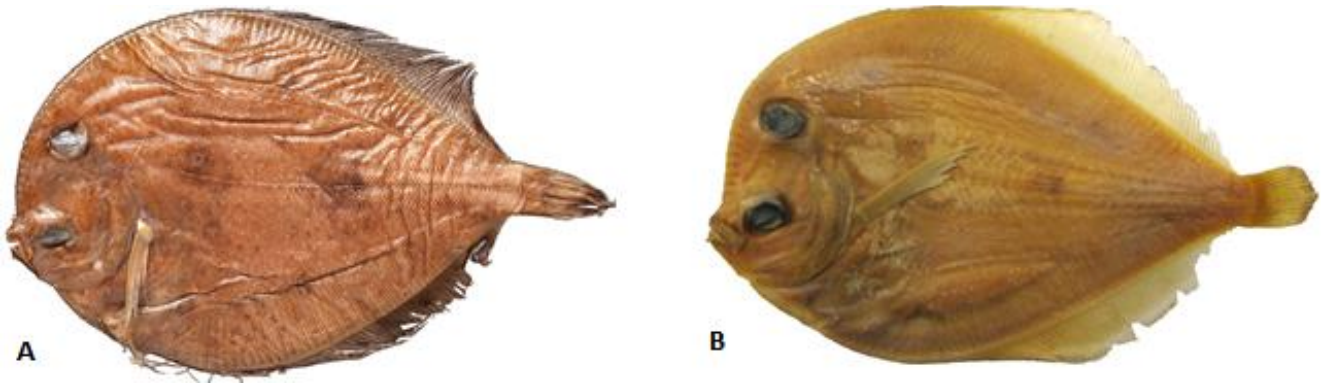


Figure 53. Images of ocular sides of *Bothus myriaster* BMNH 1933.6.12.4, adult male, 96.73 mm SL, Keerung Formola (A) and *Bothus bleekeri* BMNH 1928.3.22.17-21, 96.69 mm SL, adult female, Ceylon, (B), depicting congruent morphology and pigmentation between specimens previously proposed to be different species.

When comparing the meristic and morphological data of *Platophrys ovalis* Regan 1908 and *Platophrys circularis* Regan 1908, the observations made on specimens (Fig. 54, Table 30, 31) suggest the species are related to *Bothus myriaster* (Fig. 50). Norman (1934) and Amaoka (1969) refer to this resemblance and suggest the identification of *P.ovalis* was based on the description of a juvenille specimen of *B. myriaster.* The dorsal-fin rays (88–95 in *B. myriaster,*93 in *P.circularis*), anal-fin rays (64–72 in *B. myriaster,* 71 in *P.circularis*) are congruent thus strenghtening the possibility of a juvenille specimen. The extreme morphological changes that occur during ontogeny could explain the difference in body depth and head morphology of *P. circularis* (species of *B. myriaster* become less circular and more ovate as they mature, as with many species of *Bothus*, Fukui 1997). The observations suggest that Regan 1910 mistakenly identified a juvenille of *B. myriaster* as a new species of *Bothus*. When comparing the meristic data of *Platophrys ovalis* (Fig. 54-B, Table 30, 31) with *B. myriaster*, there are obvious overlaps such as the number of dorsal-fin rays (88–95 in *B. myriaster,* 93 in *P.ovalis*), anal-fin rays (64–72 in *B. myriaster,*72 in *P.ovalis*), and lateral-line scale count (99–113 in *B. myriaster,* 103 in *P.ovalis*). Based on the observed data *Platophrys ovalis* is also a juvenille specimen of *B. myriaster*, and should be considered a junior synonym of *B. myriaster*.

Interestingly, when comparing *P.ovalis, P. circularis,B. myriaster* they depict a timeline of maturation for *B. myriaster.* The most juvenille specimen (*P. circularis*, Fig. 54 A), followed by a more mature specimen (*P. ovalis*, Fig. 54 B), and ending with a fully developped *B. myriaster* (Fig. 50).

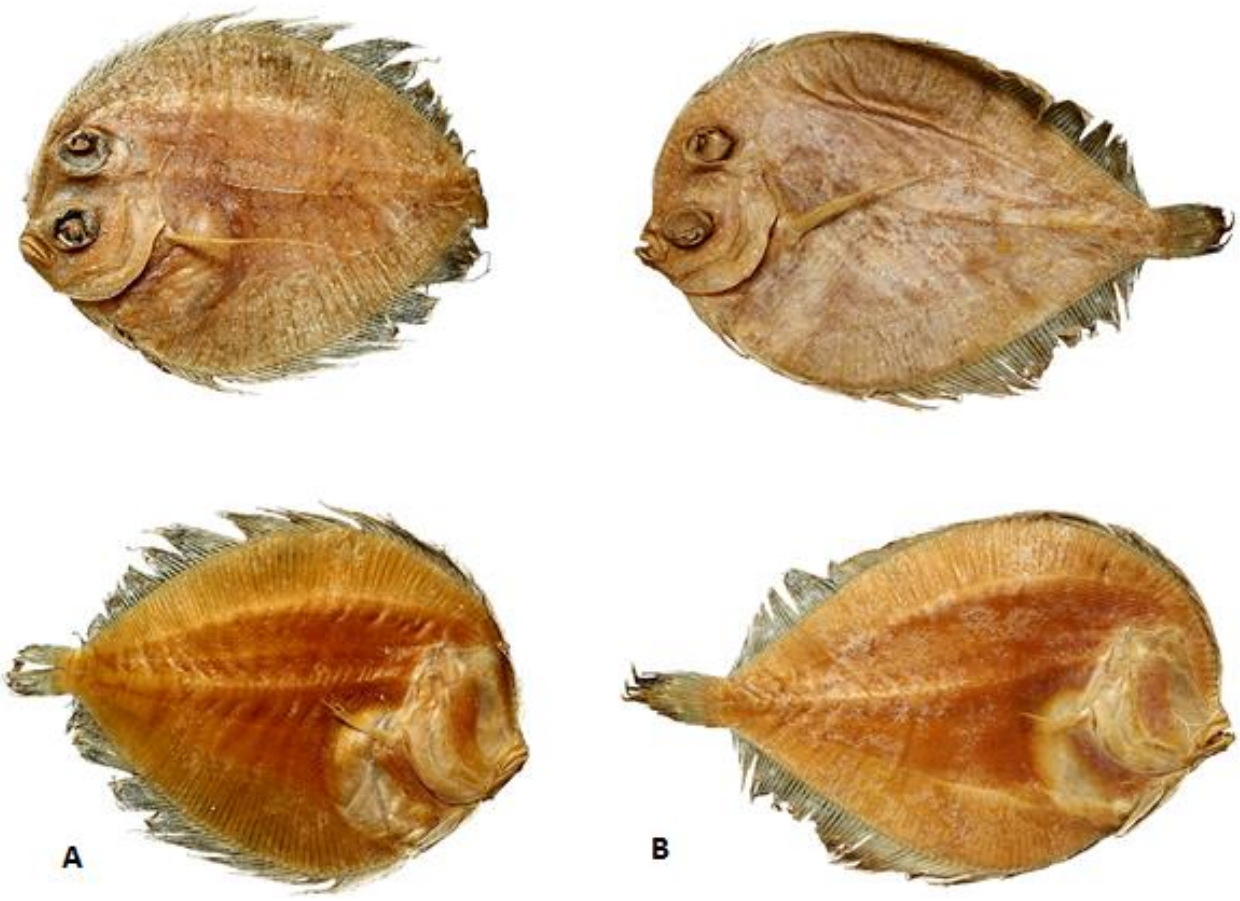


Figure 54. Images of ocular and blind sides of *Platophrys circularis*, BMNH 1908.3.23.130 Holotype, 34.07 mm SL, Amirates, (A) and *Platophrys ovalis*, BMNH 1908.3.23.127-9 Holotype, 78.15 mm SL, Amirates, (B). Depicting congruent morphology of juvenile and adult specimens previously proposed to be different species.

Citharichthys aureus Day, 1877 was identified as a synonym of *Bothus pantherinus* by Norman (1934) based on a proposed resemblance to the species. Weber (1913) proposed that *Citharichthys aureus* Day 1877 was identical or close to *Platophrys myriaster* (later classified as *B. myriaster*). Weber (1913:413) proposes that *C. aureus* closely resembles or is identical to *Platophrys myriaster*, whereas Norman (1934:235) states it as most likely a juvenile of *Bothus pantherinus*. After reviewing the type descriptions and examining larval forms of *Bothus* species (Fukui 1997) and comparing the original figures from Day (1877) (Fig. 55) this study concludes that *aureus* is most likely a post-larval form of *B.*

myriaster. This conclusion is based on the similar larval morphology (extended dorsal-fin ray and the cycloid scales present on the ocular-side) as stated by Weber (1913:413). Based on the observations made from the literature I suggest that *Citharicthys aureus* Day 1877 be designated as a synonym of *Bothus myriaster* until a further review of larval characters can be performed.

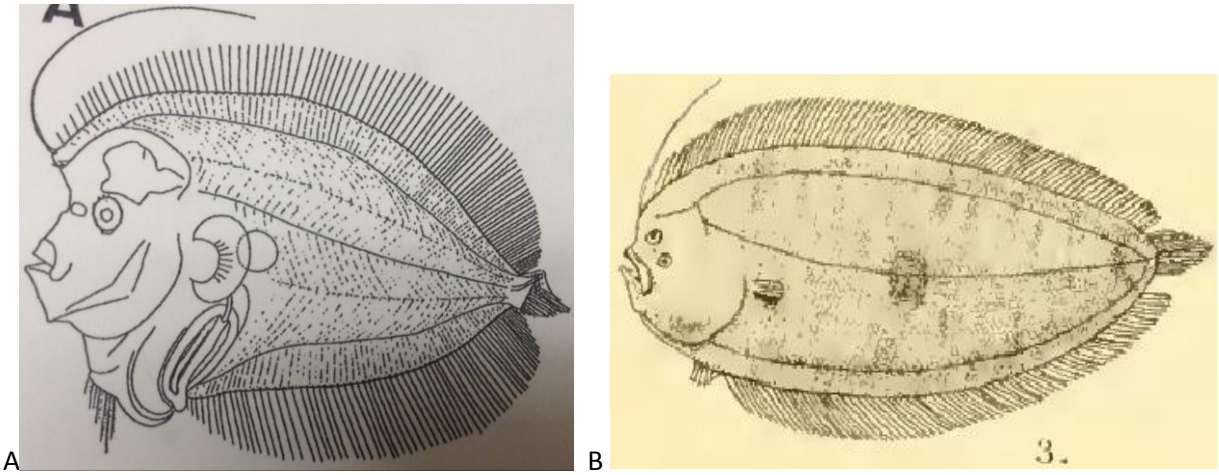


Figure 55. Illustration of larval stage *Bothus myriaster* (Fukui 1997:198:Fig 4) (A), compared against Illustration of type figure for *Citharichthys aureus* (Day 1877: pg. 10 (X): Fig 3) (B).

Comparisons: *Bothus myriaster* is also the only species in the genus to feature ocular appendages that have a broad flap shape, whereas all other species have slender long pointed ocular appendages. *Bothus myriaster* can further be distinguished from all other species of *Bothus* with its distinct its elongated filamentous pectoral fins in males (31%–59% of SL), and dark bands running vertically across the median of the body on the blind side. *Bothus ypsigrammus* most closely resembles *B. myriaster*. *Bothus ypsigrammus* is the only other species of *Bothus* that contains a single well defined ocelli on the ocular-side of the body, posterior to the curve of the lateral line. *B. ypsigrammus* is easily distinguished from *B. myriaster* through the presence of a white shaped 'Y' form encompassed by dark brown pigmentation

present in the posterior of the lateral line system (Fig. 89). *Bothus ypsigrammus* has a less steep head profile, lesser extended pectoral-fins rays (20%–32% of SL) and also lacks flap shaped eye appendages.

Bothus ocellatus (Agassiz, 1831)

Figures 56 - 60; Tables 32, 33

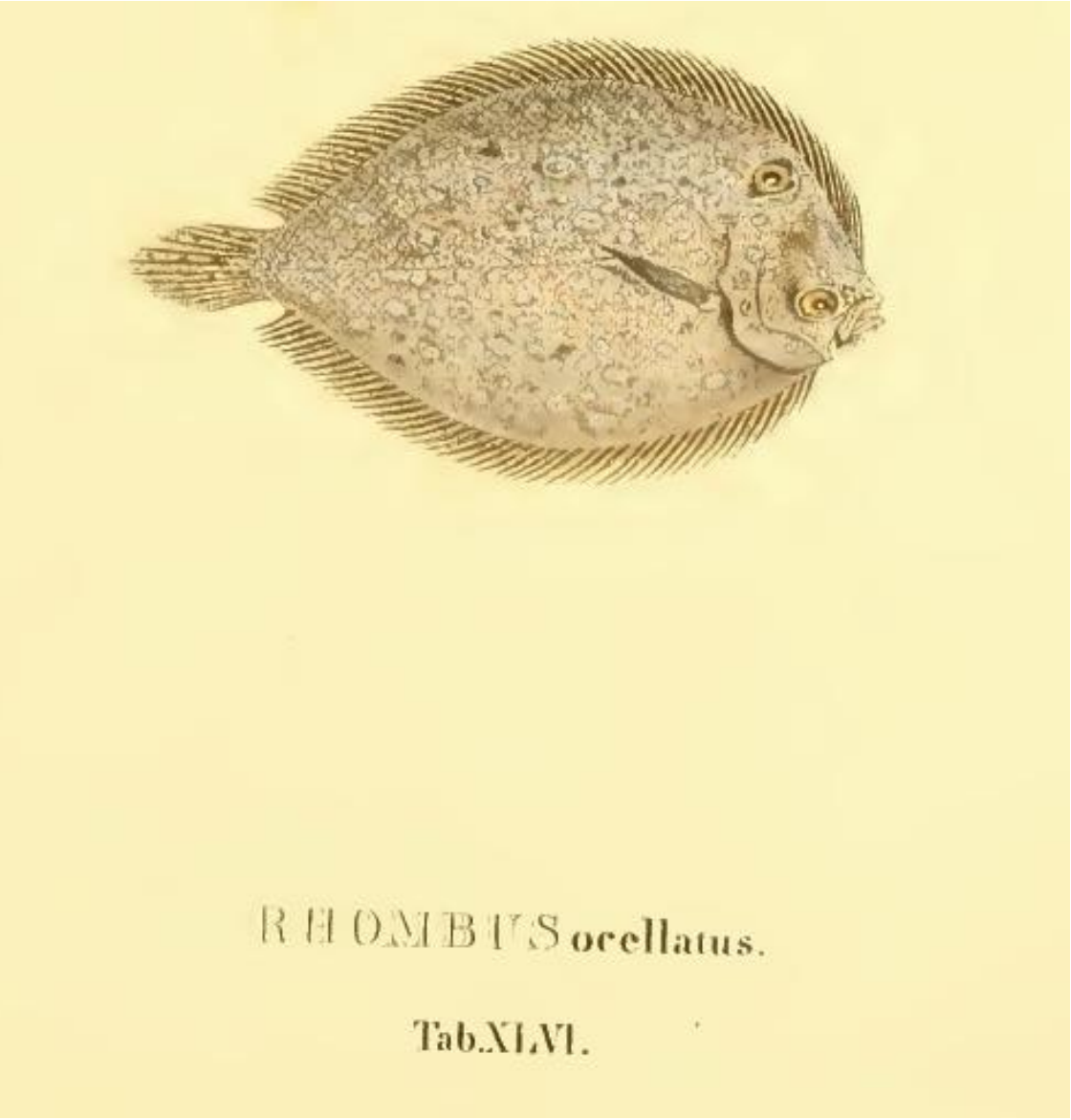


Figure 56. Original pages taken from ‘Spix, J. B. von and L. Agassiz 1829-31, Selecta genera et species piscium quos in itinere per Brasiliam annos MDCCCXVII-MDCCCXX jussu et auspiciis Maximiliani Josephi I.... colleget et pingendso curavit Dr J. B. de Spix.... Monachii. Part 2: pg. 86, Pls 46.

Synonym(s): *Rhomboidicthys spinosus* Poey 1868, *Platophrys nebularis* Jordan & Gilbert 1884, *Rhombus bahianus* Castelnau 1855.

Common name(s): Eyed Flounder (English)

Material examined: *Bothus ocellatus,* 27 specimens (35.66-119.59 mm SL)

Type material: No types known. Analyses based on Agassiz, L 1831. Selecta genera et species piscium quos in itinere per Brasiliam annos MDCCCXVII-MDCCCXX jussu et auspiciis Maximiliani Josephi I.... colleget et pingendso curavit Dr J. B. de Spix.... Monachii. Part 1: i-xvi + i-ii + 1-82, Pls. 1-48;, Part 2: 83-138, Pls. 49-101.

Non-type material: BMNH 41.8.25.42 (92.98 mm SL),Bermuda; FSBC 7931 (4)(59.3-63.69 mm SL), Cape Canaveral, Florida; FSBC 21236 (7)(83.24-100.36 mm SL), Key West, Florida; NMC 70-0068 (2) (51.04-56.16 mm SL), Bimini Islands; NMC 70-70 (58.45 mm SL), Bimini Islands; NMC 70-0073 (2) (35.66-88.69 mm SL), Bimini Islands; FSBC 10820 (2) (95.05-119.59 mm SL), Key West, Florida; ANSP 89770 (2) (41.76-43.11 mm SL), Key West, Florida; ANSP 101726 (3) (43.12-46.5 mm SL), Cuba; ROM 31369 (44.59 mm SL), Barbados; USNM 375787 (52.41 mm SL), Galapagos Islands.

Diagnosis: A species of *Bothus* with the following combination of characters: superior ray of ocular side pectoral fin not extended; lateral line scales 67–78. Two inconspicuous dark blotches about 20–30% the size of the ventral eye in a subsequent horizontal arrangement on the caudal fin (Fig. 57, 58).

Description: A species of *Bothus* reaching a maximum standard length of 119.59 mm (in examined specimens); Meristic and morphometric characters indicated in Table 32; body circular, body depth reaching 54%–71% SL; head length 27%– 57% of SL, head depth 27%–57% of SL, profile of head flat/concave; no notch above snout (Figs. 57, 58); spine on snout in some males only; interorbital

distance concave, 9%–59% of HL, spine present on orbitals in some males; ventral eye diameter 14%–36% of HL; 7–9 hourglass-shaped supracranial pterygiophores, 13–15 dorsal-fin pterygiophores before first elongated neural spine; mouth ocular-side 8%–26% of HL, blind side mouth 10%—27%; teeth shape conical , biserial; 5–10 gill-rakers on lower limb of first gill arch, 2–8 gill-rakers on upper arch; lateral line with 67–78 scales, extending from base of caudal-fin ending posterior to dorsal eye orbit, ending in bifurcated supratemporal branch; scales ctenoid on ocular side, cycloid on blind side; asymmetrical pectoral-fin rays with 10–13 on the ocular side and 9–11 on blind side; ocular-side fin rays longer 16 %–13% of SL, blind side shorter 10%–17% of SL; 73 –92 dorsal-fin rays, 56–81 anal-fin rays, 17 cauda- fin rays; 10–11 precaudal vertebrae, 25–29 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: Ocular-side of body light reddish to orange brown (Figs. 57, 58), with blind side pale yellow; two inconspicuous black blotches about 20–30% the size of the ventral eye arranged vertically in succession traversing medial region of caudal fin on ocular and blind side; dark and light speckles throughout body, dorsal, anal, caudal rays, size of eye or smaller; one or two large dark blotches on lateral line; anterior blotch beginning at junction of lateral line curve, posterior blotch located in posterior one fourth of body (Figs. 57, 58); ocular-side pectoral fin has small light and dark speckles present, blind side pectoral without pigmentation; small dark speckles on blind side anal and dorsal-fin rays, no pigmentation on blind side.

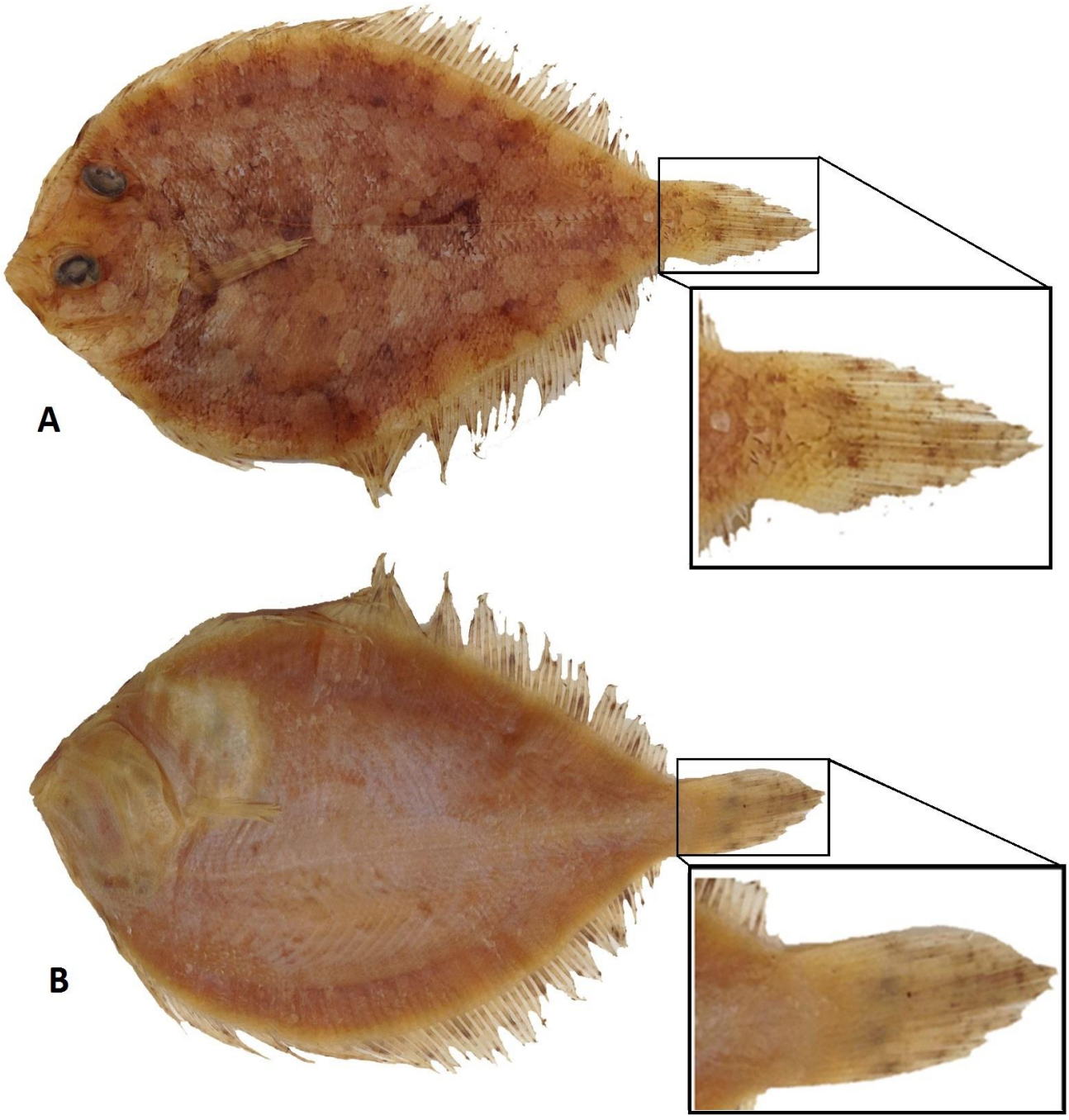


Figure 57. *Bothus ocellatus* (Agassiz 1831) from FSBC 7931 (Specimen 3) non-type specimen. 77.33 mm SL, adult male. Ocular (A) and blind (B) sides, as well as magnification of caudal fin enhancing two inconspicuous dark spots subsequent horizontal arrangement.

A

B

Figure 58. *Bothus ocellatus* (Agassiz 1831) from FSBC 7931 (Specimen 2) non-type specimen. 76.14 mm SL, adult female. Ocular and blind sides.

Table 32. Meristic and morphometric data for the original description and non-type specimens of *Bothus ocellatus* (Agassiz 1831) and *Platophrys nebularis* (Jordan & Gilbert 1884). Data for *Bothus ocellatus* and *Platophrys nebularis* were obtained from original species description and compared against non-type material (n= 27; 12 male, 15 female). Conversions from inches to mm were made when necessary. All measurements and abbreviations are described in Appendix B.

	B. ocellatus (Agassiz 1831) original description	*Platophrys nebularis* (Jordan and Gilbert 1884),original description	*B. ocellatus* non-type specimens (n=26)
Standard length			35.66-119.59 (69.11;23.48)
Total length	88.9	76.2	43.3-140.14 (84.15;28.46)
Counts			
Dorsal-fin ray	82	85	78-92 (83.7;2.98)*
Anal-fin ray	62	64	56-67 (61.18;2.48)*
Caudal-fin ray	17		17-17 (17;0)*
Precaudal vertebrae			10-11 (10.04;0.2)*
Caudal vertebrae including urostyle			25-29 (26.33;0.87)*
Hourglass shaped pterygiophores of dorsal-fin			7-9 (8.38;0.58)*
Dorsal-fin pterygiophores anterior to first elongated neural spine			13-15 (14;0.59)*
Gill rakers on lower limb of first gill arch		7	5-10 (7.92;1.04)*
Gill rakers on upper limb of first gill arch			2-8 (4.72;1.31)*
Pectoral-fin rays o.s.	12		10-13 (10.64;0.7)*
Pectoral-fin rays b.s.			9-11 (9.24;0.6)*
Pelvic-fin rays o.s.	6		6 (6;0)*
Pelvic-fin rays b.s.	5		6 (6;0)*
Lateral-line scales		75	67-78 (72.36;2.32)*
Measurements			
%SL			
Body Depth	0.57	75%	0.54-0.71 (0.63;0.05)
Head length		0.25	0.25-0.54 (0.28;0.06)
Head depth		0.5	0.27-0.57 (0.49;0.06)*
Length of pectoral fin o.s.			0.16-0.33 (0.22;0.04)*
Length of pectoral fin b.s.			0.1-0.17 (0.14;0.02)*
Length of pelvic fin o.s.			0.02-0.13 (0.1;0.02)*
Length of pelvic fin b.s.			0.08-0.12 (0.1;0.01)*
Length of base of pelvic fin o.s.			0.11-0.25 (0.13;0.03)*
Length of base of pelvic fin b.s.			0.02-0.11 (0.04;0.02)*
Length of first dorsal-fin ray			0.04-0.08 (0.06;0.01)*
Length of first anal-fin ray			0.05-0.11 (0.07;0.01)*
Depth of caudal peduncle			0.1-0.14 (0.12;0.01)*
%HL			
Preorbital length			0.08-0.5 (0.36;0.1)*
Postorbital length			0.13-0.36 (0.25;0.06)*
Predorsal distance b.s.			0.08-0.19 (0.15;0.03)*
Dorsal eye distance from anterior edge of head			0.04-0.2 (0.15;0.03)*
Snout length (o.s.)			0.01-0.26 (0.17;0.05)*
Snout to nostril distance (o.s.)			0.01-0.27 (0.15;0.05)*
Length of mouth o.s.		3 and 3/4 in head	0.08-0.26 (0.2;0.03)*
Length of mouth b.s.			0.1-0.27 (0.22;0.03)*
Ventral eye diameter		3 and 2/3 in head	0.14-0.36 (0.31;0.05)
Width of dorsal orbital			0.2-0.42 (0.35;0.04)
Interorbital Distance			0.09-0.59 (0.26;0.13)

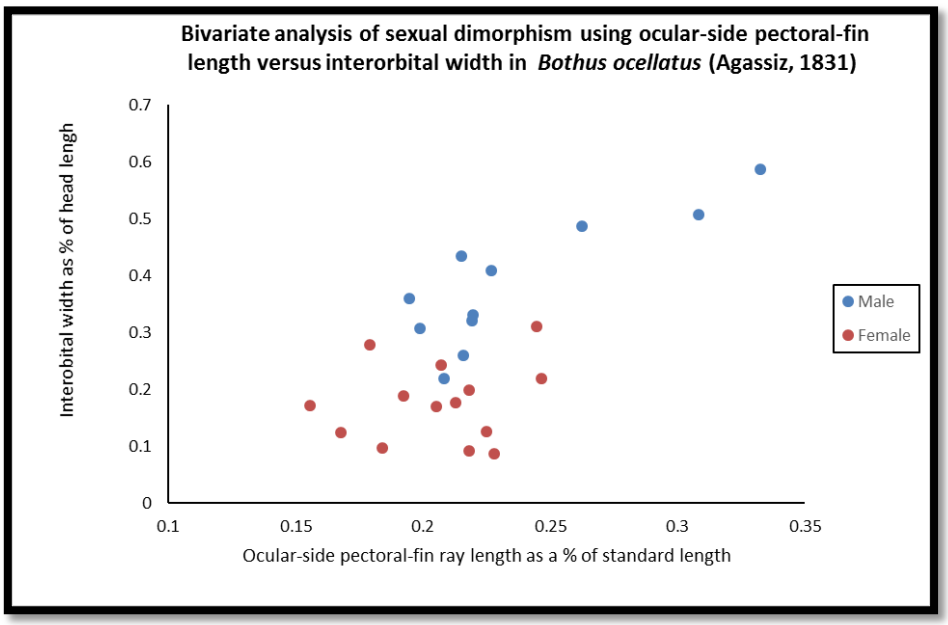
*indicates a character could not be collected for some specimens
Blank space indicates where data could not be obtained

Sexual dimorphism: males generally with spines on snout; more concave; some males with spine on anterior margin of ventral orbits; males pigmentation pattern more apparent. Male's larger Interorbital space was found to be very highly significant (t (25) =4.36, $p < 0.001$) when discriminating sex. As sexual dimorphism becomes more pronounced with maturity, overlapping values in interorbital distance in the bivariate analysis can be explained by the presence of juvenile specimen data.

Table 33. Morphometric comparison and bivariate analysis of males and females of *Bothus ocellatus* (Agassiz 1831) of non-type material (N= 27, 12 males, 15 females). Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	B. ocellatus non-type specimens (n=27)	
Character	Male, n=12	Female, n=15
Standard length	46.5-119.59 (74.05;24.34)	35.66-100.36 (67.19;22.86)
Count		
Number of eye appendages		
Number of spines on orbitals	0-1 (0.45;0.52)	
Measurements		
%SL		
Head length	0.25-0.32 (0.28;0.02)	0.25-0.54 (0.28;0.08)
Head depth	0.46-0.57 (0.51;0.04)*	0.27-0.55 (0.48;0.07)*
Length of pectoral-fin ray o.s.	0.19-0.33 (0.24;0.05)*	0.16-0.25 (0.21;0.03)*
%HL		
Interorbital distance	0.18-0.59 (0.36;0.13)	0.09-0.31 (0.18;0.07)

*indicates a character could not be collected for one specimen



Geographic distribution: *Bothus ocellatus* has been specifically reported in reported in the Atlantic Ocean (Agassiz 1831), Bermuda's, Key West, Dry Tortugas, West Indies, Monsteraat Leward Island, Panama, Trinidad, Bahia, Rio De janeiro (Norman 1934), Gulf of Maine (Collette and Klein-MacPhee 2002), West Indies (Collette, Williams,Thacker, Smith 2003), Barbados, Brazil (Menezes, Buckup, Figueiredo, Moura 2003), Pelican Cays- Belize (Smith *et al*. 2003), Gulf of Mexico (McEachran and Fechhelm 2005), St. Croix, U. S. Virgin Islands (Smith-Vaniz and Jelks 2014).

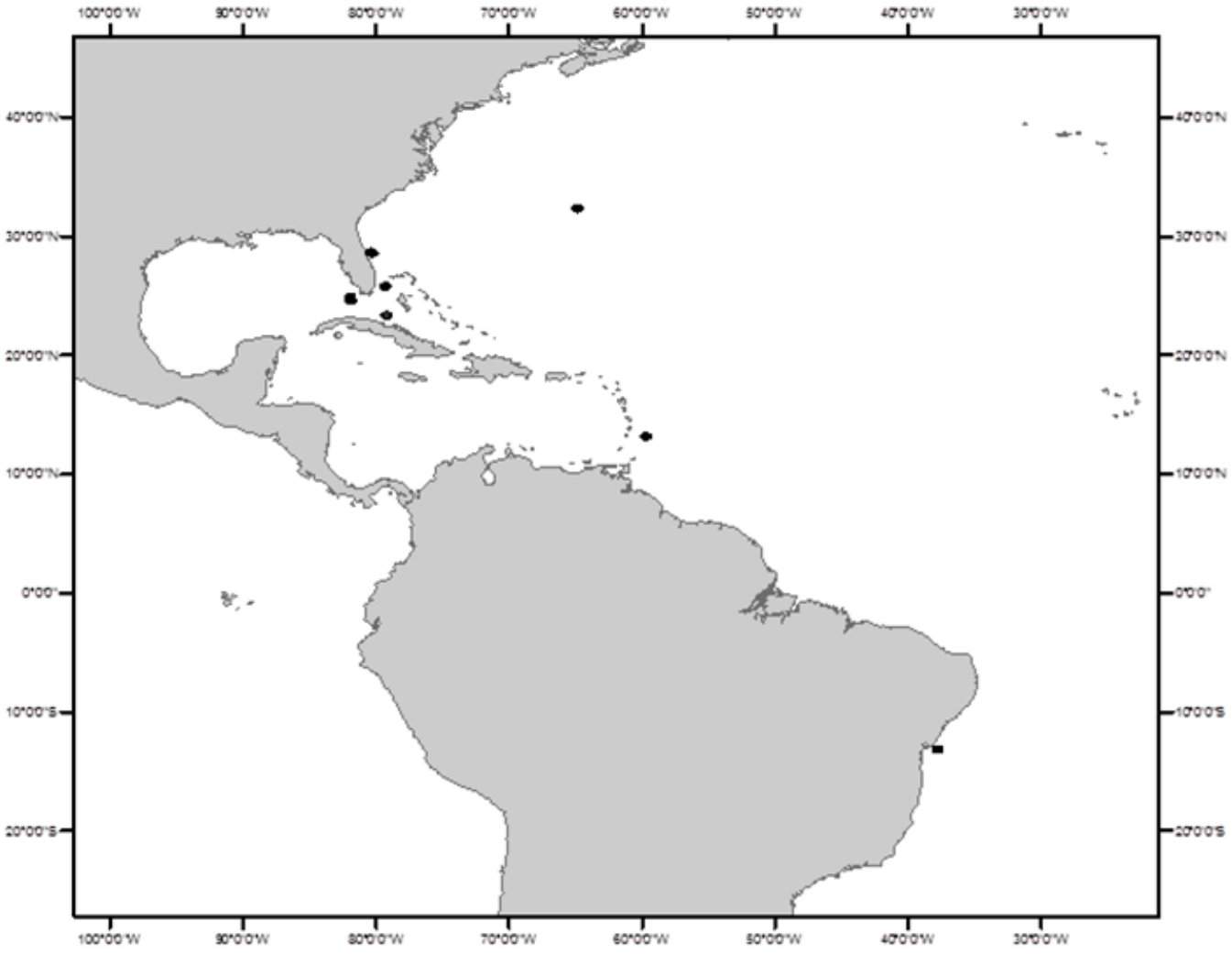


Figure 59. Geographical distribution of examined specimens of *Bothus ocellatus*.

Remarks: The original description and figure (Fig. 56) presented by Agassiz (1831:85, Pls 46) shows a peculiar flaw. Agassiz describes the species as sinistral, however the figure he presents and labels as *Rhombus ocellatus* is clearly a dextral specimen. I have found no mention of this discrepancy in the literature reviewed and conclude that this is purely a depiction error and has no relevance to the sidedness of *Bothus ocellatus*.

The current synonym species are as follows: *Rhomboidichthys spinosus* Poey, 1868, *Platophrys nebularis* Jordan and Gilbert, 1884, and *Bothus atlanticus* Kyle, 1913.

The description of *Platophrys nebularis* Jordan and Gilbert (1884:31) includes three specimens that have been collected from Key West, Florida. The meristic and morphological data (body depth at about 75% of SL, head length 25% of HL, 85 dorsal-fin rays, 64 anal-fin rays, 75 lateral-line scales) presented by Jordan and Gilbert are congruent with the observations made on *Bothus ocellatus* (Table 32). Furthermore, the pigmentation and colouration patterns described by Jordan and Gilbert (ocular side light grayish with reddish tinge, covered with small round spots of dark gray and light rings of the ground color, two black spots in the lateral line, with black spots scattered all over the coloured side) are also congruent with *Bothus ocellatus*. There is no reference to two black blotches on the caudal fin, a diagnostic character for both *Bothus ocellatus* and *Bothus robinsi* Topp & Hoff, 1972 (also distributed in Florida). Based on to the locality of the type specimens, the matching meristics, and the pigmentation pattern described of the ocular side, *Platophrys nebularis* Jordan and Gilbert, 1884 is a most likely a junior synonym of *Bothus ocellatus* (Agassiz 1831) however, without a description of the caudal fin pigmentation I can only recognize it as a synonym of *B. ocellatus*.

Rhomboidichtys spinosus Poey 1868 has been identified as a synonym of *Bothus ocellatus* (Norman 1934:222), with MCZ 11345 retained as the holotype. There is a description of the species in Jordan and Goss (1889:265) stating the species was collected in the West Indies. The description

contains the following counts: dorsal-fin ray count of 70, anal-fin ray count of 54; lateral line count of about 80; body covered with pale round blotches with dark blotches on the fin; and spines on the snout. The pigmentation of the type specimen has degraded significantly and as such cannot be used for identification. The meristics, morphological data, pigmentation pattern, and locality from the description coincide with the results observed for *Bothus ocellatus* and *Bothus robinsi*. Consequently, without the pigmentation pattern of the caudal fin I conclude that *Rhomboidichthys spinosus* Poey 1868 is recognized as a synonym of *Bothus ocellatus* Agassiz 1831 until further evidence is presented.

Rhombus bahianus Castelnau 1855 is currently synonymized with *Bothus ocellatus* (Norman 1934). It was described as coming from the east coast of Brazil in Bahia. After reviewing the figure (Fig 60, Castelnau, 1855: Pls 41), the original type description, and the meristic data (body depth 50% of SL, 70 dorsal-fin rays, 7 pectoral-fin rays) of the *R. bahianus* holotype MNHN 1999-0412, it is apparent that *R. bahianus* could be a synonym of *Bothus ocellatus or Bothus robinsi* based on the meristic values. The body depth (*B. ocellatus* at 54%–71% of SL, *B. robinsi* 37%–90% of SL) and lateral-line scale count (60–78 in *B. ocellatus* ,64–83 in *B. robinsi*)) are similar in all three species. The figure shows no distinct pigmentation on the body or caudal fin section, which identify diagnostic characters of *B. ocellatus* and *B. robinsi,* as set by this study. The lack of pigmentation could simply be a depiction error, however the geographical distribution of *Rhombus bahianus* does overlap with both species. Based on the observations made on this species I conclude that *Rhombus bahianus* will be recognized as a synonym of *B. ocellatus* until further evidence is presented.

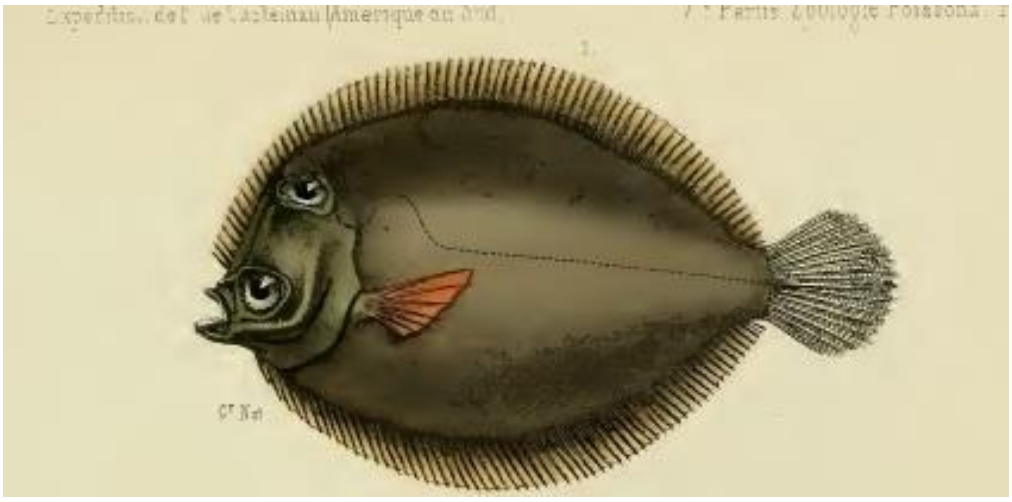


Figure 60. Original plate from Castelnau, 1855 depicting *Rhombus bahianus*.

Comparisons *Bothus ocellatus* can be distinguished from all other species of *Bothus* by its lateral-line scale count of 68–78; short pectoral fin on the ocular side, absence eye appendages, and the orange, red, grey, and the black mottled colouration of the body and anal/dorsal-fin rays. *Bothus ocellatus* most closely resembles *Bothus robinsi* (Topp and Hoff, 1972) based on their meristics (dorsal-fin rays 78–92 in both *B. robinsi* and *B. ocellatus*, anal-fin ray 56–67 in *B. robinsi* and 56–70 in *B. ocellatus*), lateral-line scales with 64–83 in *B. robinsi* and 67–78 in *B. ocellatus)*, morphology (Body depth 37%–90% of SL in *B. robinsi* and 54%–75% of SL in *B. ocellatus*, interorbital distance 16%–69% of HL in *B. robinsi* and 9%–59% of HL in *B. ocellatus*), colourful body pigmentation pattern, and geographic distribution (Tropical Atlantic Ocean, Coasts of Florida, Gulf of Mexico, and Caribbean Sea). They can be distinguished by the arrangement of the caudal fin blotches. *B. ocellatus* has two caudal blotches arranged vertically across the caudal, whereas *B. robinsi* has them arranged horizontally through the medial section of the caudal fin (Fig. 73), as well as the superior pectoral-fin ray on the ocular side is extended in *B. robinsi* (Fig. 73) whereas *B. ocellatus* exhibits no pectoral-fin ray extension.

Bothus pantherinus (Rüppell, 1830)

Figures 61 - 64; Tables 34 - 37

Figure 61. *Bothus pantherinus* (Rüppell 1830) Lectotype from SMF 7550, 100.22 mm SL, from Red Sea. Ocular and blind sides.

Synonym(s): None.

Common name(s): Leopard flounder (English), Panther flounder (English).

Material examined: *Bothus pantherinus,* 37 specimens (33.59-335 mm SL); *Passer marchionessarum* MNMH-8777 holotype (335 mm SL) stuffed specimen, Marquesas Islands.

Type material: Lectotype SMF 7550 (100.22 mm SL), Red Sea.

Non-type material: Paratypes SMF 7551(2) (109.83-116.01 mm SL), Red Sea; BPBM 35848(97.26 mm SL), Gulf of Oman; ANSP 85376 (106.3 mm SL), Red Sea; ANSP 8835 (68.59 mm SL), Hawaii; SMF 24863 (53.88 mm SL); SMF 18281 (89.3 mm SL), Red Sea; ANSP 85981 (38.99 mm SL), Mariana Islands; SMF 20242 (89.11 mm SL), Marshall Islands; USNM 138091 (5) (94.68-174.25 mm SL), Sulu Sea, Philippines; SMF 5997 (98.27 mm SL), Nicobar Islands; BPBM 25702 (142.51 mm SL), Marquesas Islands; ROM 56914 (89.95 mm SL), Comoros; ANSP 145289 (4) (75.28-112.1 mm SL), Fiji; ROM 43430 (2) 110.54-114.05 mm SL),Fiji; ROM 74063 (2) (139.5-150.77 mm SL), Mauritius; ROM 74063 (108.1 mm SL), Mauritius; ANSP 153409 (2) (33.59-44.42 mm SL), Madagascar; ANSP 145290 (2) {54.46-143.1 mm SL), Tonga; ROM 72906 (151.17 mm SL), South Africa; BPBM 15712 (3) (139.5-150.77 mm SL); BPBM 29230 (89.95 mm SL).

Diagnosis: A species of *Bothus* with the following combination of characters: convex profile of head; 0–2 eye appendages present; pectoral fins greatly extended in males 45%—90% of SL; one dark diffuse blotch larger than ventral eye diameter, near caudal on posterior one fourth of body, no distinct blotches on dorsal or anal-fin rays.

Description: A species of *Bothus* reaching a maximum standard length of 335 mm (in examined specimens); Meristic and morphometric characters indicated in Table 34; body less ovate, body depth reaching 39%–62% of SL; head length 26%– 32% of SL, head depth 29%–56% of SL; profile of head convex, slightly steep; faint notch above maxillary (Figs. 61, 62); branching spines on snout in males, simple bump on the snout in females; interorbital distance concave, 12%–21% of HL; multiple spines present on orbitals in some males; ventral eye diameter 22%–30% of HL,0-2 appendages on ventral eye, 0–2 appendages on dorsal eye; appendages on both males and females; 7–10 hourglass shaped supracranial pterygiophores, 14–16 dorsal-fin pterygiophores before first elongated neural spine; mouth ocular-side 17%–34% of HL, blind side mouth 25%—34% of HL; teeth shape conical, oriented medially, biserial; 5– 12 gill-rakers on lower limb of first gill arch, 0–6 gill-rakers on upper part of the first gill arch; lateral line with 60– 91 scales, bifurcated or trifurcated supratemporal branch; scales ctenoid on ocular side, cycloid on blind side; asymmetrical pectoral-fin rays with 9–12 rays on the ocular side and 8–12 on the blind side; ocular-side fin rays longer 10%–90% of SL, blind side is shorter; males with greatly extended pectoral ray 45%—90% of SL; 78–99 dorsal-fin rays, 57–74 anal-fin rays, 17 caudal-fin rays; 10–11 precaudal vertebrae, 25–29 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: Ocular-side of body light red tint to orange brown (Figs.62), with blind side slightly lighter in color; dark and light speckles throughout body, dorsal, anal, caudal rays; one large dark diffuse pigmentation in lateral line, located in posterior one fourth of body proximal to caudal peduncle (Fig. 62); ocular-side pectoral fin has small light and dark speckled pigmentation present, blind side pectoral without pigmentation; blind side caudal-fin ray has two dark horizontal spots traversing median of fin ray, small dark speckles on blind side anal and dorsal-fin rays; caudal fins exhibit dark speckling on blind side, no other pigmentation on blind side. Holotype specimen pigmentation pattern has degraded through conservation process.

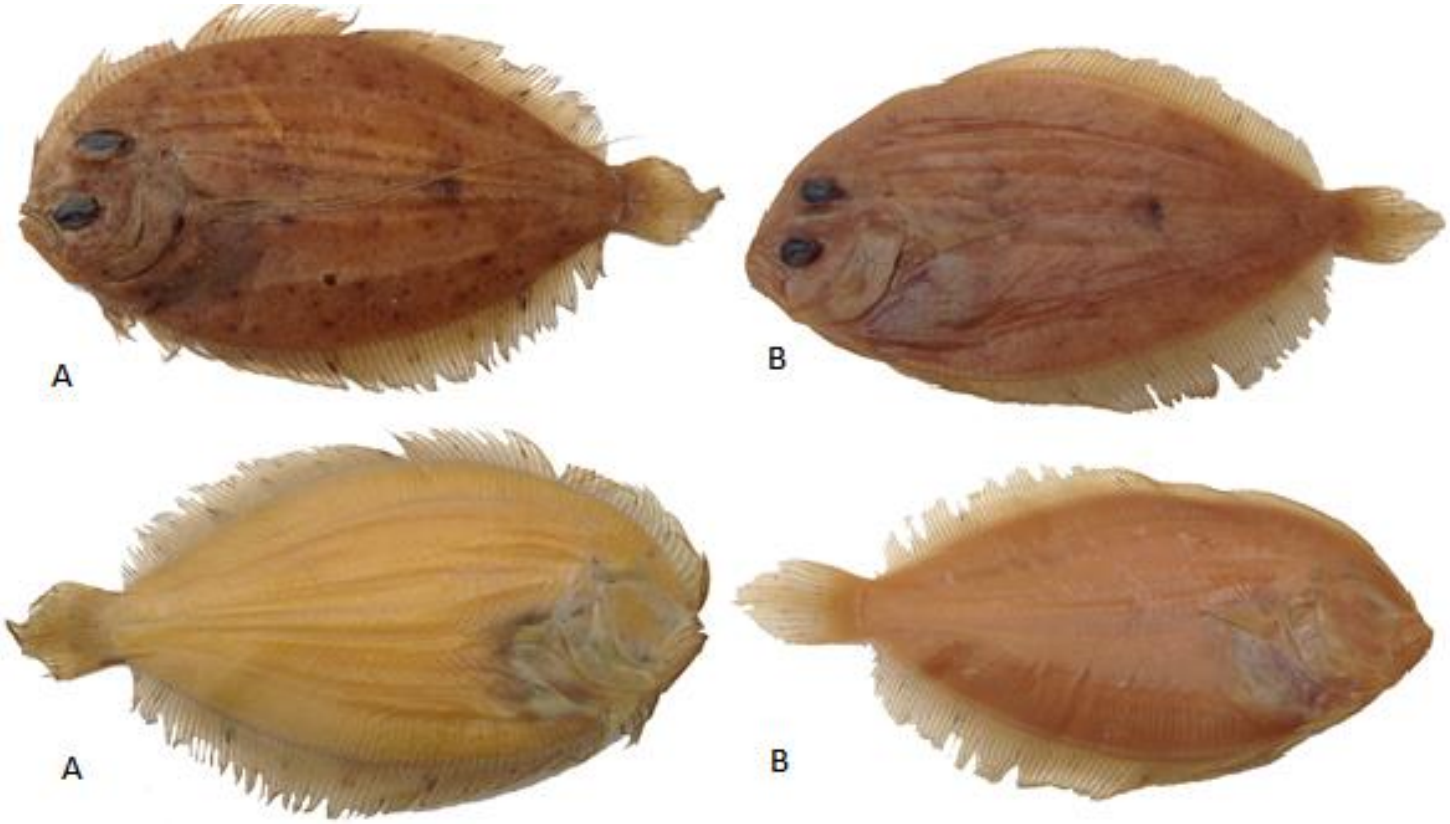


Figure 62. Depicting sexual dimorphism of *Bothus pantherinus.* BPBM 15712, 150.77 mm SL, male (A); ANSP 110.54 mm SL, Female (B).

Table 34. Meristic and morphometric data for the Lectotype SMF 7550, Paratype (2) SMF 7551, 7552, Holotype *Passer marchiossearum* and non-type specimens of *Bothus pantherinus.* Data for were obtained from type material and compared against non-type material (n= 33; 6 male, 27 female). All measurements and abbreviations are described in Appendix B.

	B. pantherinus SMF 7550 lectotype	*B. pantherinus* paratype specimens (n=2)	*B. pantherinus* non-type specimens (n=33)	*Passer marchchionessarum* Valenciennes MNHN A-8777 holotype
Standard length	100.22	109.83-116.01 (112.92;4.37)	33.59-174.25 (101.85;36.19)	335
Total length	119.9	132.14-140.51 (136.33;5.92)	40.62-200.96 (120.88;42.58)	396
Counts				
Dorsal-fin ray	82	78-84 (81.;4.24)	80-99 (89.07;4.29)*	94
Anal-fin ray	60	61-63 (62.;1.41)	57-73 (67.31;3.78)*	74
Caudal-fin ray	17	17 (17;0)	17 (17.;0.)*	17
Precaudal vertebrae	10	10 (10;0)	10-11 (10.03;0.19)*	
Caudal vertebrae including urostyle	26	25-26 (25.5;0.71)	26-29 (27.83;0.6)*	
Hourglass shaped pterygiophores of dorsal-fin	7	7 (7;0)	7-10 (8.24;0.58)*	
Dorsal-fin pterygiophores anterior to first elongated neural spine	13	14 (14;0)	13-15 (14.07;0.53)*	
Gill rakers on lower limb of first gill arch	6	8 (8;0)	5-12 (7.03;1.18)*	*
Gill rakers on upper limb of first gill arch	3	0 (0;0)	0-6 (2.25;1.81)	*
Dorsal-eye appendage	0	0 (0;0)	0-2 (0.8;0.76)*	0
Ventral-eye appendage	0	0 (0;0)	0-2 (0.77;0.73)	2
Pectoral-fin rays o.s.	10	9-10 (9.5;0.71)	9-12 (10.27;0.64)*	12
Pectoral-fin rays b.s.	9	9 (9;0)	8-11 (9.97;0.82)*	12
Pelvic-fin rays o.s.	6	6 (6;0)	6 (6;0)*	6
Pelvic-fin rays b.s.	6	6 (6;0)	6 (6;0)*	6
Lateral-line scales	75	76-79 (77.5;2.12)	71-91 (80.7;4.2)*	86
Measurements				
%SL				
Body Depth	0.53	0.53-0.55 (0.54;0.01)	0.51-0.62 (0.55;0.02)	0.39
Head length	0.26	0.28-0.29 (0.29;0.01)	0.26-0.32 (0.29;0.01)	0.26
Head depth	0.37	0.4-0.42 (0.41;0.02)	0.36-0.56 (0.45;0.05)	0.29
Length of pectoral fin o.s.	0.24	0.19-0.2 (0.2;0.01)	0.1-0.9 (0.29;0.23)*	0.13
Length of pectoral fin b.s.	0.13	0.13-0.15 (0.14;0.01)	0.11-0.17 (0.14;0.01)*	0.12
Length of pelvic fin o.s.	0.11	0.11-0.12 (0.12;0.01)	0.08-0.15 (0.11;0.01)*	0.06
Length of pelvic fin b.s.	0.10	0.1-0.1 (0.1;0.01)	0.05-0.11 (0.09;0.01)*	0.07
Length of base of pelvic fin o.s.	0.09	0.1-0.12 (0.11;0.01)	0.05-0.14 (0.12;0.02)*	0.09
Length of base of pelvic fin b.s.	0.04	0.04-0.05 (0.05;0.0048)	0.04-0.06 (0.05;0.01)*	0.04
Length of first dorsal-fin ray	0.06	0.07 (0.07;0)	0.04-0.09 (0.07;0.01)*	0.05
Length of first anal-fin ray	0.07	0.09-0.1 (0.09;0.01)	0.05-0.09 (0.07;0.01)*	0.05
Depth of caudal peduncle	0.11	0.11-0.12 (0.11;0.01)	0.1-0.13 (0.11;0.01)*	0.09
%HL				
Preorbital length	0.35	0.28-0.36 (0.32;0.06)	0.31-0.41 (0.36;0.03)*	0.08
Postorbital length	0.29	0.28-0.31 (0.3;0.02)	0.24-0.4 (0.31;0.03)*	0.28
Predorsal distance b.s.	0.13	0.14-0.15 (0.14;0.01)	0.09-0.18 (0.13;0.02)*	0.21
Dorsal eye distance from anterior edge of head	0.16	0.14-0.18 (0.16;0.03)	0.15-0.23 (0.18;0.02)*	0.13
Snout length (o.s.)	0.21	0.21-0.24 (0.22;0.02)	0.18-0.27 (0.22;0.02)*	0.4
Snout to nostril distance (o.s.)	0.16	0.17-0.19 (0.18;0.02)	0.09-0.22 (0.16;0.02)*	
Length of mouth o.s.	0.25	0.23-0.24 (0.24;0.01)	0.17-0.34 (0.26;0.03)*	0.19
Length of mouth b.s.	0.26	0.25-0.26 (0.25;0.01)	0.24-0.34 (0.29;0.02)*	0.21
Ventral eye diameter	0.25	0.22-0.24 (0.23;0.01)	0.22-0.3 (0.26;0.02)*	
Width of dorsal orbital	0.32	0.31-0.34 (0.33;0.02)	0.28-0.37 (0.32;0.03)*	
Interorbital Distance	0.19	0.17 (0.17;0)	0.12-0.21 (0.17;0.02)*	0.36

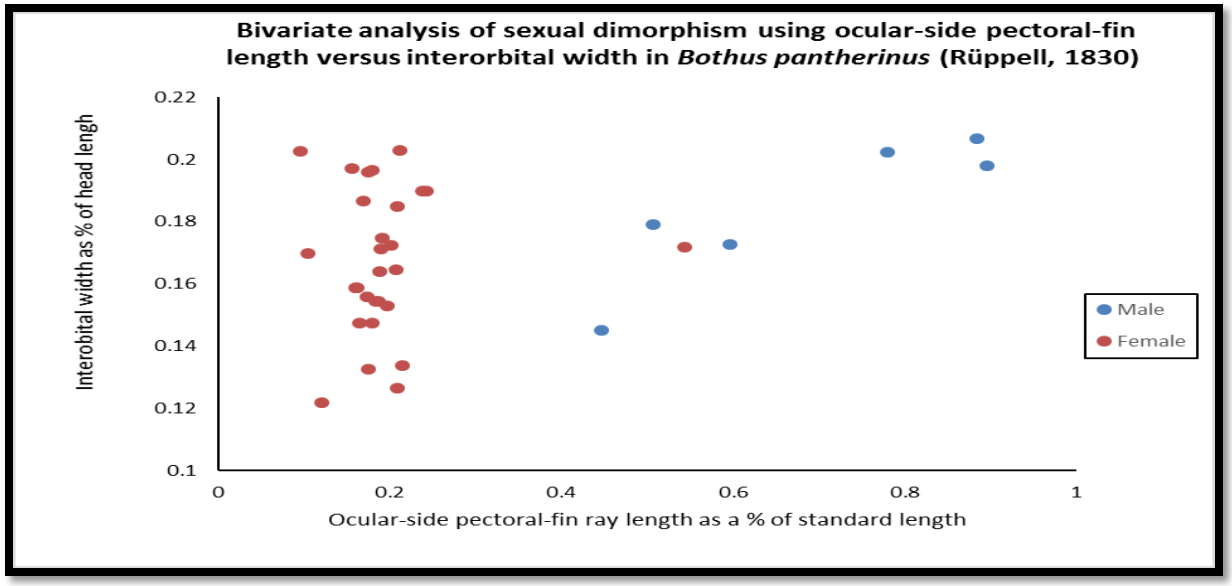
*indicates a character could not be collected for one specimen
Blank space indicates where data could not be obtained

Sexual dimorphism: Sexual dimorphism is characterized in *Bothus pantherinus* (Table 35) by the following characters: males generally with one to two spines on snout; no spine or small bump on snout in females; males with up to nine spines on anterior margins of eyes; both males and females with eye appendages; males generally with more; male's pigmentation pattern more apparent on body with darker blotches and larger pigmentation markings. Male's greater extension of the ocular-side pectoral-fin ray was found to be very highly significant (t (32) =3.5, $p < 0.001$) when discriminating sex.

Table 35. Morphometric comparison and bivariate analysis of males and females of *Bothus pantherinus* (Rüppell 1830) type and non-type material (N= 33, 6 males, 27 females). Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	B. pantherinus SMF 7550 lectotype	*B. pantherinus paratype specimens (female, n=2)*	*B. pantherinus non-type specimens (n=33)*	
Character	Female	Female, n=6	Male, n=6	Female, n=27
Standard length	100.22	109.83-116.01 (112.92;4.37)	98.27-150.77 (124.54;20.3)	33.59-174.25 (96.8;37.25)
Count				
Number of eye appendages		0-1 (0.83;0.41)	2-4 (3.67;0.82)*	0-3 (0.93;1.07)*
Number of spines on orbitals			0-9 (4.67;3.72)*	
Measurements				
%SL				
Head length	0.26	0.28-0.29 (0.29;0.01)	0.27-0.29 (0.28;0.01)*	0.26-0.32 (0.29;0.02)*
Head depth	0.37	0.4-0.42 (0.41;0.02)	0.36-0.46 (0.41;0.04)*	0.37-0.56 (0.45;0.05)*
Length of pectoral-fin ray o.s.	0.24	0.19-0.2 (0.2;0.01)	0.45-0.9 (0.68;0.19)*	0.1-0.54 (0.19;0.08)*
%HL				
Interorbital distance	0.19	0.17 (0.17;0.)	0.14-0.21 (0.18;0.02)*	0.12-0.2 (0.17;0.02)*

*indicates a character could not be collected for one specimen
Blank space indicates where data could not be obtained



Geographic distribution: *Bothus pantherinus* has a wide distribution within the Pacific, Indian, and Indo-pacific oceans. It has been specifically reported in Mohila, Red Sea(Rüppell 1830), Amami islands Amaoka (1969), Persian Gulf, Seychelles, Amirates, Maldives, Madagascar, Zanzibar, Mombosa, Durban, Mauritius, Karachi, Nicobar, Java Sea, Amboya, New Britain, Goram, Philippines, Lord Howe Island, Queensland, Hawaii, Samoa, Fiji, Tahiti, Ponape (Norman 1934), India (Mishra and Krishnan 2003), Red Sea and Coast of Turkey (Bilecenoglu,Taskavak, Mater, Kaya 2002), South Africa and Mauritian Island (Heemstra, P. C. and E. Heemstra 2004), Hawaii and South Pacific (Randall 2005, 2007), Kogashima-Japan (Ohashi and Motomura 2011), East Indies (Allen and Erdmann 2012), Coast of Saudi Arabia (Bogorodsky *et al.* 2014).

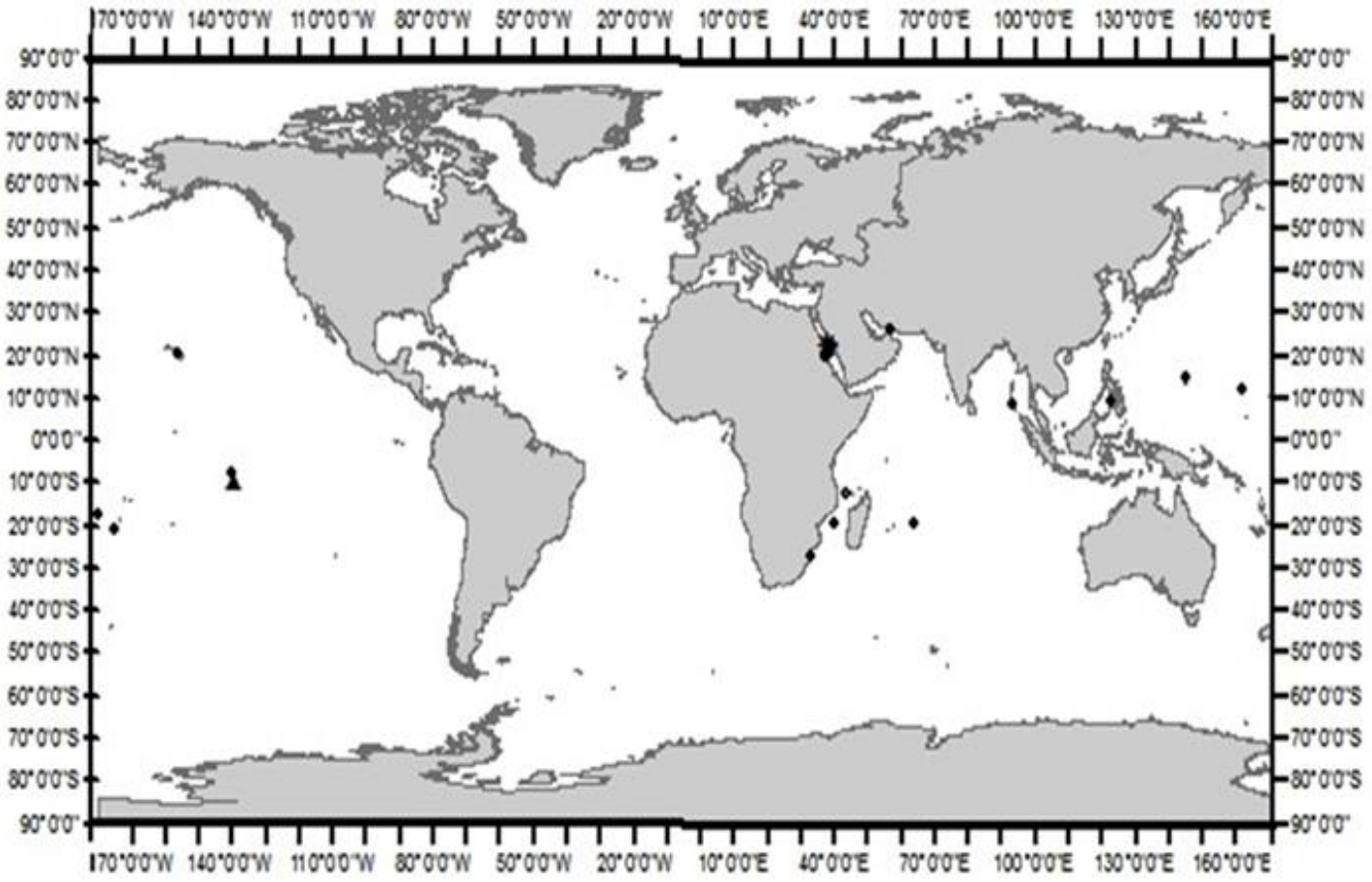


Figure 63. Geographical distribution of examined specimens of *Bothus pantherinus.* Asterisks denotes locality of SMF 7550 Holotype, and Paratypes SMF 7551, SMF 7552 specimens of *Bothus pantherinus*; triangle denotes locality of MNHN A-8777 holotype of *Passer marchionessarum* Valenciennes 1846.

Remarks: *Bothus pantherinus* was first described by as *Rhombus pantherinus* Rüppell, 1830. The current synonyms of *Bothus pantherinus* include *Passer marchionessarum* Valenciennes, 1846, and *Citharichthys aureus* Day 1877 (Eschmeyer, 2015). *Citharichthys aureus* has been reclassified as a synonym to *Bothus myriaster* in this *study* (see *Bothus myriaster*, pg. 149).

Passer marchionessarum Valenciennes, 1846 is listed as a synonym of *Bothus pantherinus* in Norman (1934). After reviewing the meristic and morphology as well as the literature, it has been concluded that *Passer marchionessarum* most closely resembles *Bothus mancus, Bothus tricirrhitus*, and *Bothus pantherinus.* The resemblance to *B. tricirrhitus* is based on the presence of a large band traversing the blind side vertically at the median of the body (Fig. 64), which is a diagnostic feature of *B. tricirrhitus*. Problematically *P. marchionessarum* exhibits only two ventral eye appendages, whereas the other diagnostic character of *B. tricirrhitus* is the presence of exactly three slender eye appendages on the posterior of each eye and as such forfeit *P. marchionessarum* as a possible junior synonym. Another problem with this resemblance is that the dark banding could be the result of a preservation error on the *P. marchionessarum* stuffed and mounted specimen. Therefore *P. marchionessarum* Valenciennes, 1846 should not be placed as a synonym of *B. tricirrhitus*.

The resemblance of *B. mancus* (Broussonet, 1782) to *B. pantherinus* is based on similar meristics, morphological, and geographical distributions shared by the two species. The meristic data accumulated for *B. mancus* (i.e. dorsal-fin ray count, anal-fin ray count, pectoral-fin ray count, interorbital distance, and SL) show significant congruencies with the type specimen of *P. marchionessarum* (Table 36). Only species of *B. mancus* observed in this study reached the length as large as the holotype of Valenciennes, 1846. The collection location of *P. marchionessarum* (Marquesas Islands) is similar to that of the geographic distribution of *B. mancus* (South Pacific). However, *P. marchionessarum*). *P. marchionessarum* cannot be specified as a synonym of *Bothus mancus* because of

the ocular side lacking distinct pigmentation (large white blotches the size of the ventral eye) and the presence of the dark band vertically traversing the blind side of its body. This band may be a preservation error as the specimen is stored as a stuffed and mounted specimen, however the lack of ocular side pigmentation cannot be ignored. *P. marchionessarum* also lacks the large triangular protuberance on anterior of ocular-side maxillary, which is a diagnostic character of *Bothus mancus*. Based on the observations made I conclude that until new specimens of *Passer marchionessarum* Valenncienes 1846 are collected I am not able to conclude the status of the synonym, thus it shall remain as a synonym of *Bothus pantherinus* as previously proposed by Norman (1934).

Passer marchionessarum was doubtfully placed as a synonym of *Bothus pantherinus* Norman (1934) although not stated why. Valenciennes, 1846 originally stated that the specimen resembled *Bothus podas* however, after reviewing the type specimen it is obvious that it is not a *B. podas.* Desoutter, Chapleau, Munroe, Chanet and M. Beaunier, 2001, also examined the specimen and concluded that it did not belong to the genus *Bothus* and should instead be classified as a synonym of Scopthalmidae. Therefore, based on the observations made on the specimen and the literature reviewed, I corroborate and conclude that it be deemed a synonym of the Scopthalmidae and not of *Bothus*.

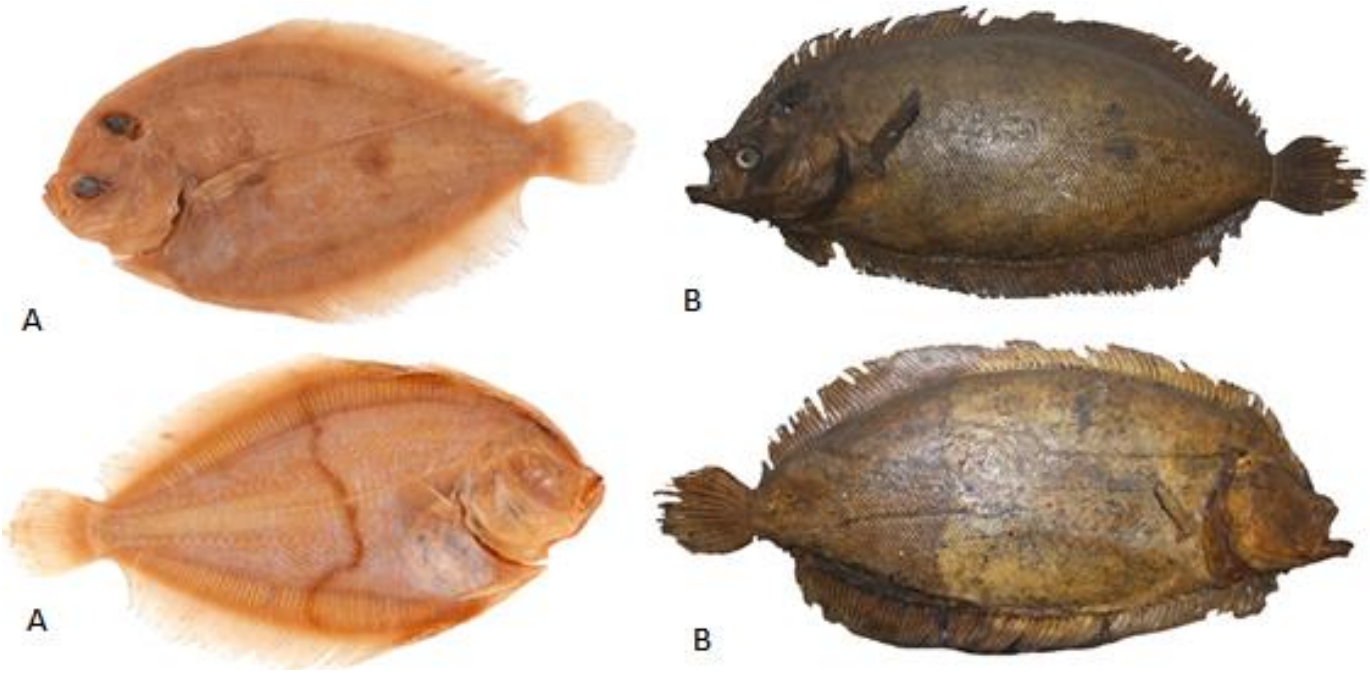


Figure 64. Ocular and blind side of *Bothus tricirrhitus* ZMH 5559 Holotype, 117.38 mm SL, North coast of Somalia, (**A**); compared with *Passer marchionessarum* MNHN A-8777 Holotype 335 mm SL, Marquesas Islands, (B).

Table 36. Comparisons of meristic and measurement ratio data for *Bothus mancus* original description, *Bothus mancus* non-type material, *Bothus pantherinus* lectotype and paratype (2), *Bothus pantherinus* non-type and *Passer marchionessarum* holotype. Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	Broussonet 1758 *Pleuronectes mancus* Original Description	*B. mancus* non-type specimens (n=20)	*B. pantherinus* SMF 7550 Lectotype	*B. pantherinus* paratype specimens (n=2)	*B. pantherinus* non-type specimens (n=33)	*Passer marchionessarum* Valenciennes 1846 MNHN A-8777 holotype
Standard length		39.93-284 (118.2;69.57)	100.22	109.83-116.01 (112.92;4.37)	33.59-174.25 (101.85;36.19)	335
Total length		40.13-350 (139.04;86.4)	119.9	132.14-140.51 (136.33;5.92)	40.62-200.96 (120.88;42.58)	396
Counts						
Dorsal-fin ray	94	87-103 (97.67;4.77)*	82	78-84 (81.;4.24)	80-99 (89.07;4.29)*	94
Anal-fin ray	80	66-82 (75.94;4.49)*	60	61-63 (62.;1.41)	57-73 (67.31;3.78)*	74
Caudal-fin ray	17	16-18 (17;0.34)	17	17 (17;0)	17 (17.;0.)*	17
Precaudal vertebrae		10-11 (10.12;0.33)	10	10 (10;0)	10-11 (10.03;0.19)*	
Caudal vertebrae including urostyle		28-30 (28.88;0.7)	26	25-26 (25.5;0.71)	26-29 (27.83;0.6)*	
Hourglass shaped pterygiophores of dorsal-fin		8-9 (8.25;0.45)*	7	7 (7;0)	7-10 (8.24;0.58)*	
Dorsal-fin pterygiophores anterior to first elongated neural spine		14-16 (15.06;0.64)*	13	14 (14;0)	13-15 (14.07;0.53)*	
Gill rakers on lower limb of first gill arch		6-12 (9.44;1.76)*	6	8 (8;0)	5-12 (7.03;1.18)*	
Gill rakers on upper limb of first gill arch		0-4 (0.22;0.94)	3	0 (0;0)	0-6 (2.25;1.81)*	
Dorsal-eye appendage		0-2 (0.33;0.69)	0	0 (0;0)	0-2 (0.8;0.76)*	
Ventral-eye appendage		0-1 (0.28;0.46)	0	0 (0;0)	0-2 (0.77;0.73)*	2
Pectoral-fin rays o.s.	13	10-13 (11.67;0.77)*	10	9-10 (9.5;0.71)	9-12 (10.27;0.64)*	12
Pectoral-fin rays b.s.	12	10-12 (11.11;0.9)*	9	9 (9;0)	8-11 (9.97;0.82)*	12
Pelvic-fin rays o.s.	6	6 (6;0)*	6	6 (6;0)	6 (6;0)*	6
Pelvic-fin rays b.s.		6 (6;0)*	6	6 (6;0)	6 (6;0)*	6
Lateral-line scales		75-99 (84.25;5.37)*	75	76-79 (77.5;2.12)	60-91 (79.96;5.69)*	86
Measurements						
%SL						
Body Depth		0.49-0.64 (0.56;0.03)	0.53	0.53-0.55 (0.54;0.01)	0.51-0.62 (0.55;0.02)	0.39
Head length		0.25-0.32 (0.29;0.02)	0.26	0.28-0.29 (0.29;0.01)	0.26-0.32 (0.29;0.01)	0.26
Head depth		0.36-0.55 (0.45;0.05)*	0.37	0.4-0.42 (0.41;0.02)	0.36-0.56 (0.45;0.05)	0.29
Length of pectoral fin o.s.		0.17-0.38 (0.21;0.06)	0.24	0.19-0.2 (0.2;0.01)	0.1-0.9 (0.29;0.23)*	0.13
Length of pectoral fin b.s.		0.12-0.15 (0.14;0.01)	0.13	0.13-0.15 (0.14;0.01)	0.11-0.17 (0.14;0.01)*	0.12
Length of pelvic fin o.s.		0.08-0.15 (0.1;0.02)*	0.11	0.11-0.12 (0.12;0.01)	0.08-0.15 (0.11;0.01)*	0.06
Length of pelvic fin b.s.		0.07-0.11 (0.09;0.01)*	0.10	0.1-0.1 (0.1;0.01)	0.05-0.11 (0.09;0.01)*	0.07
Length of base of pelvic fin o.s.		0.08-0.12 (0.1;0.01)*	0.09	0.1-0.12 (0.11;0.01)	0.05-0.14 (0.12;0.02)*	0.09
Length of base of pelvic fin b.s.		0.03-0.06 (0.05;0.01)*	0.04	0.04-0.05 (0.05;0.0048)	0.04-0.06 (0.05;0.01)*	0.04
Length of first dorsal-fin ray		0.04-0.08 (0.06;0.01)*	0.06	0.07 (0.07;0)	0.04-0.09 (0.07;0.01)*	0.05
Length of first anal-fin ray		0.06-0.08 (0.07;0.01)*	0.07	0.09-0.1 (0.09;0.01)	0.05-0.09 (0.07;0.01)*	0.05
Depth of caudal peduncle		0.05-0.12 (0.11;0.01)	0.11	0.11-0.12 (0.11;0.01)	0.1-0.13 (0.11;0.01)*	0.09
%HL						
Preorbital length		0.11-0.44 (0.37;0.08)	0.35	0.28-0.36 (0.32;0.06)	0.31-0.41 (0.36;0.03)*	0.08
Postorbital length		0.11-0.44 (0.32;0.08)	0.29	0.28-0.31 (0.3;0.02)	0.24-0.4 (0.31;0.03)*	0.28
Predorsal distance b.s.		0.05-0.18 (0.14;0.03)	0.13	0.14-0.15 (0.14;0.01)	0.09-0.18 (0.13;0.02)*	0.21
Dorsal eye distance from anterior edge of head		0.05-0.19 (0.15;0.03)	0.16	0.14-0.18 (0.16;0.03)	0.15-0.23 (0.18;0.02)*	0.13
Snout length (o.s.)		0.07-0.27 (0.22;0.04)	0.21	0.21-0.24 (0.22;0.02)	0.18-0.27 (0.22;0.02)*	0.40
Snout to nostril distance (o.s.)		0.03-0.2 (0.17;0.04)	0.16	0.17-0.19 (0.18;0.02)	0.09-0.22 (0.16;0.02)*	
Length of mouth o.s.		0.23-0.33 (0.28;0.02)	0.25	0.23-0.24 (0.24;0.01)	0.17-0.34 (0.26;0.03)*	0.19
Length of mouth b.s.		0.24-0.32 (0.29;0.02)	0.26	0.25-0.26 (0.25;0.01)	0.24-0.34 (0.29;0.02)*	0.21
Ventral eye diameter		0.08-0.29 (0.21;0.05)*	0.25	0.22-0.24 (0.23;0.01)	0.22-0.3 (0.26;0.02)*	
Width of dorsal orbital		0.09-0.33 (0.26;0.05)*	0.32	0.31-0.34 (0.33;0.02)	0.28-0.37 (0.32;0.03)*	
Interorbital Distance		0.14-0.32 (0.23;0.07)*	0.19	0.17 (0.17;0)	0.12-0.21 (0.17;0.02)*	0.36

*indicates a character could not be collected for one specimen
Blank space indicates where data could not be obtained

Comparisons: *Bothus pantherinus* can be distinguished from all other species of *Bothus* except for *Bothus* guibei, *Bothus tricirrhitus*, and *Bothus maculiferus* by: its convex head with a slight notch above the maxillary, its less deep body (51%–62% of SL), its extended pectoral-fin rays in males (45%–90% of SL), branching orbital spines, and one dark diffuse botch located in the posterior one fourth of the body.

There morphology of *B. pantherinus, B. guibei, and B. maculiferus* are similar as displayed in Table 37. All three specimens exhibit a concave head with almost no notch above the maxillary, body depths ranging from 49%–62% of the SL, males with ocular side pectoral fins that extend over 50% of the SL, and lateral line ranging from scales at 71–91 across all species.

B. guibei can be distinguished from *B. pantherinus* through the arrangement of the blotch pattern on the caudal fin, its ocular side pectoral-fin ray length in males (76%–83% of SL) and the absence gill-rakers on the upper limb of the first arch. Secondly, *B. pantherinus* has no distinct blotch pigmentation on its dorsal or anal-fin rays, whereas *B. guibei* has two symmetrical blotches of nearly equal size situated on the dorsal and anal-fin rays in posterior quarter of body (Fig. 29). *B. guibei* is also distributed within the Atlantic near Guinea, whereas *B. pantherinus* has been observed in the Pacific, Indian, and Indo-pacific Oceans.

Bothus maculiferus can be differentiated from *B. pantherinus* by its usually higher dorsal-fin rays count at 92–98, its shorter pectoral-fin rays in males at 50%–58% of SL, and most noticeably the presence of two dark diffuse blotches on the lateral line in, as opposed to only one blotch in the posterior one fourth of the body in *B. pantherinus*. Geographically, has only been reported in the Western Atlantic Ocean, mainly in the West Indies, whereas *B. pantherinus* has been reported in the Pacific, Indian, and Indo-pacific Oceans.

Bothus tricirrhitus shares a resemblance with *B. pantherinus* by their similar extended pectoral-fin ray (75% of SL), their concave head profile with a slight notch above the maxillary, and their geographic distribution. However, *B. tricirrhitus* can easily be distinguished by the presence of exactly three ocular appendages on the posterior of each eye in, and the prominent dark band traversing vertically across the median of the blind side, which are both absent in *B. pantherinus*.

Table 37. Observed meristic and morphological ratio data compared between species of *Bothus pantherinus, Bothus maculiferus, and Bothus guibei*. Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	B. pantherinus SMF 7550 lectotype	*B. pantherinus* paratype specimens (n=2)	*B. pantherinus* non-type specimens (n=33)	*Passer marchchionessarum* Valenciennes MNHN A-8777 holotype	*B. maculiferus* non-type specimens (n=13)	*B. guibei* holotype MNHN 1964-0438	*B. guibei* paratypes MNHN specimens (n=3)
Standard length	100.22	109.83-116.01 (112.92;4.37)	33.59-174.25 (101.85;36.19)	335	41.31-216 (100.62;50.72)	184.17	165.6-190.46 (178.43;12.45)
Total length	119.9	132.14-140.51 (136.33;5.92)	40.62-200.96 (120.88;42.58)	396	51.77-241 (118.83;56.27)	229.1	197.6-229.3 (215.2;16.14)
Counts							
Dorsal-fin ray	82	78-84 (81.;4.24)	80-99 (89.07;4.29)*	94	92-98 (94.38;01.89)	87	91-94 (92.5;2.12)*
Anal-fin ray	60	61-63 (62.;1.41)	57-73 (67.31;3.78)*	74	71-77 (73.54;01.76)	71	73-75 (74;1.41)*
Caudal-fin ray	17	17 (17;0)	17 (17.;0.)*	17	17 (17;0)	17	17 (17;0)
Precaudal vertebrae	10	10 (10;0)	10-11 (10.03;0.19)*		10 (10;0)	10	10 (10;0)
Caudal vertebrae including urostyle	26	25-26 (25.5;0.71)	26-29 (27.83;0.6)*		28-29 (28.62;0.51)	28	28 (2.;0)
Hourglass shaped pterygiophores of dorsal-fin	7	7 (7;0)	7-10 (8.24;0.58)*		8-9 (8.08;0.28)	8	8 (8;0)
Dorsal-fin pterygiophores anterior to first elongated neural spine	13	14 (14;0)	13-15 (14.07;0.53)*		14-16 (14.31;0.63)	13	13 (13;0)
Gill rakers on lower limb of first gill arch	6	8 (8;0)	5-12 (7.03;1.18)*	*	7-11 (7.69;1.18)	5	6-7 (6.33;0.58)
Gill rakers on upper limb of first gill arch	3	0 (0;0)	0-6 (2.25;1.81)	*	0-3 (0.46;1.13)	0	0 (0;0)
Dorsal-eye appendage	0	0 (0;0)	0-2 (0.8;0.76)*	0	1-3 (1.38;0.65)	2	1-4 (2;1.73)
Ventral-eye appendage	0	0 (0;0)	0-2 (0.77;0.73)	2	0-2 (1.15;0.55)	2	1-6 (2.67;2.89)
Pectoral-fin rays o.s.	10	9-10 (9.5;0.71)	9-12 (10.27;0.64)*	12	10-11 (10.92;0.29)*	11	11 (11;0)
Pectoral-fin rays b.s.	9	9 (9;0)	8-11 (9.97;0.82)*	12	10-11 (10.54;0.52)	11	10-11 (10.67;0.58)
Pelvic-fin rays o.s.	6	6 (6;0)	6 (6;0)*	6	6 (6;0)	6	6 (6;0)
Pelvic-fin rays b.s.	6	6 (6;0)	6 (6;0)*	6	6 (6;0)	6	6 (6;0)
Lateral-line scales	75	76-79 (77.5;2.12)	71-91 (80.7;4.2)*	86	79-89 (84.5;3.45)	89	82-87 (85.;2.65)
Measurements							
%SL							
Body Depth	0.53	0.53-0.55 (0.54;0.01)	0.51-0.62 (0.55;0.02)	0.39	0.46-0.59 (0.55;0.03)	0.53	0.52-0.54 (0.53;0.01)
Head length	0.26	0.28-0.29 (0.29;0.01)	0.26-0.32 (0.29;0.01)	0.26	0.25-0.44 (0.30;0.04)*	0.26	0.26-0.29 (0.28;0.02)
Head depth	0.37	0.4-0.42 (0.41;0.02)	0.36-0.56 (0.45;0.05)	0.29	0.28-0.49 (0.44;0.06)	0.37	0.35-0.37 (0.36;0.01)
Length of pectoral fin o.s.	0.24	0.19-0.2 (0.2;0.01)	0.1-0.9 (0.29;0.23)*	0.13	0.15-0.58 (0.29;0.17)	0.83	0.17-0.76 (0.37;0.34)
Length of pectoral fin b.s.	0.13	0.13-0.15 (0.14;0.01)	0.11-0.17 (0.14;0.01)*	0.12	0.11-0.21 (0.14;0.02)	0.19	0.15-0.17 (0.16;0.01)
Length of pelvic fin o.s.	0.11	0.11-0.12 (0.12;0.01)	0.08-0.15 (0.11;0.01)*	0.06	0.09-0.14 (0.11;0.01)*	0.11	0.11-0.13 (0.12;0.01)
Length of pelvic fin b.s.	0.10	0.1-0.1 (0.1;0.01)	0.05-0.11 (0.09;0.01)*	0.07	0.08-0.12 (0.10;0.01)*	0.13	0.09-0.11 (0.1;0.01)
Length of base of pelvic fin o.s.	0.09	0.1-0.12 (0.11;0.01)	0.05-0.14 (0.12;0.02)*	0.09	0.10-0.12 (0.11;0.006)*	0.11	0.08-0.11 (0.1;0.02)
Length of base of pelvic fin b.s.	0.04	0.04-0.05 (0.05;0.0048)	0.04-0.06 (0.05;0.01)*	0.04	0.04-0.06 (0.05;0.01)*	0.06	0.06-0.07 (0.06;0.01)
Length of first dorsal-fin ray	0.06	0.07 (0.07;0)	0.04-0.09 (0.07;0.01)*	0.05	0.06-0.09 (0.07;0.01)*	0.12	0.07 (0.07;0)
Length of first anal-fin ray	0.07	0.09-0.1 (0.09;0.01)	0.05-0.09 (0.07;0.01)*	0.05	0.05-0.12 (0.08;0.02)*	0.08	0.08-0.09 (0.08;0.005)
Depth of caudal peduncle	0.11	0.11-0.12 (0.11;0.01)	0.1-0.13 (0.11;0.01)*	0.09	0.09-0.12 (0.11;0.01)	0.12	0.11 (0.11;0)
%HL							
Preorbital length	0.35	0.28-0.36 (0.32;0.06)	0.31-0.41 (0.36;0.03)*	0.08	0.20-0.36 (0.30;0.05)	0.26	0.26-0.31 (0.29;0.03)
Postorbital length	0.29	0.28-0.31 (0.3;0.02)	0.24-0.4 (0.31;0.03)*	0.28	0.24-0.42 (0.31;0.05)	0.46	0.36-0.48 (0.43;0.06)
Predorsal distance b.s.	0.13	0.14-0.15 (0.14;0.01)	0.09-0.18 (0.13;0.02)*	0.21	0.02-0.13 (0.09;0.03)	0.14	0.16-0.19 (0.17;0.01)
Dorsal eye distance from anterior edge of head	0.16	0.14-0.18 (0.16;0.03)	0.15-0.23 (0.18;0.02)*	0.13	0.06-0.20 (0.15;0.05)	0.17	0.15-0.17 (0.16;0.01)
Snout length (o.s.)	0.21	0.21-0.24 (0.22;0.02)	0.18-0.27 (0.22;0.02)*	0.4	0.14-0.27 (0.22;0.03)	0.23	0.22-0.23 (0.23;0.01)
Snout to nostril distance (o.s.)	0.16	0.17-0.19 (0.18;0.02)	0.09-0.22 (0.16;0.02)*		0.11-0.17 (0.15;0.02)	0.15	0.13-0.16 (0.14;0.01)
Length of mouth o.s.	0.25	0.23-0.24 (0.24;0.01)	0.17-0.34 (0.26;0.03)*	0.19	0.17-0.31 (0.26;0.04)	0.30	0.25-0.27 (0.26;0.01)
Length of mouth b.s.	0.26	0.25-0.26 (0.25;0.01)	0.24-0.34 (0.29;0.02)*	0.21	0.19-0.33 (0.27;0.04)	0.32	0.31-0.33 (0.32;0.01)
Ventral eye diameter	0.25	0.22-0.24 (0.23;0.01)	0.22-0.3 (0.26;0.02)*		0.18-0.28 (0.24;0.04)	0.26	0.2-0.27 (0.24;0.04)
Width of dorsal orbital	0.32	0.31-0.34 (0.33;0.02)	0.28-0.37 (0.32;0.03)*		0.20-0.37 (0.31;0.05)	0.26	0.2-0.27 (0.24;0.04)
Interorbital Distance	0.19	0.17 (0.17;0)	0.12-0.21 (0.17;0.02)*	0.36	0.12-0.20 (0.16;0.03)	0.21	0.17-0.2 (0.19;0.01)

*indicates a character could not be collected for one specimen
Blank space indicates where data could not be obtained

Bothus podas (Delaroche, 1809)

Figures 65 - 72; Tables 38 - 43

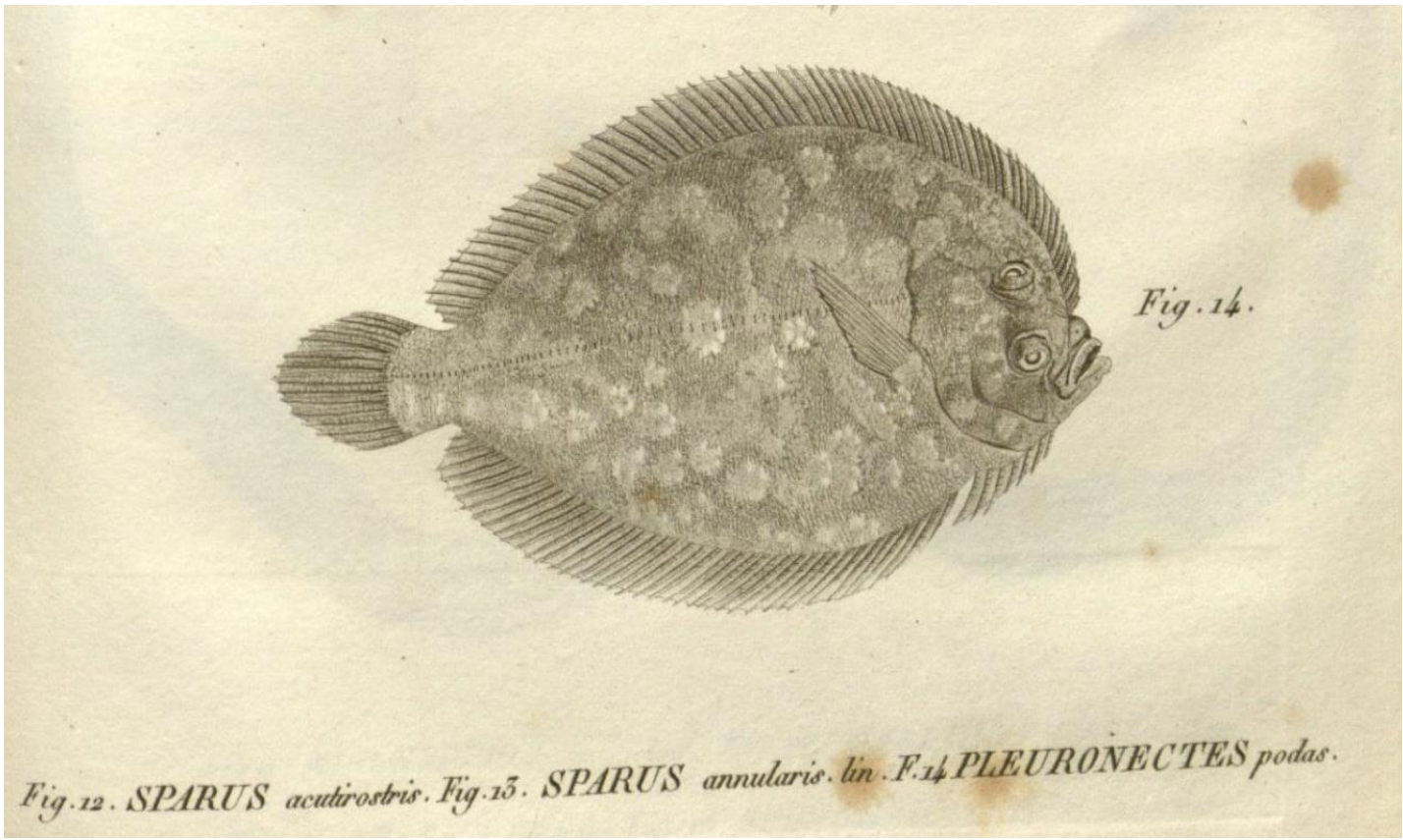


Figure 65. *Bothus podas* (Delaroche 1809) Holotype. Original Delaroche (1809) description plate: Suite du mémoire sur les espèces de poissons observées à Iviça. Observations sur quelques-uns des poissons indiqués dans le précédent tableau et descriptions des espèces nouvelles ou peu connues. Annales du Muséum d'Histoire Naturelle, Paris v. 13: 354, Pls. 20-25. Ocular side.

Synonym (s) : *Bothus rumolo* Rafinesque 1810, *Solea rhomboides* Rafinesque 1810, *Bothus diaphanus* Rafinesque 1814, *Bothus punctatus* Rafinesque 1814, *Bothus diagrammus* Rafinesque 1814, *Rhombus gesneri* Risso 1826, *Rhombus rhomboides* Bonaparte 1833, Rhombus *maderensis* Lowe 1834, *Rhombus serratus* Valenciennes 1839, *Peloria heckelii* Cocco 1844, *Bothus podas africanus* Nielsen 1961

Common name(s): Wide-eyed flounder (English)

Material examined: *Bothus podas,* 61 specimens (31.37-195.02 mm SL)

Type material: Holotype, MNHN 1999-416 (120.5 mm SL), Mediterranean. Paratype**:** *Bothus podas africanus* BMNH 1962 6.18:34-35 (76.02 mm SL), Guinea; *Bothus podas africanus* BMNH 1962 6.18:34-35 PARATYPE (small specimen) (31.37 mm SL), Guinea; *Rhombus rhomboides* USNM 164910 PARATYPE (synonym of B. *podas*) (111.78 mm SL). Syntypes**:** *Rhombus rhomboides* ANSP 8847 (2) (31.37-138.84 mm SL), Mediterranean; *Rhombus podas*, (TYPE of Rhombus serratus) MNHN 1999-313 Synonym of *Bothus podas* (2) (122.04-127.7 mm SL), Canary Islands; *Rhomboidichthys podas* SMF (107.42 mm SL).

Non-Type material: USNM 028469 (53.82 mm SL), Livorno, Italy; SMF 1409 (2) (64.51-74.28 mm SL), Messina, Sicily, Italy; SMF 23379 (117.04 mm SL), Palermo, Italy; SMF 23380 (114.71 mm SL), Palermo, Italy; ZMH 19932 (109.84 mm SL), Messina, Sicily, Italy; ANSP 149171 (11) (68.96-131.08 mm SL), Mediterranean; USNM 261530 (15) (67.69-162.92 mm SL), Lebanon; ZMH 19927 (2) (87.98-91.72 mm SL), Madeira, Portugal; ZMH 19930 (72.96 mm SL), Funchal, Madeira; MNHN A8730 (118.3 mm SL), Canary Islands; ZMH 102349 podas africanus 254-1964 (116.94 mm SL), Cape Verde, Senegal; ZMH 102351 podas africanus 282-1964 (81.46 mm SL), Senegal; ZMH 298164 podas africanus 102353 (2) (124.8-195.02 mm SL), Guinea; ZMH 101631 podas africanus 165-1963 (2)(137.33-139.82 mm SL), Guinea; ZMH 102993 podas africanus 1227-1964 (2) (113.15-134.74 mm SL), Sierra Leone; ZMH 102354 podas africanus 1207-1964 (154.96 mm SL), Ghana; ZMH 19926 (72.15 mm SL), Cameroon; SMF 23144

(2) (94.87-108.51 mm SL), Angola. *Rhombus bahianus* Type MNHN 1999-0412, 81.4 mm SL, Brazil; Rhombus rhomboides USNM 164910 (111.78 mm SL), Guinea; *Bothus podas maderensis* ANSP 88783 (4) (109.21-123.3 mm SL), Funchal, Madeira.

Diagnosis: A species of *Bothus* with the following combination of characters: steep almost straight profile of head; body depth 44–63% of SL; wide interorbital space; short pectoral rays at 6%–29% of SL; only distinct markings two dark diffuse blotches along margin of lateral line.

Description: A species of *Bothus* reaching a maximum standard length of 195.02 mm (in examined specimens). Meristic and morphometric characters are indicated in Table 38; Anterior profile of head almost straight between interorbital region, body moderately ovate, body depth reaching 44%–78% SL; head length 27%– 66% of SL, head depth 27%–66% of SL; anterior profile of head with steep slope, slope not as steep in females; males with spine on snout, females have small bump (Figs. 67, 68); interorbital distance concave, 20%–67% of HL; posterior edge of ventral eye in advance of posterior edge of dorsal eye in males; ventral spine present on orbitals in some males 0–3; ventral eye diameter 24%–35% of HL; 0–2 appendages on ventral eye, 0–3 appendages on dorsal eye; 8–11 hourglass-shaped supracranial pterygiophores, 14–16 dorsal-fin pterygiophores before first elongated neural spine; mouth ocular-side 7%–25% of HL, blind side 11%—27% of HL; teeth shape conical, biserial; 5–12 gill-rakers on lower limb of first gill arch, 0–8 gill-rakers on upper limb of first gill arch; lateral line with 74–101 scales, ending in trifurcated or bifurcated supratemporal branch; scales ctenoid on ocular side, cycloid on blind side; asymmetrical pectoral-fin rays with 10–12 rays on ocular side and 9–11 on the blind side; ocular-side pectoral-fin 6%–29% of SL, blind side 12%—16%; no rays extended greatly; 83–105 dorsal-fin rays, 61–75 anal-fin rays, 16–18 caudal-fin rays; 10–11 precaudal vertebrae, 28–30 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: Ocular-side of body tan, orange, red, brown; blind side orange tan (Figs. 67, 68)or pale yellow; generally small speckles of black, red, grey, orange (more apparent in live specimens), throughout body anal, dorsal, and caudal-fin rays; generally two dark diffuse blotches along margin of lateral line on ocular side; anterior blotch situated at junction of straight and curved portion of lateral line; posterior blotch situated on lateral line one fourth of SL from caudal peduncle about 50% of ventral eye size or larger; ocular-side pectoral fin generally with light pigmentation, blind side pectoral-fins and body without pigmentation. The pigmentation in live specimens is very different from that of preserved specimens as shown in Figure 66, however this colouration was seldom seen in specimens examined in this study and was not quantifiable for observation as the pigmentation changes so drastically during the preservation process.

Figure 66. Picture of live specimen of *Bothus podas,* depicting different skin colour and pigmentations than that of preserved specimens. Picture Taken by Hernández-González, C. L. 1998; location- Canary Islands.

Table 38. Meristic and morphometric data for the type description, Holotype MNHN 1999-0416, and non-type specimens of *Bothus podas*. Data for *Bothus podas* was obtained from original species description (Delaroche 1809), and physical examination of type and non-type material (n=39, 15 male, 24 female). All measurements and abbreviations are described in Appendix B.

	B. podas Delaroche (1809) original description	*B. podas* holotype MNHN 1999-0416	*B. podas* non-type specimens (n=39)
Standard length		120.5	53.82-162.92 (88.67;26.11)
Total length		147.5	66.56-190.96 (106.82;31.87)
Counts			
Dorsal-fin ray	89	85	83-97 (87.84;2.84)*
Anal-fin ray	70	68	61-72 (65.46;13.34)*
Caudal-fin ray	17	17	17-18 (17.03;0.16)*
Precaudal vertebrae			10-11 (9.76;1.63)*
Caudal vertebrae including urostyle			28-30 (28.18;4.56)*
Hourglass shaped pterygiophores of dorsal-fin			8-10 (8.53;1.56)*
Dorsal-fin pterygiophores anterior to first elongated neural spine			14-16 (14.34;2.49)*
Gill rakers on lower limb of first gill arch		7	5-12 (7.79;1.75)*
Gill rakers on upper limb of first gill arch		0	0-8 (4.47;1.82)*
Dorsal-eye appendage		1	0-1 (0.37;0.49)*
Ventral-eye appendage		1	0-2 (0.42;0.55)*
Pectoral-fin rays o.s.	9	10	10-12 (10.82;0.56)*
Pectoral-fin rays b.s.		9	9-11 (9.76;1.72)*
Pelvic-fin rays o.s.	6	6	6-7 (5.86;1)*
Pelvic-fin rays b.s.		6	6 (6;0)*
Lateral-line scales		79	78-101 (83.5;4.41)*
Measurements			
%SL			
Body Depth		0.61	0.44-0.63 (0.59;0.04)
Head length		0.29	0.24-0.6 (0.27;0.06)
Head depth		0.07	0.27-0.65 (0.48;0.06)
Length of pectoral fin o.s.		0.21	0.06-0.29 (0.17;0.04)
Length of pectoral fin b.s.		0.16	0.12-0.16 (0.13;0.02)
Length of pelvic fin o.s.		0.09	0.07-0.19 (0.1;0.02)*
Length of pelvic fin b.s.		0.08	0.01-0.17 (0.09;0.03)*
Length of base of pelvic fin o.s.		0.12	0.02-0.13 (0.11;0.02)*
Length of base of pelvic fin b.s.		0.03	0.01-0.11 (0.04;0.02)*
Length of first dorsal-fin ray		0.06	0.03-0.07 (0.05;0.01)*
Length of first anal-fin ray		0.08	0.04-0.09 (0.06;0.01)*
Depth of caudal peduncle		0.12	0.11-0.13 (0.12;0.005)
%HL			
Preorbital length		0.85	0.05-0.51 (0.38;0.09)*
Postorbital length		0.30	0.01-0.37 (0.28;0.06)*
Predorsal distance b.s.		0.15	0.1-0.22 (0.15;0.04)*
Dorsal eye distance from anterior edge of head		0.16	0.08-0.18 (0.13;0.02)*
Snout length (o.s.)		0.21	0.04-0.28 (0.18;0.04)
Snout to nostril distance (o.s.)		0.16	0.08-0.2 (0.14;0.03)
Length of mouth o.s.		0.24	0.07-0.25 (0.19;0.04)*
Length of mouth b.s.		0.23	0.11-0.27 (0.21;0.05)*
Ventral eye diameter		0.26	0.08-0.29 (0.36;0.42)*
Width of dorsal orbital		0.26	0.14-0.38 (0.33;0.04)*
Interorbital Distance		0.52	0.2-0.67 (0.38;0.19)*

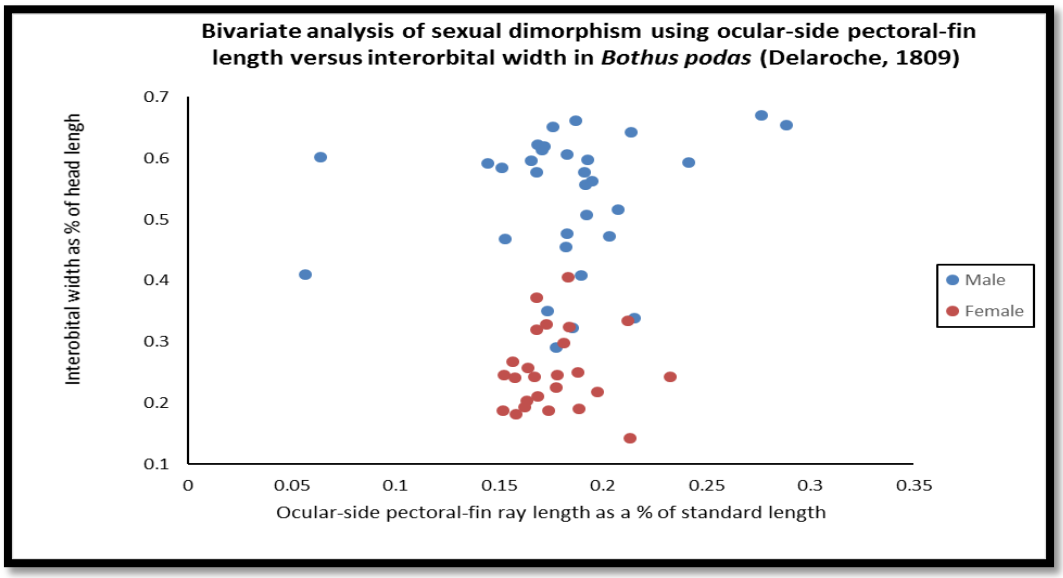
* measurements missing because of small specimen
Blank space indicates where data is missing

Sexual dimorphism: Sexual dimorphism is characterized between males and females in *Bothus podas* (Figs. 67, 68, Table 39) by the following characters: Males with spine on snout; females with small bump; some males with spines on anterior of orbits; pigmentation similar in both sexes. Male's larger interorbital space was found to be very highly significant (t (55) =12.03, $p < 0.001$) for discriminating sex. Overlapping male/female values can be explained by the presence of juvenile specimens in the analysis.

Table 39. Morphometric comparison and bivariate analysis of males and females of *Bothus podas* (Delaroche 1809) of type and non-type material (N=39, 15 males, 24 females). All measurements and abbreviations are described in Appendix B.

	B. podas holotype MNHN 1999-0416	*B.podas non-type specimens (n=39)*	
Character	Male	Male, n=15	Female, n=24
Standard length	120.50	68.96-162.92 (98.54;29.4)	53.82-118.3 (76.1;12.82)
Count			
Number of eye appendages	2	0-2 (1.5;0.89)	0 (0;0)
Number of spines on orbitals	3	0-2 (1;0.59)	
Measurements			
%SL			
Head length	0.29	0.24-0.6 (0.28;0.08)	0.25-0.29 (0.26;0.01)
Head depth	0.07	0.27-0.6 (0.48;0.06)	0.27-0.65 (0.47;0.07)
Length of pectoral-fin ray o.s.	0.21	0.06-0.29 (0.17;0.06)	0.15-0.21 (0.17;0.02)
%HL			
Interorbital distance	0.52	0.32-0.67 (0.53;0.11)*	0.14-0.37 (0.23;0.06)

*indicates a character could not be collected for some specimens
Blank space indicates where data could not be obtained



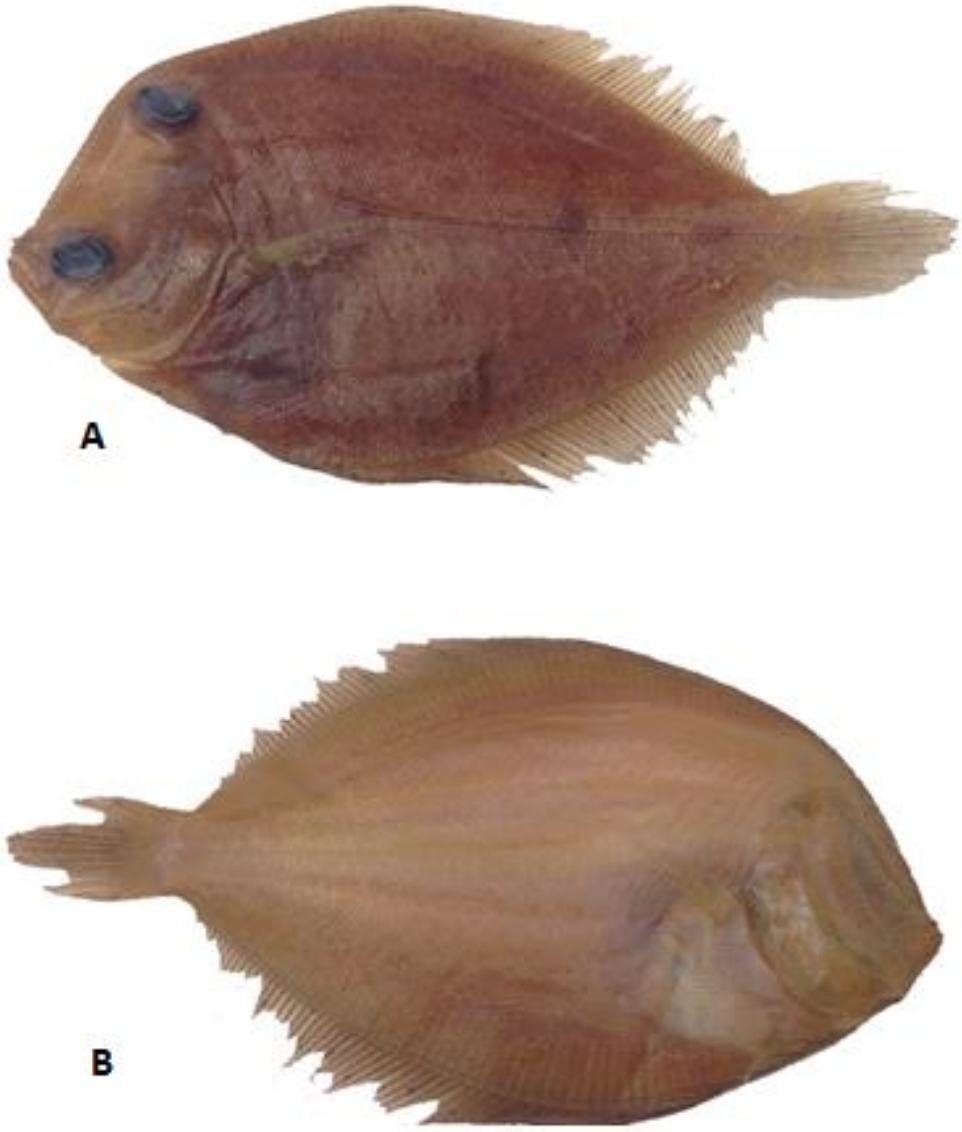


Figure 67. *Bothus podas* (Delaroche 1809) from USNM 261530 (Specimen 15) non-type specimen. 90.06 mm SL, adult male, St Georges Bay, Lebanon. Ocular and blind sides.

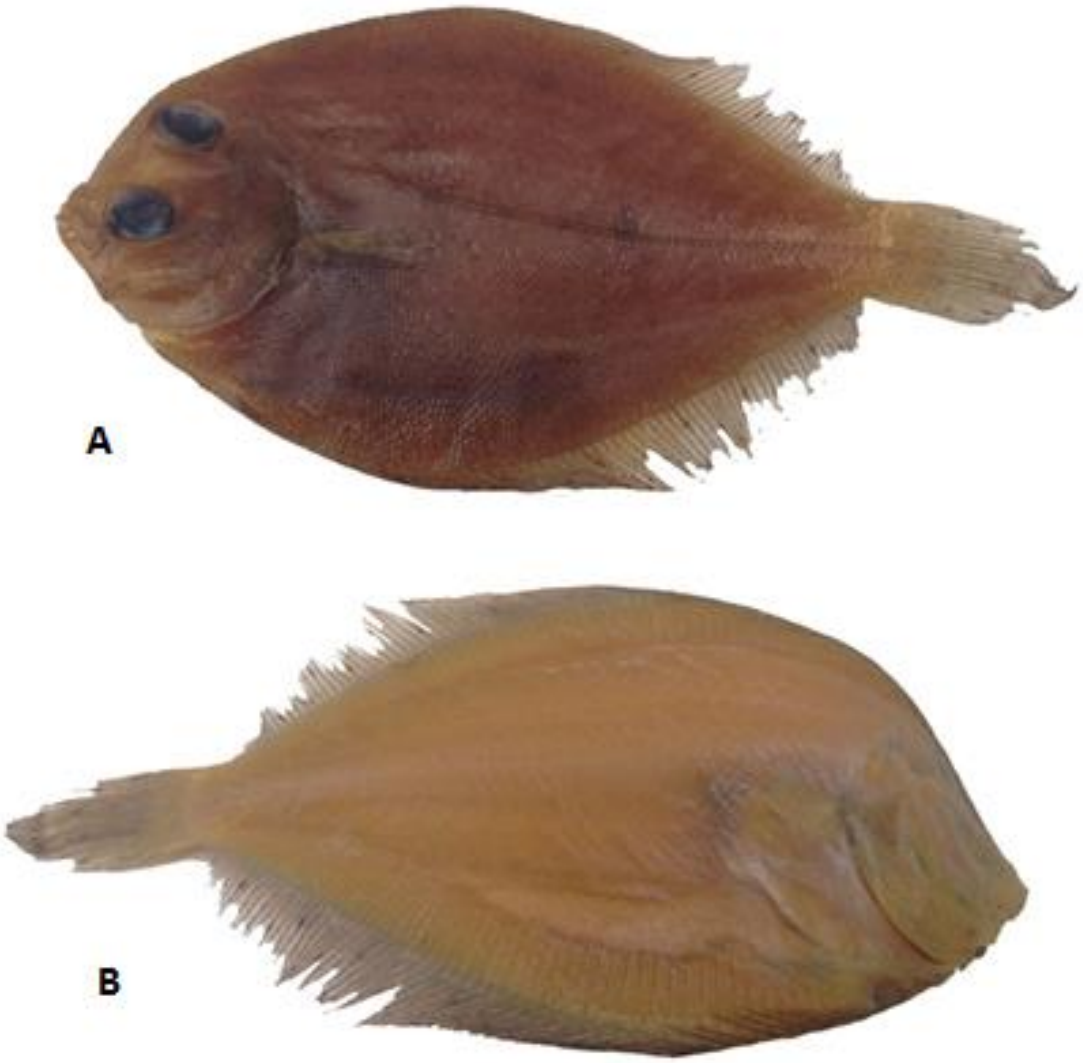


Figure 68. *Bothus podas* (Delaroche 1809) from USNM 261530 (Specimen 9) non-type specimen. 84.09 mm SL, adult female, St. Georges Bay, Lebanon. Ocular and blind sides.

Geographic distribution: *Bothus podas* has been reported in the Atlantic, Angola, Ashkelon, Canary Islands, Cyprus, Cape, Cannes, Ghana, Livorno, Lazarote, Messina, Madeira, Mediterranean, Nice, Sicily, St. Vincent, (Norman 1934), and specifically West Africa (Edwards, A.J., Anthony, C.G. and Abohweyere, P.O. 2001), Guinea (Afonso *et al.* 1999), Turkey (Fricke, R., M. Bilecenoglu and H. M. Sari 2007).

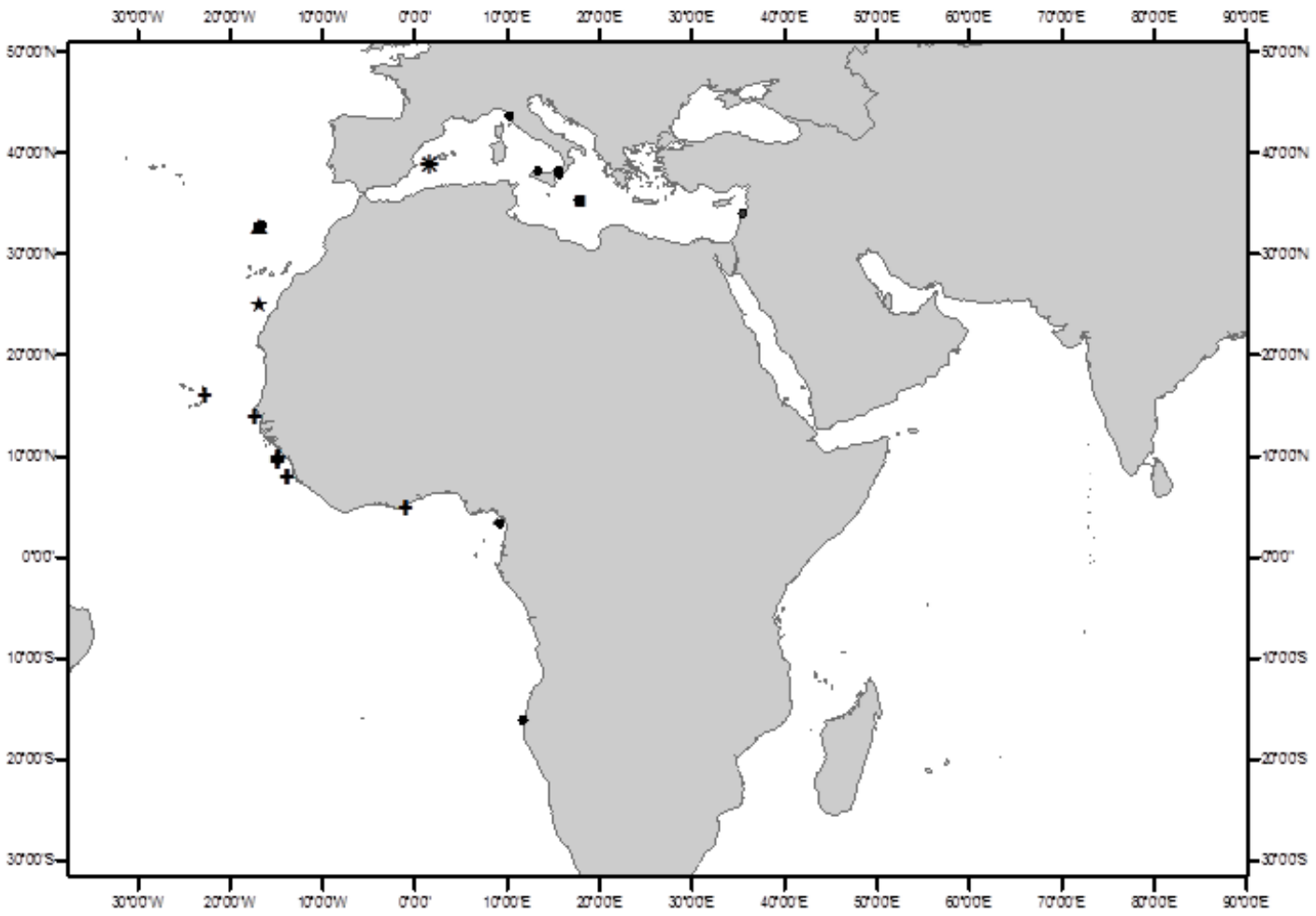


Figure 69. Geographical distribution of examined specimens of *Bothus podas*. Asterisk denotes the locality of the *Bothus podas* holotype MNHN 1999-0416; addition sign indicates *Bothus podas africanus* type and non-type material; star indicates types of *Rhombus serratus*, square represents syntype of *Rhombus rhomboides*; triangle denotes non-types of *Bothus podas maderensis*. Depth of 7-11 meters.

Remarks: The type specimen description of *Bothus* podas (Delaroche, 1809) and the meristic data obtained from examining the holotype MNHN 1999-0416 show a slight variance in data, mainly the dorsal and anal-fin rays. The examined lateral line count was 79 as opposed to the description count of 80. This is important because the lateral line count is one of the diagnostic characters of *Bothus podas*. When comparing the length given in the original description versus the length of the holotype, they are found to be congruent. Based on the matching lengths Iconclude that the examined holotype is the same as in the original description.

Pleuronectes podas was first introduced by Delaroche (1809:354). Delaroche's original description of *Pleuronectes podas* states the species as possibly being confused with the *Pleuronectes rhombus* Linneaus 1758, however he states that they are distinct because of the less rhomboidal shape and the spot pigmentation pattern present in *P*. *podas*. *Pleuronectes podas* Delaroche 1809 is currently listed as the valid species *Bothus podas* (Delaroche 1809). Two other synonyms of *Bothus podas* have been re-classified based on the designation that certain species are juvenile forms of previously described species: *Peloria heckli* (Cocco, 1844) and *Bothus diaphanus* were found to be larvae of *Pleuronectes podas* (Jordan and Goss, 1889; Emery 1878).

Solea rhomboides Rafinesque 1810 is described as a species from the waters around Italy with a body that is twice as long as it is high with about 60 anal rays, and no spines anteriorly. Rafinesque is could be describing a species of *Bothus* based on the matching diagnostic character of a body depth being 50% of the SL (*B. podas* 44%–63% of SL). However, the vague description makes it impossible to compare the other diagnostic characters of *B. podas* with this species. Therefore, I conclude that it should not be synonymized with *Bothus podas* as the evidence is inconclusive.

Bothus rumolo Rafinesque, 1810 is described as having the length of the body to be equal to body depth, the lateral line curves at the base of the pectoral fin, the blind side of the body without the bleak blotches, the straight whitish tail round. *Bothus rumolo* is the type species for *Bothus* by subsequent designation, however of the vagueness of the description does not allow for further investigation into the diagnostic characters to identify which species he is referring too. *Bothus rumolo* should therefore remain as a synonym of *Bothus* due to the general features described however, it will not be deemed a junior synonym of *B. podas*.

Bothus tappa Rafinesque, 1810 was included in the first description of the genus *Bothus*. There are no types known and no diagrams of *Bothus tappa* Rafinesque, 1810 and the analysis was done using the original Rafinesque (1810) description. Based on the observations from Rafinesque 1810, I conclude that *Bothus tappa* be classified as a synonym of *Bothus podas* on the premises that its original description mentions a close relationship to *Bothus rumolo* Rafinesque 1810. The description is vague and does not allow further interpretation of the exact diagnostic characters of the species. Based on this observation Iconclude that *Bothus tappa* be classified as a synonym of the closest recognized species - *Bothus podas* (Delaroche, 1809), previously classified as *Bothus rumolo* Rafinesque, 1810.

Bothus atlanticus Kyle 1913 was listed in Norman (1934) as possibly being a synonym of *Bothus ocellatus*. Kyle describes *B. atlanticus* as a Mediterranean species of *Bothus* that resembles the species B. *ocellatus* from the east coast of Brazil as described Jordan and Goss (1889). Kyle refers to the bright colouration in live specimens that is seen in *Bothus* species from that locality, however, there is no reference to dark blotches in the caudal fin, which are the diagnostic characters of *B. ocellatus*. Furthermore, the specimen was collected 37 degrees parallel north which is the common locality of *B. podas*. *B. podas* also exhibits bright pigmentation patterns in live specimens (Fig. 66) comparable to the mottled and spot filled pigmentation of *B. ocellatus*. Based on the observations I place *B. atlanticus* as a

junior synonym of *B. podas* due to the similar colouration/pigmentation described and the overlapping geographical distributions.

Bothus podas africanus Nielsen, 1961 was described as a sub-species of *Bothus podas* located off the west coast of Africa. The holotype of the *Bothus podas africanus* ZMUC P853008 was not examined however, the original paratypes described with the holotype were: BMNH 1962 6.18:34-35 paratypes (2). The paratypes and non-type material of *Bothus podas africanus* (Nielsen, 1961) were compared with the holotype MNHN 1999-0416, and non-type material of *Bothus podas* using measurements, meristics, and morphometric data (Table 40). Based on observations made of these specimens I conclude *B. podas* does show similarities as well as slight differences in diagnostic morphology and pigmentation patterns (Fig. 67, 70). When comparing meristic data the dorsal, anal, caudal, pectoral-fins counts; pterygiophore counts, and vertebrae there are not significant differences, however when comparing morphology there are notable differences. *B. podas africanus* is slightly different from *B. podas* as its anterior profile of the head is not as steeply angled, the eye is not as offset vertically from one another, the body is slightly deeper (59%–79% of SL in *B. podas africanus* versus 44%–63% of SL in *B. podas*), and the skin shows a much brighter completion of light tan, almost yellowish when compared to preserved specimens of *B. podas*. Furthermore *B. podas africanus* is described as being specifically distributed along the West Coast of Africa near Sierra alone and Liberia, whereas *B. podas* was described on a species from the Mediterranean (Fig. 69). When comparing the geographical distribution, it is apparent that there are some isolated groupings of *B. podas africanus* and *B. podas* supporting the hypothesis of a sub-species (Fig. 69). Based on these observations of morphological, meristic, pigmentation, and geographic data I conclude that *Bothus podas africanus* Nielsen 1961 should remain a sub-species of *Bothus podas* (Delaroche 1809).

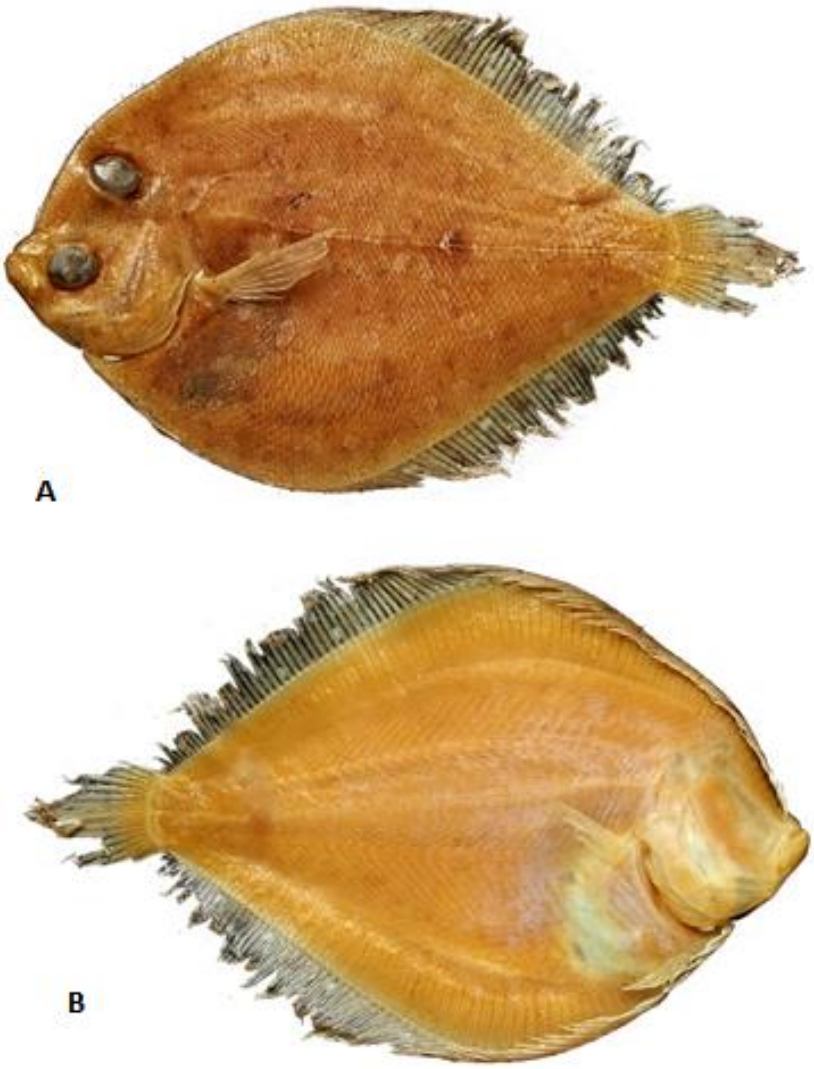


Figure 70. Picture of *Bothus podas africanus* BMNH 1962 6.18:34-35 paratype, 76.02 mm SL, adult female. Depicting similar morphology when compared with *Bothus podas*.

Table 40. Comparison of meristics and morphological data ratios of: *Bothus podas* MNHN 1999-0416 holotype, *Bothus podas* non-type material; *Bothus podas africanus* paratypes (2) BMNH 1962 6.18:34-35, and *Bothus* podas africanus non-type material. All measurements and abbreviations are described in Appendix B.

	B. podas holotype MNHN 1999-0416	*B. podas* non-type specimens (n=39)	*B. podas africanus* BMNH 1962 6.18:34-35 paratypes (n=2)	*B. podas africanus* non-type specimens (n=9)
Standard length	120.5	53.82-162.92 (88.67;26.11)	31.37-76.02 (53.7;31.57)	81.46-195.02 (131.23;31.02)
Total length	147.5	66.56-190.96 (106.82;31.87)	38.19-90.9 (64.55;37.27)	93.44-215.9 (153.74;34.61)
Counts				
Dorsal-fin ray	85	83-97 (87.84;2.84)	89 (89;0)*	87-105 (92.67;5.17)
Anal-fin ray	68	61-72 (65.46;13.34)	68 (68;0)*	69-74 (71.22;1.64)
Caudal-fin ray	17	17-18 (17.03;0.16)	17 (17;0)*	17 (17;0)
Precaudal vertebrae	0	10-11 (9.76;1.63)	10 (10;0)*	10 (10;0)
Caudal vertebrae including urostyle	0	28-30 (28.18;4.56)	28 (28;0)*	29-30 (29.33;0.5)
Hourglass shaped pterygiophores of dorsal-fin	0	8-10 (8.53;1.56)	10 (10;0)*	9 (9;0)
Dorsal-fin pterygiophores anterior to first elongated neural spine	0	14-16 (14.34;2.49)	16 (16;0)*	14-15 (14.78;0.44)
Gill rakers on lower limb of first gill arch	7	5-12 (7.79;1.75)	7 (7;0)*	5-9 (7.11;1.27)
Gill rakers on upper limb of first gill arch	0	0-8 (4.47;1.82)	4 (4;0)	0-7 (4;2.65)
Dorsal-eye appendage	1	0-1 (0.37;0.49)	0 (0;0)	0-1 (0.11;0.33)
Ventral-eye appendage	1	0-2 (0.42;0.55)	0 (0;0)	0-1 (0.11;0.33)
Pectoral-fin rays o.s.	10	10-12 (10.82;0.56)	11 (11;0)	10-12 (11.11;0.6)
Pectoral-fin rays b.s.	9	9-11 (9.76;1.72)	10 (10;0)	9-11 (10.11;0.6)
Pelvic-fin rays o.s.	6	6-7 (5.86;1)	6 (6;0)	6 (6;0)
Pelvic-fin rays b.s.	6	6 (6;0)	6 (6;0)	6 (6;0)
Lateral-line scales	79	78-101 (83.5;4.41)	75 (75;0)	76-90 (80.33;4.74)
Measurements				
%SL				
Body Depth	0.61	0.44-0.63 (0.59;0.04)	0.55-0.69 (0.62;0.1)	0.59-0.78 (0.65;0.06)
Head length	0.29	0.24-0.6 (0.27;0.06)	0.29 (0.29;0)	0.24-0.56 (0.29;0.1)
Head depth	0.07	0.27-0.65 (0.48;0.06)	0.45-0.58 (0.52;0.09)	0.43-0.66 (0.47;0.07)
Length of pectoral fin o.s.	0.21	0.06-0.29 (0.17;0.04)	0.21-0.23 (0.22;0.01)	0.11-0.24 (0.19;0.04)
Length of pectoral fin b.s.	0.16	0.12-0.16 (0.13;0.02)	0.12-0.14 (0.13;0.02)	0.08-0.14 (0.12;0.02)
Length of pelvic fin o.s.	0.09	0.07-0.19 (0.1;0.02)	0.1 (0.1;0)	0.05-0.11 (0.09;0.02)
Length of pelvic fin b.s.	0.08	0.01-0.17 (0.09;0.03)	0.1 (0.1;0)	0.05-0.1 (0.08;0.01)
Length of base of pelvic fin o.s.	0.12	0.02-0.13 (0.11;0.02)	0.13 (0.13;0)	0.08-0.13 (0.11;0.01)
Length of base of pelvic fin b.s.	0.03	0.01-0.11 (0.04;0.02)	0.04 (0.04;0)	0.02-0.04 (0.03;0.01)
Length of first dorsal-fin ray	0.06	0.03-0.07 (0.05;0.01)	0.05 (0.05;0)	0.03-0.07 (0.05;0.01)
Length of first anal-fin ray	0.08	0.04-0.09 (0.06;0.01)	0.06 (0.06;0)	0.03-0.09 (0.06;0.02)
Depth of caudal peduncle	0.12	0.11-0.13 (0.12;0.005)	0.11-0.12 (0.12;0.01)	0.06-0.12 (0.11;0.02)
%HL				
Preorbital length	0.85	0.05-0.51 (0.38;0.09)	0.38 (0.38;0)	0.14-0.57 (0.43;0.13)
Postorbital length	0.30	0.01-0.37 (0.28;0.06)	0.2 (0.2;0)	0.07-0.31 (0.21;0.07)
Predorsal distance b.s.	0.15	0.1-0.22 (0.15;0.04)	0.12 (0.12;0)	0.05-0.17 (0.13;0.03)
Dorsal eye distance from anterior edge of head	0.16	0.08-0.18 (0.13;0.02)	0.14 (0.14;0)	0.04-0.2 (0.14;0.04)
Snout length (o.s.)	0.21	0.04-0.28 (0.18;0.04)	0.15 (0.15;0)	0.07-0.22 (0.17;0.04)
Snout to nostril distance (o.s.)	0.16	0.08-0.2 (0.14;0.03)	0.13 (0.13;0)	0.06-0.16 (0.13;0.03)
Length of mouth o.s.	0.24	0.07-0.25 (0.19;0.04)	0.22 (0.22;0)	0.04-0.23 (0.18;0.06)
Length of mouth b.s.	0.23	0.11-0.27 (0.21;0.05)	0.22 (0.22;0)	0.06-0.24 (0.2;0.06)
Ventral eye diameter	0.26	0.08-2.87 (0.36;0.42)	0.25-0.29 (0.27;0.03)	0.28-0.78 (0.37;0.16)
Width of dorsal orbital	0.26	0.14-0.38 (0.33;0.04)	0.33-0.36 (0.35;0.02)	0.32-0.79 (0.41;0.15)
Interorbital Distance	0.52	0.1-0.67 (0.38;0.19)	0.24 (0.24;0)	0.08-0.66 (0.42;0.19)

* Indicate value missing for one specimen

Blank space indicates where value could not be obtained

Three syntypes of *Rhombus rhomboides* were examined: USNM 164910, ANSP 8847 (2 specimens). The syntypes meristic and morphological data were compared against the holotype and non-type material of *Bothus podas* (Table 41). The meristic values and measurement ratios observed coincide with the parameters set by the diagnosis, description, and data collected of *Bothus podas*. There are slight varying values for eye appendage counts between the type material of *B. podas* and the syntypes of *R. rhomboides,* however they are not significant. Based on the observations of these species I conclude that they are the same based on the similar anterior profile of the head, body depth ratio, interorbital space, pectoral-fin ray length, dorsal-fin ray counts, anal-fin ray counts, pectoral-fin ray counts, pterygiophore counts, vertebrae count, gill-raker counts and pigmentation patterns. *Rhombus rhomboides* Bonaparte, 1833 is to be classified as a junior synonym of *Bothus podas*.

Table 41. Comparison of meristics and morphological data ratios of: *Bothus podas* MNHN 1999-0416 holotype, non-type material; *Rhombus rhomboids* Paratype USNM 164910; *Rhombus rhomboids* ANSP 8847 Syntypes (N=2). All measurements and abbreviations are described in Appendix B.

	B. podas holotype MNHN 1999-0416	*B. podas* non-type specimens (n=39)	*Rhombus rhomboides* USNM 164910 syntype	*Rhombus rhomboides* syntypes ANSP 8847 specimens (n=2)
Standard length	120.5	53.82-162.92 (88.67;26.11)	111.78	122.04-138.84 (130.44;11.88)
Total length	147.5	66.56-190.96 (106.82;31.87)	131.18	148.19-175 (161.6;18.96)
Counts				
Dorsal-fin ray	85	83-97 (87.84;2.84)	88	84-90 (87;4.24)
Anal-fin ray	68	61-72 (65.46;13.34)	68	12-62 (37;35.36)
Caudal-fin ray	17	17-18 (17.03;0.16)	17	17 (17;0)
Precaudal vertebrae		10-11 (9.76;1.63)	10	10 (10;0)
Caudal vertebrae including urostyle		28-30 (28.18;4.56)	29	28-30 (29;1.41)
Hourglass shaped pterygiophores of dorsal-fin		8-10 (8.53;1.56)	9	9-10 (9.5;0.71)
Dorsal-fin pterygiophores anterior to first elongated neural spine		14-16 (14.34;2.49)	15	15-16 (15.5;0.71)
Gill rakers on lower limb of first gill arch	7	5-12 (7.79;1.75)	7	7 (7;0)
Gill rakers on upper limb of first gill arch	0	0-8 (4.47;1.82)	3	3-5 (4;1.41)
Dorsal-eye appendage	1	0-1 (0.37;0.49)	0	0 (0;0)
Ventral-eye appendage	1	0-2 (0.42;0.55)	0	0 (0;0)
Pectoral-fin rays o.s.	10	10-12 (10.82;0.56)	11	10-11 (10.5;0.71)
Pectoral-fin rays b.s.	9	9-11 (9.76;1.72)	10	9-10 (9.5;0.71)
Pelvic-fin rays o.s.	6	6-7 (5.86;1)	6	6 (6;0)
Pelvic-fin rays b.s.	6	6 (6;0)	6	6 (6;0)
Lateral-line scales	79.00	78-101 (83.5;4.41)	81	74-81 (77.5;4.95)
Measurements				
%SL				
Body Depth	0.61	0.44-0.63 (0.59;0.04)	0.62	0.59-0.63 (0.61;0.02)
Head length	0.29	0.24-0.6 (0.27;0.06)	0.25	0.24-0.26 (0.25;0.01)
Head depth	0.07	0.27-0.65 (0.48;0.06)	0.53	0.49-0.52 (0.51;0.02)
Length of pectoral fin o.s.	0.21	0.06-0.29 (0.17;0.04)	0.19	0.17-0.18 (0.17;0.01)
Length of pectoral fin b.s.	0.16	0.12-0.16 (0.13;0.02)	0.14	0.14-0.15 (0.14;0.01)
Length of pelvic fin o.s.	0.09	0.07-0.19 (0.1;0.02)	0.09	0.08-0.11 (0.09;0.02)
Length of pelvic fin b.s.	0.08	0.01-0.17 (0.09;0.03)	0.09	0.09-0.1 (0.1;0.002)
Length of base of pelvic fin o.s.	0.12	0.02-0.13 (0.11;0.02)	0.11	0.1-0.11 (0.1;0.003)
Length of base of pelvic fin b.s.	0.03	0.01-0.11 (0.04;0.02)	0.04	0.03-0.04 (0.04;0.01)
Length of first dorsal-fin ray	0.06	0.03-0.07 (0.05;0.01)	0.05	0.04-0.05 (0.04;0.004)
Length of first anal-fin ray	0.08	0.04-0.09 (0.06;0.01)	0.07	0.06 (0.06;0)
Depth of caudal peduncle	0.12	0.11-0.13 (0.12;0.005)	0.12	0.11-0.12 (0.12;0.01)
%HL				
Preorbital length	0.85	0.05-0.51 (0.38;0.09)	0.48	0.41-0.5 (0.45;0.06)
Postorbital length	0.30	0.01-0.37 (0.28;0.06)	0.26	0.21-0.39 (0.3;0.13)
Predorsal distance b.s.	0.15	0.1-0.22 (0.15;0.04)	0.14	0.16 (0.16;0)
Dorsal eye distance from anterior edge of head	0.16	0.08-0.18 (0.13;0.02)	0.13	0.12-0.13 (0.12;0.001)
Snout length (o.s.)	0.21	0.04-0.28 (0.18;0.04)	0.14	0.19 (0.19;0)
Snout to nostril distance (o.s.)	0.16	0.08-0.2 (0.14;0.03)	0.15	0.15-0.18 (0.16;0.03)
Length of mouth o.s.	0.24	0.07-0.25 (0.19;0.04)	0.21	0.2-0.23 (0.22;0.02)
Length of mouth b.s.	0.23	0.11-0.27 (0.21;0.05)	0.24	0.26-0.29 (0.28;0.02)
Ventral eye diameter	0.26	0.08-2.87 (0.36;0.42)	0.31	0.27 (0.27;0)
Posterior of ventral orbit to anterior of dorsal orbit	0.15	0.01-0.46 (0.14;0.08)	0.11	0.03-0.07 (0.05;0.03)
Interorbital Distance	0.52	0.1-0.67 (0.38;0.19)	0.56	0.6-0.65 (0.62;0.04)

Blank space indicates where value could not be obtained

Bothus podas maderensis (Lowe 1834) was described as a species from the island of Madeira, it was classified as a sub-species of *Bothus podas* by Nielsen (1973) mainly based on its unique pigmentation pattern and its geographical distribution specifically to that of Madeira. The original description mentions that the species has circular planet-like pigmentations that are unique. When examining the *Pleuronectes podas* Delaroche 1809, holotype plate (Fig 65), it exhibits white blotches devoid of any pigmentation pattern, however live specimens do exhibit bright circular pigmentations (Fig. 66). Images of live specimens (Fig 71) of *B. podas maderensis* have bright blueish white circular pigmentations as well as contrasting dark skin colour, which is not observed in *B. podas*. When comparing diagnostic features of *B. podas* maderensis exhibits a steep straight anterior profile of the head, a wide interorbital space, a body depth, pectoral fin-ray length ratio similar to that of *B. podas* (Table 42). When comparing the *B. podas* holotype image (Fig. 64), the live specimen images *B. podas* (Fig 66) and the live specimen photo of *B. podas maderensis* (Fig. 71), there is an obvious difference. The dark skin complexion and bright bluish white ring like pigmentations are vibrant and in contrast with the pigmentation present in *B. podas*. The geographical distribution for *B. podas maderensis* of Madeira is mainly isolated and differs slightly from the overall distribution of *B. podas.* Based on the similar observations made on species, I corroborate with Nielsen (1973) that *Bothus podas maderensis* (Lowe 1834) is designated a sub-species of *Bothus podas*.

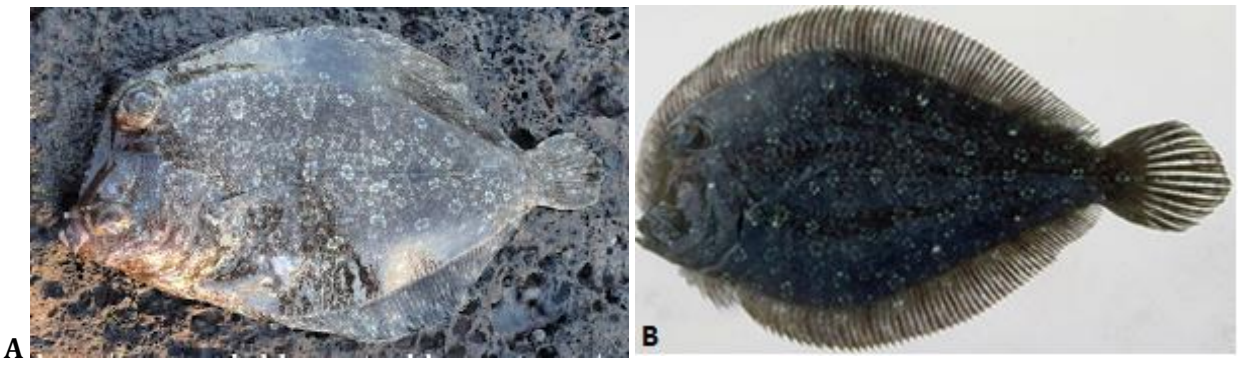


Figure 71. Picture of two live specimens of *Bothus podas maderensis* (Nielson 1973). Specimen (A) taken in Madeira and Specimen (B) taken in the Azores.

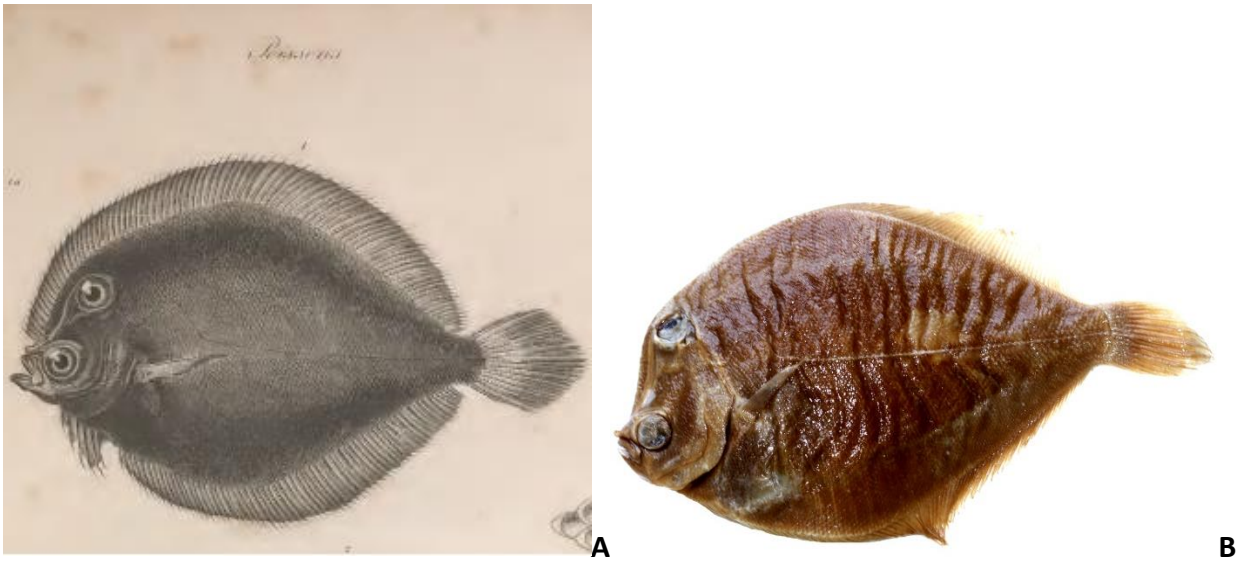
Table 42. Comparison of meristic counts of: *Bothus podas* MNHN 1999-0416 holotype, non-type material; *Bothus podas maderensis* (Lowe 1838) original description counts; *Bothus podas maderensis non-type specimens* (N=4) collected in Madeira. All measurements and abbreviations are described in Appendix B.

	B. podas holotype MNHN 1999-0416	*B. podas* non-type specimens (n=39)	*B. podas maderensis* (Lowe, R. T. 1834), original type	*B. podas maderensis* ANSP 88783 non-type specimens (n=4)
Standard length	120.5	53.82-162.92 (88.67;26.11)		87.98-109.45 (99.59;11.35)
Total length	147.5	66.56-190.96 (106.82;31.87)		102.87-135.53 (120.92;16.99)
Counts				
Dorsal-fin ray	85	83-97 (87.84;2.84)	91	88-91 (89.25;1.26)
Anal-fin ray	68	61-72 (65.46;13.34)	69	66-70 (67.75;1.71)
Caudal-fin ray	17	17-18 (17.03;0.16)	15	17 (17;0)
Precaudal vertebrae	0	10-11 (9.76;1.63)		10 (10;0)
Caudal vertebrae including urostyle	0	28-30 (28.18;4.56)		29-30 (29.25;0.5)
Hourglass shaped pterygiophores of dorsal-fin	0	8-10 (8.53;1.56)		9 (9;0)
Dorsal-fin pterygiophores anterior to first elongated nei	0	14-16 (14.34;2.49)		14-15 (14.75;0.5)
Gill rakers on lower limb of first gill arch	7	5-12 (7.79;1.75)		6-8 (7.5;1)
Gill rakers on upper limb of first gill arch	0	0-8 (4.47;1.82)		5-7 (5.75;0.96)
Dorsal-eye appendage	1	0-1 (0.37;0.49)		0-1 (0.5;0.58)
Ventral-eye appendage	1	0-2 (0.42;0.55)		0-1 (0.5;0.58)
Pectoral-fin rays o.s.	10	10-12 (10.82;0.56)	10	11 (11;0)
Pectoral-fin rays b.s.	9	9-11 (9.76;1.72)	9	10 (10;0)
Pelvic-fin rays o.s.	6	6-7 (5.86;1)	6	6 (6;0)
Pelvic-fin rays b.s.	6	6 (6;0)	5	6 (6;0)
Lateral-line scales	79	78-101 (83.5;4.41)		81-89 (85;3.27)
Measurements				
%SL				
Body Depth	0.61	0.44-0.63 (0.59;0.04)		0.46-0.62 (0.57;0.08)
Head length	0.29	0.24-0.6 (0.27;0.06)		0.24-0.25 (0.25;0.0046)
Head depth	0.07	0.27-0.65 (0.48;0.06)		0.49-0.52 (0.51;0.01)
Length of pectoral fin o.s.	0.21	0.06-0.29 (0.17;0.04)		0.17-0.19 (0.18;0.01)
Length of pectoral fin b.s.	0.16	0.12-0.16 (0.13;0.02)		0.14-0.15 (0.15;0.003)
Length of pelvic fin o.s.	0.09	0.07-0.19 (0.1;0.02)		0.08-0.1 (0.09;0.01)
Length of pelvic fin b.s.	0.08	0.01-0.17 (0.09;0.03)		0.07-0.09 (0.09;0.01)
Length of base of pelvic fin o.s.	0.12	0.02-0.13 (0.11;0.02)		0.11-0.12 (0.11;0.01)
Length of base of pelvic fin b.s.	0.03	0.01-0.11 (0.04;0.02)		0.03-0.05 (0.04;0.0049)
Length of first dorsal-fin ray	0.06	0.03-0.07 (0.05;0.01)		0.03-0.05 (0.04;0.01)
Length of first anal-fin ray	0.08	0.04-0.09 (0.06;0.01)		0.04-0.06 (0.05;0.01)
Depth of caudal peduncle	0.12	0.11-0.13 (0.12;0.005)		0.12-0.13 (0.12;0.0046)
%HL				
Preorbital length	0.85	0.05-0.51 (0.38;0.09)		0.3-0.48 (0.37;0.08)
Postorbital length	0.30	0.01-0.37 (0.28;0.06)		0.3-0.33 (0.31;0.02)
Predorsal distance b.s.	0.15	0.1-0.22 (0.15;0.04)		0.12-0.16 (0.14;0.02)
Dorsal eye distance from anterior edge of head	0.16	0.08-0.18 (0.13;0.02)		0.11-0.13 (0.13;0.01)
Snout length (o.s.)	0.21	0.04-0.28 (0.18;0.04)		0.17-0.19 (0.18;0.01)
Snout to nostril distance (o.s.)	0.16	0.08-0.2 (0.14;0.03)		0.12-0.15 (0.14;0.01)
Length of mouth o.s.	0.24	0.07-0.25 (0.19;0.04)		0.18-0.2 (0.19;0.01)
Length of mouth b.s.	0.23	0.11-0.27 (0.21;0.05)		0.21-0.24 (0.22;0.01)
Ventral eye diameter	0.26	0.08-2.87 (0.36;0.42)		0.29-0.3 (0.29;0.01)
Width of dorsal orbital	0.26	0.14-0.38 (0.33;0.04)		0.33-0.36 (0.35;0.01)
Interorbital Distance	0.52	0.1-0.67 (0.38;0.19)		0.29-0.51 (0.38;0.1)

Blank spaces indicate data that could not be obtained

Rhombus serratus Valenciennes, 1839, is currently listed as a synonym of *Bothus podas* (Delaroche, 1809) (Norman, 1934). Valenciennes provides an image of the holotype and a lengthy description characters that match those diagnostic of *B. podas* (a steep notched anterior profile of the

head, a body depth at 50% of the SL, an interorbital distance that is equal to *Bothus podas,* pectoral fins that aren`t extended). Other observed meristic and morphometric data show similarities between *B. podas* and *R. serratus* (Table 43). When comparing the meristic data values of the proposed holotype of *Rhombus serratus*, and the holotype and non-type material of *Bothus podas* there are clear overlapping values. Valenciennes (1839) does not clearly state why he has placed *Rhombus serratus* as a separate species but just that they are similar. Based on the congruencies within diagnostic characters Iconclude that *Rhombus serratus* Valenciennes 1839 is a junior synonym of *Bothus podas*. On a separate note, there is a high probability that the previously undefined holotype of *Rhombus serratus* Valenciennes 1839 is specimen MNHN 1999-0313 (specimen 1), 127.7 mm SL. Even though the examined type specimen shows slight variations in original description meristic (90 dorsal-fin rays 90,57 anal-fin rays, 96 scales in lateral line), there is a strong resemblance when comparing specimen MNHN 1999-0313 and depiction plates from the original *R. serratus* literature (Fig. 72). This strong resemblance could explain the whereabouts of the holotype for *R. serratus*.



A **B**

Figure 72. Original plate from Valenciennes (1839: Pls.18) depicting *Rhombus serratus* (A), and matching Holotype MNHN 1999-0313 127.7 mm SL, adult male (B).

Table 43. Comparison of meristic counts of: *Bothus podas* MNHN 1999-0416 holotype, non-type material; *Rhombus serratus* Types MNHN 1999-0313 (n=2), MNHN A-8730. All measurements and abbreviations are described in Appendix B.

	B. podas Holotype MNHN 1999-0416	*B. podas* non-type specimens (n=39)	*Rhombus serratus* TYPE MNHN 1999-0313 specimens (n=2)	MNHN A-8730 *Rhombus serratus* non-type synonym
Standard length	120.5	53.82-162.92 (88.67;26.11)	123.3-127.7 (125.5;3.11)	105
Total length	147.5	66.56-190.96 (106.82;31.87)	151.8-156.3 (154.05;3.18)	128.5
Counts				
Dorsal-fin ray	85	83-97 (87.84;2.84)	90-98 (94;5.66)	88
Anal-fin ray	68	61-72 (65.46;13.34)	72-75 (73.5;2.12)	66
Caudal-fin ray	17	17-18 (17.03;0.16)	17-18 (17.5;0.71)	17
Precaudal vertebrae		10-11 (9.76;1.63)		
Caudal vertebrae including urostyle		28-30 (28.18;4.56)		
Hourglass shaped pterygiophores of dorsal-fin		8-10 (8.53;1.56)		
Dorsal-fin pterygiophores anterior to first elongated neural spine		14-16 (14.34;2.49)		
Gill rakers on lower limb of first gill arch	7	5-12 (7.79;1.75)	7-8 (7.5;0.71)	
Gill rakers on upper limb of first gill arch	0	0-8 (4.47;1.82)	0 (0;0)	
Dorsal-eye appendage	1	0-1 (0.37;0.49)	0-3 (1.5;2.12)	0
Ventral-eye appendage	1	0-2 (0.42;0.55)	0-1 (0.5;0.71)	0
Pectoral-fin rays o.s.	10	10-12 (10.82;0.56)	10 (10;0)	10
Pectoral-fin rays b.s.	9	9-11 (9.76;1.72)	10 (10;0)	
Pelvic-fin rays o.s.	6	6-7 (5.86;1)	6 (6;0)	
Pelvic-fin rays b.s.	6	6 (6;0)	6 (6;0)	
Lateral-line scales	79	78-101 (83.5;4.41)	84-86 (85.;1.41)	75
Measurements				
%SL				
Body Depth	0.61	0.44-0.63 (0.59;0.04)	0.59-0.62 (0.6;0.02)	0.56
Head length	0.29	0.24-0.6 (0.27;0.06)	0.25-0.26 (0.25;0.01)	0.31
Head depth	0.07	0.27-0.65 (0.48;0.06)	0.34-0.42 (0.38;0.05)	0.40
Length of pectoral fin o.s.	0.21	0.06-0.29 (0.17;0.04)	0.17-0.2 (0.18;0.02)	0.19
Length of pectoral fin b.s.	0.16	0.12-0.16 (0.13;0.02)	0.15 (0.15;0)	0.00
Length of pelvic fin o.s.	0.09	0.07-0.19 (0.1;0.02)	0.1-0.11 (0.11;0.01)	0.10
Length of pelvic fin b.s.	0.08	0.01-0.17 (0.09;0.03)	0.09-0.11 (0.1;0.02)	0.00
Length of base of pelvic fin o.s.	0.12	0.02-0.13 (0.11;0.02)	0.1-0.11 (0.11;0.01)	0.08
Length of base of pelvic fin b.s.	0.03	0.01-0.11 (0.04;0.02)	0.04 (0.04;0)	0.00
Length of first dorsal-fin ray	0.06	0.03-0.07 (0.05;0.01)	0.05-0.06 (0.05;0.01)	0.00
Length of first anal-fin ray	0.08	0.04-0.09 (0.06;0.01)	0.07-0.08 (0.07;0.0044)	0.05
Depth of caudal peduncle	0.12	0.11-0.13 (0.12;0.005)	0.11-0.12 (0.11;0.01)	0.12
%HL				
Preorbital length	0.85	0.05-0.51 (0.38;0.09)	0.32-0.46 (0.39;0.1)	0.42
Postorbital length	0.30	0.01-0.37 (0.28;0.06)	0.35-0.38 (0.37;0.03)	0.31
Predorsal distance b.s.	0.15	0.1-0.22 (0.15;0.04)	0.15-0.21 (0.18;0.04)	0.00
Dorsal eye distance from anterior edge of head	0.16	0.08-0.18 (0.13;0.02)	0.12-0.14 (0.13;0.02)	0.10
Snout length (o.s.)	0.21	0.04-0.28 (0.18;0.04)	0.19-0.21 (0.2;0.01)	0.28
Snout to nostril distance (o.s.)	0.16	0.08-0.2 (0.14;0.03)	0.12-0.15 (0.14;0.02)	0.00
Length of mouth o.s.	0.24	0.07-0.25 (0.19;0.04)	0.17-0.21 (0.19;0.03)	0.00
Length of mouth b.s.	0.23	0.11-0.27 (0.21;0.05)	0.25-0.29 (0.27;0.03)	0.00
Ventral eye diameter	0.26	0.08-2.87 (0.36;0.42)	0.26 (0.26;0)	0.31
Width of dorsal orbital	0.26	0.14-0.38 (0.33;0.04)	0.26 (0.26;0)	0.31
Interorbital Distance	0.52	0.1-0.67 (0.38;0.19)	0.05-0.24 (0.15;0.14)	0.15

Blank space indicates where data was unavailable

Bothus diagrammus Rafinesque, 1814 and *Bothus punctatus* Rafinesque 1814 were described with *Bothus diaphanus* Rafinesque (1814). The species were all collected in the Mediterranean with the species descriptions based on: the presence of red colouration on the operculum and caudal (*Bothus*

diaphanus); a reddish white ocular side (*Bothus punctatus*); no red colouration (*Bothus diagrammus*). These limited descriptions do not allow for an analyses of diagnostic characters, and could be matched with any species of *Bothus* observed in this study. However, with the previous designation of *Bothus diaphanus* being a juvenile specimen of *Pleuronectes podas* (Jordan & Goss 1889: Emery 1878) it is possible that *Bothus diagrammus* and *Bothus punctatus* are also juvenile forms of *Bothus podas* based on their similar morphology and collection points. Colouration and pigmentation varies across *Bothus podas* as stated earlier in this study. There is no type material for these species. As such, *Bothus diaphanus*, *Bothus diagrammus,* and *Bothus punctatus* are classified as junior synonyms of *Bothus podas* until new evidence or data suggests otherwise.

Rhombus gesneri Risso, 1826 was collected in the north west of the Mediterranean Sea exhibiting the following characters: a wide interorbital distance; the ocular side with a dark reddish scattered with yellow and brown spots; a greyish pale blind side; 76 dorsal-fin rays, 68 anal-fin rays; 10 pectoral-fin rays; and 17 caudal-fin rays. Except for the dorsal-fin ray count, all of the other meristic, morphological characters, and pigmentation coincide with the description of *Bothus podas* set by this study. Furthermore, the description of the wide interorbital space does match one of the diagnostic characters for *B. podas*. There are no species of *Bothus* examined in this study that have a dorsal-fin ray count of 76. The holotype is stated as unique with its whereabouts unknown (Eschmeyer 2015). Consequently, the designation of *Rhombus gesneri* will remain as a synonym of *Bothus podas* until the holotype of *Rhombus gesneri* Risso, 1826 is located or a *Bothus* specimen with a dorsal-fin ray count of 76 can be collected and identified.

Comparisons: *Bothus podas* can be distinguished from all other species of *Bothus* except *Bothus assimilis, Bothus ocellatus, Bothus robinsi*, and *Bothus mellissi,* through the presence of its steep anterior profile of the head, body depth generally at 44%–63% of SL, its wide interorbital space in males (especially in males at 32%–67% of the SL), short pectoral fins 6%–29% of SL, and the presence of two dark diffuse blotches on the lateral line.

Bothus assimilis has a body depth at 65% of SL, and interorbital distance at 52% of HL in males, which resembles B. *podas* that has a body depth at 44%–68% of SL and an interorbital distance in males at 32%–67% of SL. Using meristic, *B. podas* can be distinguished from *B. assimilis* by its higher dorsal and anal-ray fin count (*B. podas* with 83–105 dorsal-fin rays and 61–75 anal-fin rays, *B. assimilis* with 86 dorsal-fin rays and 64 anal-fin rays), and the presence of orbital spines in *B. podas*. The most important distinguishing character is the presence of distinct blue spots along the anterior profile of the head present in only *Bothus assimilis* (absent in *B. assimilis*) and the absence of blotches along the lateral line (present in *B. assimilis*). Lastly, *B. assimilis* is geographically distributed in the South China Sea near Taiwan, whereas *B. podas* is distributed in the Atlantic Ocean.

Bothus podas resembles *Bothus ocellatus* and *Bothus robinsi* with similar body depths (*B. ocellatus* at 54%–71% of SL*, B. robinsi* at 37%–90% of SL), their short pectoral–fin rays (*B. ocellatus* at 16%–33% of SL*, B. robinsi* at 30%–38% of SL) and their general appearance. *B. podas* can be distinguished from *B. ocellatus* and *B. robinsi* by the pigmentation pattern in the caudal fin. *B. podas* exhibits no distinct features on the caudal fin, where as both *B. ocellatus* and *B. robinsi* have two dark blotches on the median of the caudal fin that are a diagnostic character of the species. The geographic distribution of *B. ocellatus* and *B. robinsi* are different as they are distributed in the Western Atlantic Ocean, conflicting with the Eastern Atlantic Ocean distribution of *B. podas*.

Bothus mellissi has the closest resemblance to *Bothus podas* with its similar body depth (60%–66% of SL), interorbital distance (31%–52% of HL), ventral eye diameter (13%–19% of HL), short pectoral fin rays (13%–19% of SL), and general appearance. *B. mellissi* can be distinguished by its absence of eye appendages (present *B. podas*), its larger body size (134–179 mm SL compared to 53–162 mm SL *B. podas*), and most importantly the differing diagnostic characters. *B. mellissi* has a uniform brown almost black colouration of the ocular side with no blotches or pigmentations, where as *B. podas* has one to two prominent blotches on the lateral line in the posterior of the body. Geographically *B. mellissi* has a strict distribution of St. Helena Island and species from its specific geographical distribution of St. Helena and Ascension Island, in contrast to the west coast of Africa into the Mediterranean for *B. podas*.

Bothus robinsi Topp & Hoff, 1972

Figures 73 - 76: Tables 44, 45

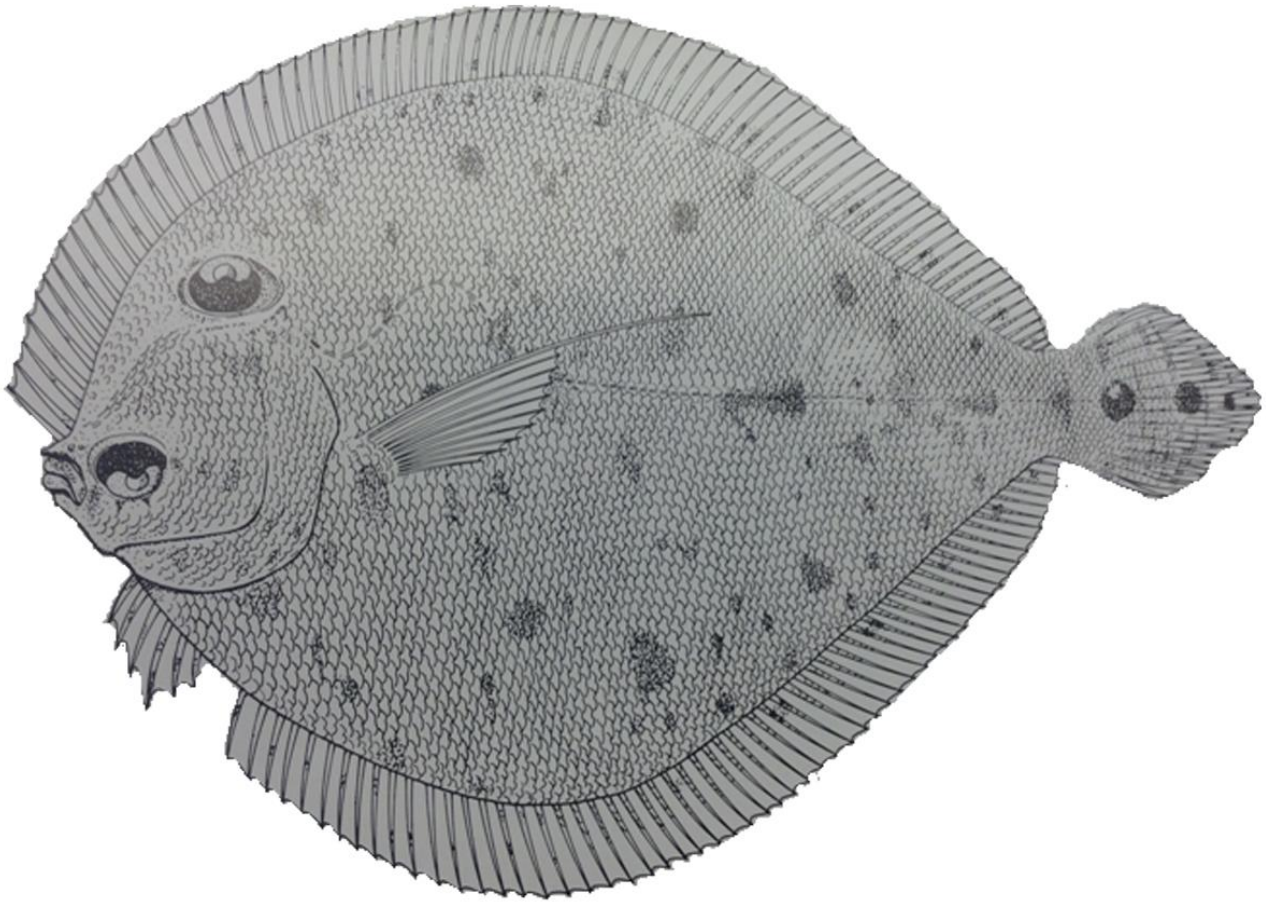


Figure 73. *Bothus robinsi* Topp & Hoff 1972, from original Topp & Hoff description, FSBC 3839 'Figured' Holotype, 122 mm SL, Tampa Bay, Florida.

Synonym(s): None.

Common name(s): Blotch tail flounder (English), Two blotch Flounder (English)

Material examined: *Bothus robinsi,* 57 specimens (47.6-232.09 mm SL)

Type material examined: Syntype FSBC 3898 (Not examined). Analyses based on original description of Topp & Hoff 1972 (ex Jutare), Flatfishes (Pleuronectiformes). Memoirs of Hourglass Cruises v. 4 (pt. 2): 1-135.

Non-type material: ANSP 130404 (55.16 mm SL), Brigantine, New Jersey; ANSP 126215 (52.05 mm SL), Bermuda; USNM 103124 (133.5 mm SL), Panama City, Florida; FSBC 13558 (2) (119.08-139.45 mm SL), St. Petersburg, Florida; FSBC 13815 (9) (114.33-232.09 mm SL), St. Petersburg, Florida; FSBC 13839 (5) (112.66-134.05 mm SL), St. Petersburg, Florida; FSBC 13899 (6) (118.33-133.94 mm SL), St. Petersburg, Florida; FSBC 13894 (4) (109-135.37 mm SL),), St. Petersburg, Florida; FSBC 14816 (4) (47.6-130.02 mm SL), Fort Myers, Florida; FSBC 14951 (4) (61.23-128.34 mm SL), Fort Myers, Florida; FSBC 10190 (3) (69.45-123.35 mm SL), Key West, Florida; FSBC 9854 (2) (76.17-124,99 mm SL), Key West, Florida; USNM 282732 (15) (67.28-90.62 mm SL), Brazil

Diagnosis: A species of *Bothus* with the following combination of characters: two prominent black pigmentations in a subsequent horizontal arrangement on caudal fin (Fig. 73, 74, 75); second pectoral fin-ray of ocular side extended in males (Fig. 73, 74).

Description: A species of *Bothus* reaching a maximum standard length of 232.09 mm (in examined specimens). Meristic and morphometric characters indicated in Table 44; body ovate, body depth reaching 37%–90% of SL; head length 13%– 31% of SL, head depth 26%–61% of SL; profile of head convex, straight profile along edge of interorbital space; defined notch above the snout (Figs. 74); spine

on snout in both sexes; interorbital distance concave 16%–69% of HL, eyes offset with posterior edge of ventral eye anterior to anterior edge of dorsal eye; no spines present on orbitals; ventral eye diameter 28%–42% of HL, no ventral or dorsal-eye appendages present**;** 8–10 hourglass-shaped supracranial pterygiophores, 13–16 dorsal-fin pterygiophores before first elongated neural spine; mouth ocular-side 10%–24% of HL, blind side 15%—26% of HL; teeth shape conical, biserial; 5–9 gill-rakers on lower limb of first gill arch, 3–7 gill-rakers on upper limb of first gill arch; lateral line with 64– 83 scales, ending in bifurcated supratemporal branch; scales feebly ctenoid or cycloid on ocular side, cycloid on blind side in males, females feebly ctenoid on ocular side, cycloid on eye side; asymmetrical pectora-fin rays with 8–12 on ocular side and 8–11 on blind side; male ocular-side fin rays longer 3%–38% of SL, female ocular-side pectoral-fin ray 9%–29%, second pectoral fin-ray of males greatly extended beyond other rays; blindside pectoral fins of both sexes shorter; 78–92 dorsal-fin rays, 56 –70 anal-fin rays, 16—23 caudal-fin; 9–11 precaudal vertebrae, 26–28 caudal vertebrae including urostyle.

Pigmentation of preserved specimens: Ocular-side tan brown to orange (Figs. 74, 75), with blind side slightly lighter tone; two distinct spots arranged horizontally in succession traversing medial region of caudal fin on ocular and blind side; dark and light pigmentations speckled throughout body, dorsal, anal, caudal rays, size of eye or smaller; one or two large diffuse blotches in close proximity to lateral line; up to 6 dark blotches placed symmetrically opposite each other close to edges of body (Figs. 74, 75) on ocular side; ocular-side pectoral fin has small light and dark speckles, blind side pectoral without pigmentation; blind side caudal fin has two dark spots traversing median of caudal; small dark speckles on blind side anal and dorsal-fin rays, no pigmentation on blind side.

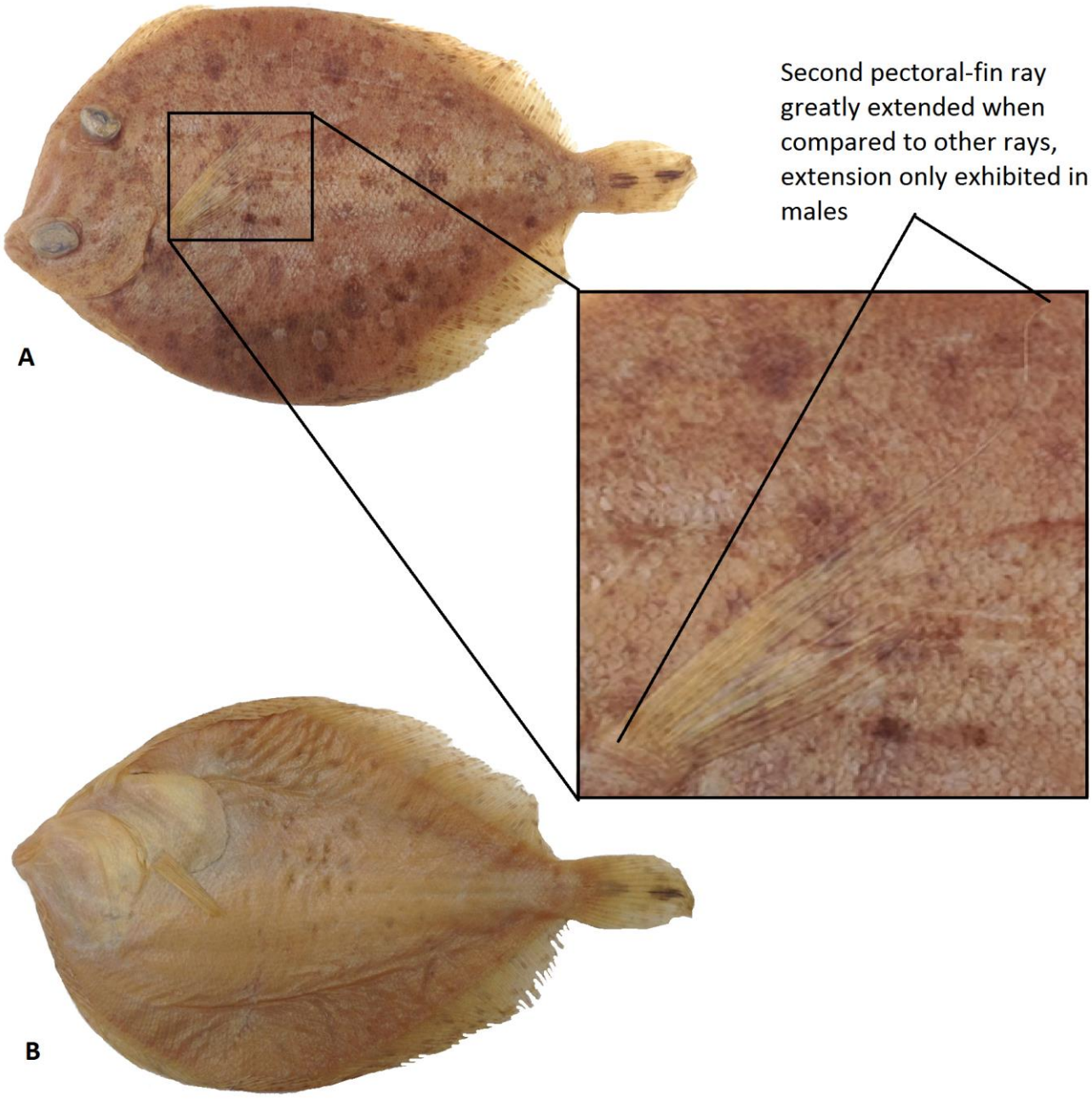


Figure 74. *Bothus robinsi* Topp & Hoff, 1972, from USNM 282732 (Specimen 15) non-type specimen. 90.62 mm SL, adult male. Magnification of extended pectoral-fin ray observed on the second ray in males. Ocular (A) and blind sides (B).

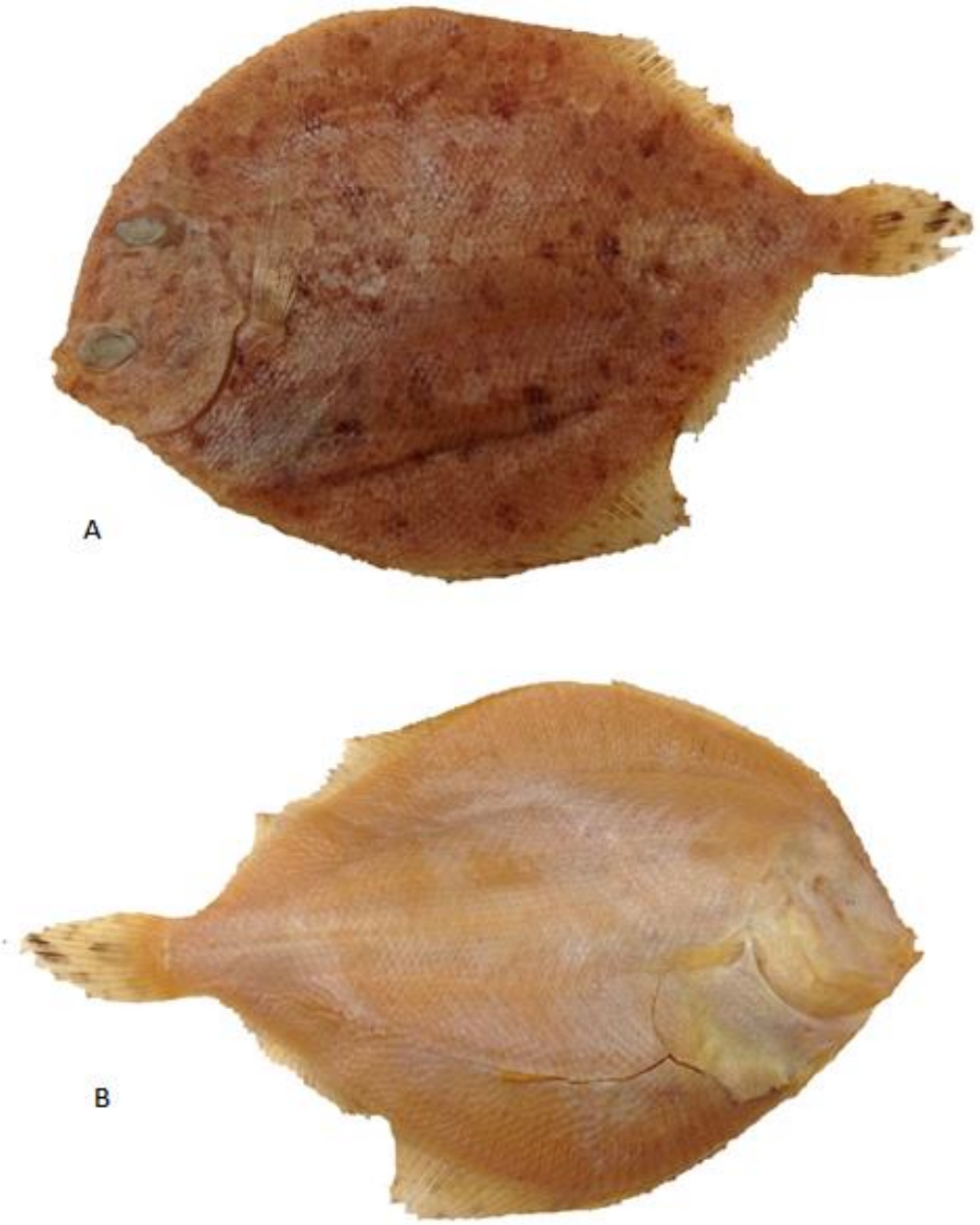


Figure 75. *Bothus robinsi* Topp & Hoff, 1972, from FSBC 9854 (Specimen 2) non-type specimen. 76.17 mm SL, adult female. Ocular (A) and blind (B) sides.

Table 44. Comparison of meristic counts and morphological data ratios for the type description and non-type specimens of *Bothus robinsi* Topp & Hoff 1972: Data for *Bothus robinsi* original species description and compared against non-type material (n= 57; 25 male, 32 female). All measurements and abbreviations are described in Appendix B.

	B. robinsi original description Jutare (1968)	*B. robinsi* non-type specimens (n=57)
Standard length	116	47.6-232.09 (105.61;31.51)
Total length		58.41-170. (125.99;33.01)
Counts		
Dorsal-fin ray	85	78-92 (84.52;3.27)*
Anal-fin ray	63	56-70 (63.09;2.85)*
Caudal-fin ray		16-23 (16.98;0.92)*
Precaudal vertebrae	10	9-11 (9.98;0.23)
Caudal vertebrae including urostyle	28	26-28 (27.09;0.47)
Hourglass shaped pterygiophores of dorsal-fin		8-10 (8.58;0.57)
Dorsal-fin pterygiophores anterior to first elongated neural spine		13-16 (14.53;0.73)
Gill rakers on lower limb of first gill arch	8	5-9 (6.89;0.88)
Gill rakers on upper limb of first gill arch	4	3-7 (4.68;0.83)
Dorsal-eye appendage		0-0 (0.;0.)
Ventral-eye appendage		0-0 (0.;0.)
Pectoral-fin rays o.s.	9	8-12 (10.98;0.52)
Pectoral-fin rays b.s.	8	8-11 (9.26;0.74)
Pelvic-fin rays o.s.		6-6 (6.;0.)
Pelvic-fin rays b.s.		4-6 (5.96;0.26)
Lateral-line scales	74	64-83 (73.7;3.4)*
Measurements		
%SL		
Body Depth	0.52	0.37-0.9 (0.68;0.08)
Head length	0.22	0.13-0.31 (0.26;0.03)
Head depth		0.26-0.61 (0.49;0.06)
Length of pectoral fin o.s.		0.03-0.38 (0.26;0.07)
Length of pectoral fin b.s.		0.09-0.2 (0.15;0.02)
Length of pelvic fin o.s.		0.07-0.14 (0.11;0.01)
Length of pelvic fin b.s.		0.03-0.15 (0.1;0.02)
Length of base of pelvic fin o.s.		0.03-0.14 (0.11;0.02)
Length of base of pelvic fin b.s.		0.01-0.16 (0.04;0.02)
Length of first dorsal-fin ray		0.03-0.08 (0.06;0.01)
Length of first anal-fin ray		0.04-0.1 (0.07;0.01)
Depth of caudal peduncle		0.06-0.12 (0.11;0.01)
%HL		
Preorbital length		0.17-0.75 (0.4;0.08)
Postorbital length		0.1-0.37 (0.23;0.06)
Predorsal distance b.s.		0.1-0.23 (0.14;0.02)
Dorsal eye distance from anterior edge of head		0.08-0.39 (0.15;0.04)
Snout length (o.s.)		0.09-0.3 (0.18;0.03)
Snout to nostril distance (o.s.)		0.09-0.22 (0.14;0.02)
Length of mouth o.s.		0.1-0.24 (0.18;0.03)
Length of mouth b.s.		0.15-0.26 (0.2;0.02)
Ventral eye diameter		0.28-0.42 (0.32;0.03)
Width of dorsal orbital		0.29-0.54 (0.37;0.04)
Interorbital Distance	0.38	0.16-0.69 (0.36;0.11)

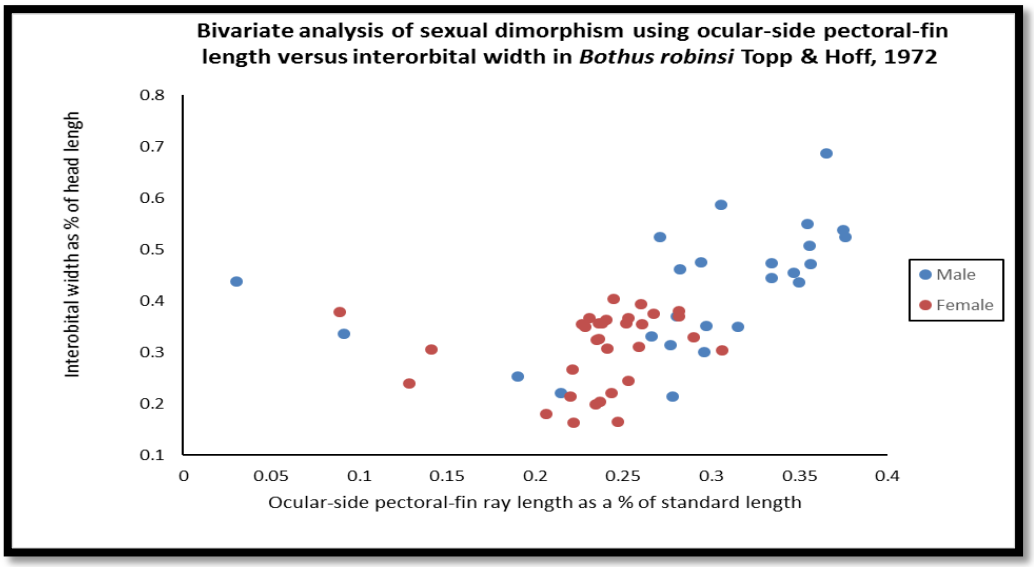
*indicates a character could not be collected for some specimens
Blank space indicates where data could not be obtained

Sexual dimorphism: Sexual dimorphism in *Bothus robinsi* is characterized by males exhibiting the following characters: a spine on snout, More distinct pigmentation patterns. Male's larger interorbital space (t (55) =4.2, $p < 0.01$) was found to be highly significant, whereas ocular-side pectoral-fin ray lengths (t (55) =2.89, $p < 0.001$) was found to be very highly significant when discriminating sexes. Overlapping values are most likely due to juvenile specimens present in the analysis, as sexual dimorphism becomes more prominent with maturation.

Table 45. Morphometric comparison and bivariate analysis of males and females of *Bothus robinsi* Topp and Hoff 1972 of non-type material (N= 57, 25 males, 32 females). All measurements and abbreviations are described in Appendix B.

	B. robinsi Original description Jutare (1968)	*B. robinsi non-type specimens (n=57)*	
Character	Male/Female	Male, n=25	Female, n=32
Standard length		61.23-139.45 (103.14;27.56)*	47.6-232.09 (104.06;43.38)*
Measurements			
%SL			
Head length		0.18-0.28 (0.25;0.03)	0.13-0.29 (0.25;0.03)
Head depth		0.41-0.61 (0.5;0.06)	0.26-0.58 (0.48;0.08)
Length of pectoral-fin ray o.s.		0.03-0.38 (0.28;0.1)	0.09-0.29 (0.23;0.05)
%HL			
Interorbital distance	0.53/0.37	0.21-0.69 (0.41;0.13)	0.16-0.4 (0.3;0.08)

*indicates a character could not be collected for some specimens
Blank space indicates where data could not be obtained



Geographic distribution: *Bothus robinsi* has been reported in the Florida Keys (Topp & Hoff, 1972), the coast of Georgia to the Dry Tortugas (Jutare, 1968), as well as Brigantine (New Jersey), Panama City, St. Petersburg, Fort Myers, and one specimen collected as far as Brazil.

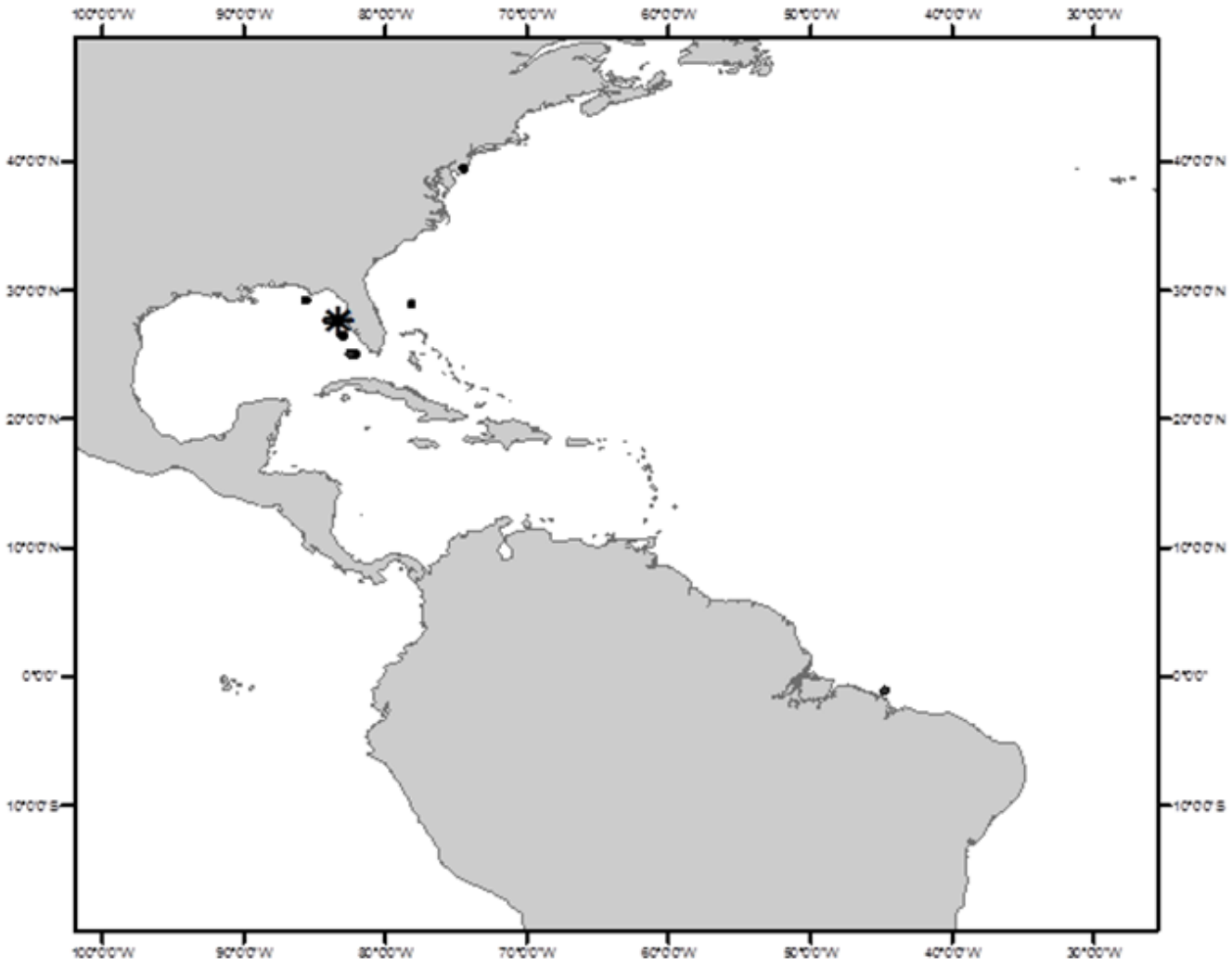


Figure 76. Geographical distribution of examined specimens and holotype of *Bothus robinsi* (Topp & Hoff, 1972). Asterisks denote location of holotype FSBC 3839. Specimens examined found at 55 meters' depth or less.

Remarks: The first record of *Bothus robinsi* came from the University of Miami in an unpublished M.Sc. thesis manuscript by Thelma Jutare (1970). The literature contains an in-depth study on the species *Bothus ocellatus* as well as the designation and proposition of the new species *Bothus robinsi*. Topp and Hoff (1972) officially published the findings on *Bothus robinsi*.

Bothus robinsi and *Bothus ocellatus* are the only species of *Bothus* that exhibit unique caudal fin pigmentations in *Bothus*. Their individual character states are distinguished by the vertical (*B. ocellatus*) and horizontal (*B. robinsi*) arrangement on the pigmentation on the caudal fin. There are other species of *Bothus* that exhibit random speckling and sports on the caudal region however these two species are the only species exhibit a consistent arrangement on the caudal fin.

Comparisons: *Bothus robinsi* can be distinguished from all congeners in having two distinct dark pigmentations in succession arranged vertical along the median of the caudal fin and the individual elongation of superior most pectoral-fin ray on the ocular side in males. It most closely resembles *B. ocellatus* via their similar body morphology and pigmentations patterns. They can be easily distinguished by the arrangement of botches in the caudal fin with two spots arranged vertically in *B. ocellatus* (See comparison of B. ocellatus, pg. 161).

Bothus swio Hensley, 1997

Figures 77 - 80; Table 46

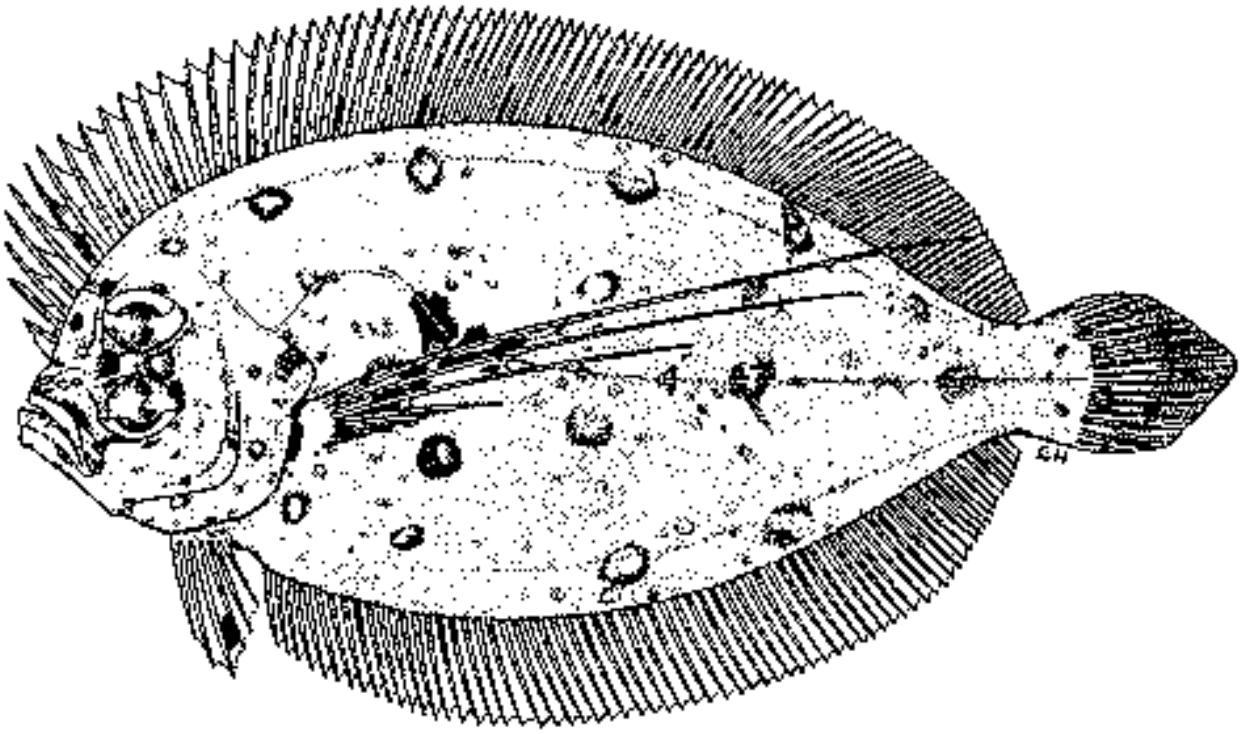


Figure 77. *Bothus swio* Hensley, 1997, Holotype SAM 33861, 157 mm SL male. Figure included with original description of *Bothus swio.* Adult male.

Synonym(s): None.

Common name(s): None.

Material examined: None. Analyses based off Hensley (1997), Hoshino & Amaoka (2006)

Type material: SAM 33681 (not examined). Analyses based off original description of *Bothus* swio holotype SAM 33681, 157 mm SL, from Hensley (1997)

Non-type material: None. Analyses based off description of *Bothus swio* non-type specimen CSIRO CA 4252, 137.7 mm SL, from Hoshino & Amaoka (2006).

Diagnosis: A species with the following combination of characters: a narrow interorbital distance (6%–9% of SL, extended pectoral fins 66%–71% of SL, no ocular appendages or orbital spines.

Description: A species of reaching a maximum standard length of 157 mm (SAM 33681 Holotype). Meristics and morphological data indicated in Table 46;moderately ovate; body depth 52 % of SL; head length 26—28% of SL; profile of head convex; strong rostral spine, no spines on orbital margins eye appendages absent; interorbital distance concave, 6%—9% of SL; ventral eye diameter 28 % of SL; teeth sharp conical shape; uniserial; 9 gill-rakers on lower limb of first gill arch, gill-rakers on upper limb of first gill arch naked; lateral line with 92 scales, bifurcated supratemporal branch; scales ctenoid on ocular side; cycloid on blind side; asymmetrical pectoral-fin rays with 10 on ocular side and 9 on blind side; ocular-side fin rays slightly longer 66%–71% of SL, blind side 16% of SL; 88–90 dorsal-fin rays, 70–72 anal-fin rays, 17 caudal-fin rays; 10 precaudal vertebrae, 29 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: Brown, light tan colouration on ocular side, cream colored on blind side; some large dark spots on head; three dark diffuse blotches slightly smaller than ventral eye,

located in the posterior section of the body; anterior blotch at junction of curve of lateral line system, second most posterior blotch located in posterior one third of body on lateral line; posterior most blotch located just anterior to caudal peduncle, 4 smaller blotches arranged in rows traversing body vertically, arranged equidistant from each other across median and edges of body; dorsal and anal ray fins with dark speckles, pectoral fins with distinct black pigmentations, pelvic fin with large black blotch in median region of fin.

Table 46. Meristic and morphometric data comparing the holotype description and non-type specimen of *Bothus swio* Hensley 1997. Data for *Bothus swio* was obtained from Hensley's (1997) original description and Hoshino & Amoaka's (2006) report on the non-type specimen of *Bothus swio.* All measurements and abbreviations are described in Appendix B.

	B. swio SAM 33861 holotype original description	*B. swio* non-type CSIRO CA 4240
Standard length	154.5	137.7
Total length		
Counts		
Dorsal-fin ray	88	90
Anal-fin ray	72	70
Caudal-fin ray	17	17
Precaudal vertebrae	10	10
Caudal vertebrae including urostyle	29	29
Hourglass shaped pterygiophores of dorsal-fin		
Dorsal-fin pterygiophores anterior to first elongated neural spine		
Gill rakers on lower limb of first gill arch	9	9
Gill rakers on upper limb of first gill arch	0	0
Dorsal-eye appendage	0	0
Ventral-eye appendage	0	0
Pectoral-fin rays o.s.	10	10
Pectoral-fin rays b.s.	9	9
Pelvic-fin rays o.s.	6	6
Pelvic-fin rays b.s.	6	6
Lateral-line scales	92	92
HL	43.04	36.24
Measurements		
%SL		
Body Depth	0.52	0.52
Head length	0.28	0.26
Head depth		
Length of pectoral fin o.s.	0.66	0.71
Length of pectoral fin b.s.	0.16	0.16
Length of pelvic fin o.s.	0.14	0.11
Length of pelvic fin b.s.	0.09	0.10
Length of base of pelvic fin o.s.	0.08	0.07
Length of base of pelvic fin b.s.	0.04	0.04
Length of first dorsal-fin ray		
Length of first anal-fin ray		
Depth of caudal peduncle	0.11	0.12
%HL		
Preorbital length		
Postorbital length		
Predorsal distance b.s.		
Dorsal eye distance from anterior edge of head		
Snout length (o.s.)	0.27	0.24
Snout to nostril distance (o.s.)		
Length of mouth o.s.		
Length of mouth b.s.		
Ventral eye diameter	0.28	0.28
Width of dorsal orbital	0.28	0.27
Interorbital Distance	0.06	0.09

Blank space indicates where data could not be obtained

Sexual dimorphism: Sexual dimorphism cannot be established as only two specimens have been collected for the species *Bothus swio*.

Geographic distribution: *Bothus swio* Hensley, 1997 has been described coming from the northern coast of Mozambique and the northwestern coast of Australia, at a maximum depth of 88m (Hensley 1997, Hoshino & Amaoka 2006). This is a vast geographic separation between the two specimens with the holotype of *Bothus swio* (SAM 33861, Hensley 1997) being collected off the northern coast of Mozambique, and the non-type specimen being collected off the northeastern coast of Australia (CSIRO CA 4240, Hoshino & Amaoka 2006). With only two specimens of *Bothus swio* ever being collected and a geographical distribution this disperse, it is not a strong geographical representation of the species. The collection of more specimens of *B. swio* in the future will develop a more defined geographical distribution of the species.

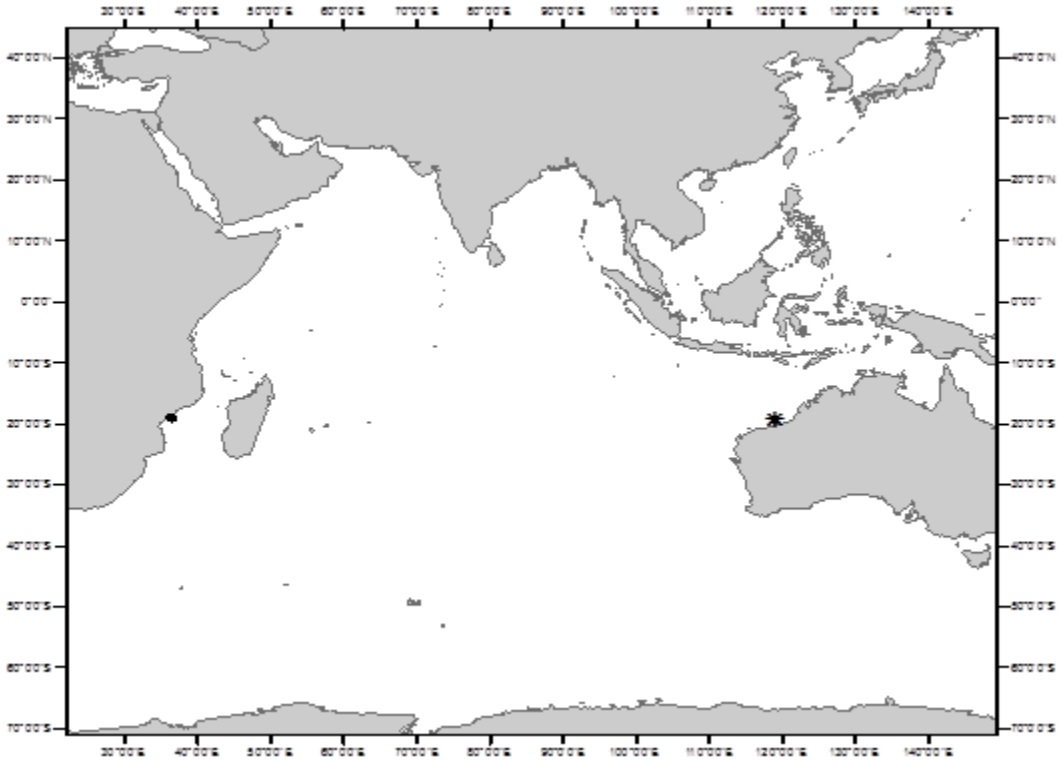


Figure 78. Geographical distribution of examined specimens of *Bothus swio* Holotype SAM 33681, 1.54 mm SL) and non-type material CSRIO-CA4252 (137.7 mm SL), both males. Asterisks denote type locality.

Remarks: *Bothus* is thought to be a monophyletic group based on the thick ventral expansion of the haemapophyses of the precaudal vertebrae, a character only seen in this genus. *Bothus swio* features haemapophyses that are pointed and triangular in shape (Fig. 79). *Bothus* also shares an osteological character (the anterior extension of the sciatic part of the urohyal past the main part of the urohyal) with its proposed outgroups *Engyprosopon and Crossorhombus*. *B. swio* does not have an anterior extension of the urohyal past the main part of the urohyal (Fig. 79). Hensley stated that although *B. swio* resembles species of *Grammatobothus* and *Bothus,* it was not a species *Grammatobothus* based on the absence of a well-developed lateral line on the blind-side (a diagnostic feature of the genus) and therefore provisionally placed it *Bothus*. Amaoka and Hoshino (2006) performed an analyses of *B. swio* and agreed with the provisional designation of Hensley (1997), as *B. swio* does not belong to any other Bothinae (Amaoka 1969) genera based on the lack of matching diagnostic features. Although Hensley (1997), Amaoka and Hoshino (2006) all examined the morphological similarities between *B. swio* and other Bothidae genera, they never compared the osteology of the morphology similar *Grammatobothus* and *B. swio*. When comparing the haemapophyses and urohyal of *B. swio* with species of *Grammatobothus*, they both exhibit triangular haemapohyses and lack an extension of the sciatic part of the urohyal past the main part (Fig. 79, 80). *B. swio*'s superficial morphology (close concave interorbital distance, extended pectoral fins, ctenoid scales on the ocular side, cycloid on the blind, and pigmentation patterns) and osteological morphology (Fig. 79, 80) are similar to those of *Grammatobothus*. However, the absence of a well-defined lateral-line on the blind side excludes *B. swio* from *Grammatobothus*. Consequently, *B. swio* is identified by a unique set of diagnostic characters: no extension of the sciatic part of the urohyal past the main part of the urohyal, triangular haemapophyses, and the absence of a lateral line on the blind side. The unique combination of characters proposes that *B. swio* is possibly a new genus of Bothidae. An examination of the type specimen of *B. swio* (not available in this study) and the further examination of other Bothidae genera will allow for the

development of this hypothesis. Therefore, until further research is completed, *B. swio* should remain a species of *Bothus* as its superficial morphology is congruent with the genus and conflicts with all other genera of Bothidae.

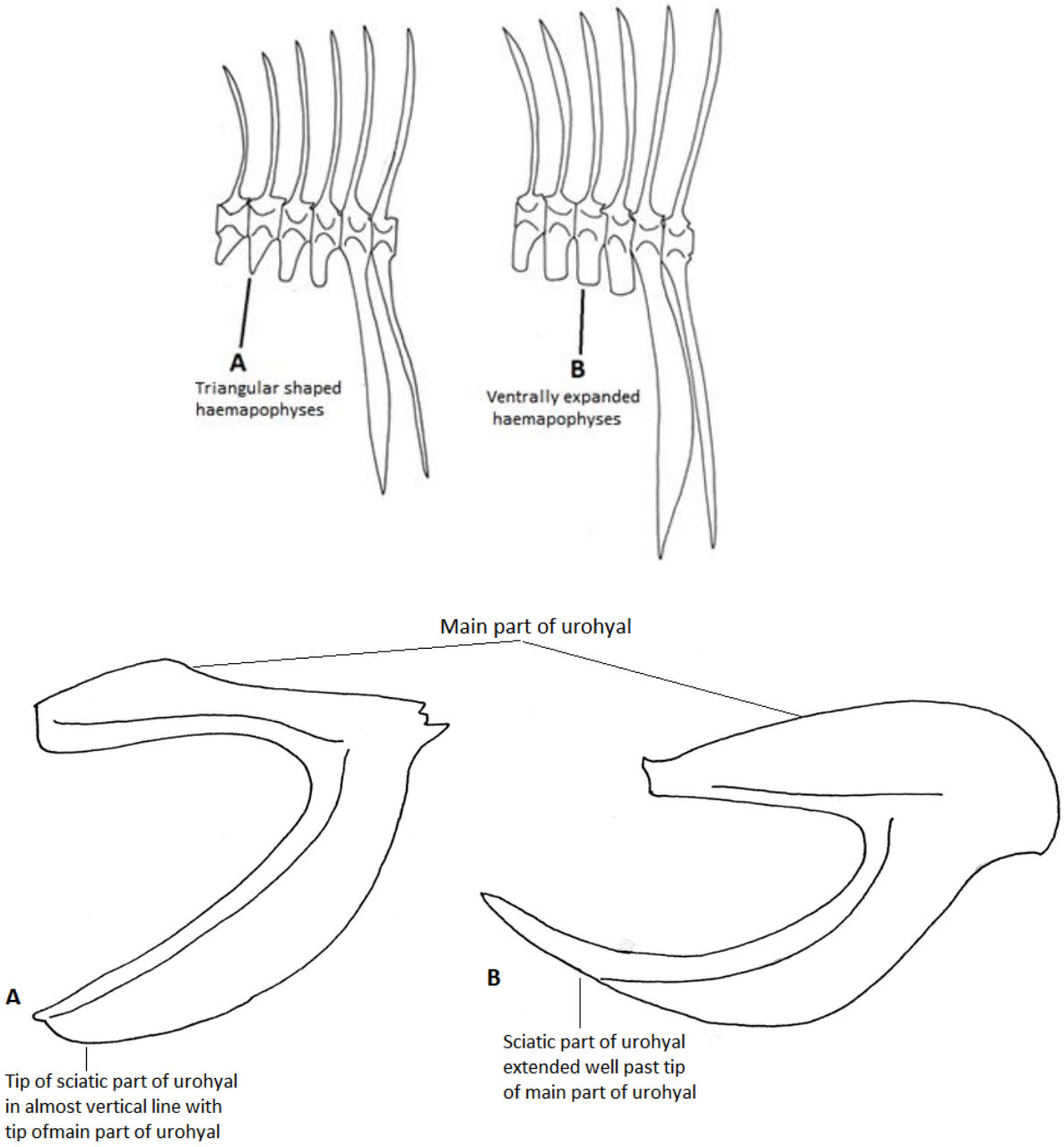


Figure 79. Modified diagram from Hoshino and Amaoka 2006, depicting morphology of precaudal vertebrae haemapophyses and urohyal in *B. swio,* CSIRO CA4252 (A) and *B. podas,* BMNH1938-11-15:54-55 (B).

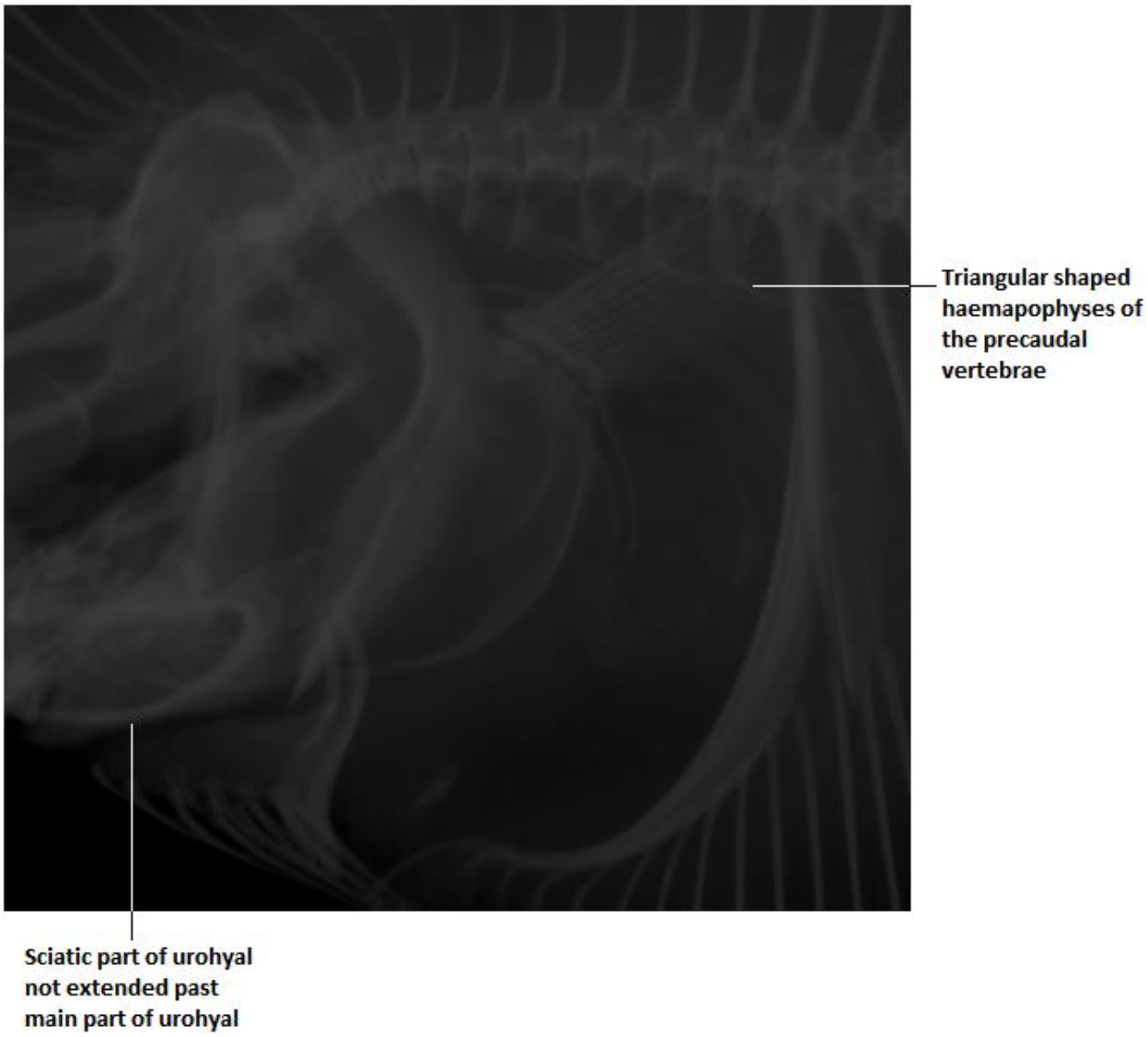


Figure 80. Radiograph of *Grammatobothus polyopthalmus* USNM 362520(Spec. 1), exhibiting triangular haemapophyses and urohyal lacking anterior extension of sciatic part past the pain part of the urohyal.

Comparison: *Bothus swio* most closely resembles *Bothus* pantherinus, *Bothus tricirrhitus,* and *Bothus guibei* based on their extended pectoral-fin rays of the ocular side at over 60% of the SL, shorter interorbital distances under 30% of the HL, and their general appearance. *B. tricirrhitus*, *B. pantherinus,* and *B. guibei* can all be distinguished via the presence of eye appendages on both eyes and larger interorbital distances of 17%–21% of HL in *B.* guibei, 28% of HL in *B. tricirrhitus*, and 12%–21% of HL in *B. pantherinus,* versus that of *B. swio* at 6–9% of HL.

Bothus thompsoni (Fowler, 1923)

Figures 81 - 85; Tables 47, 48

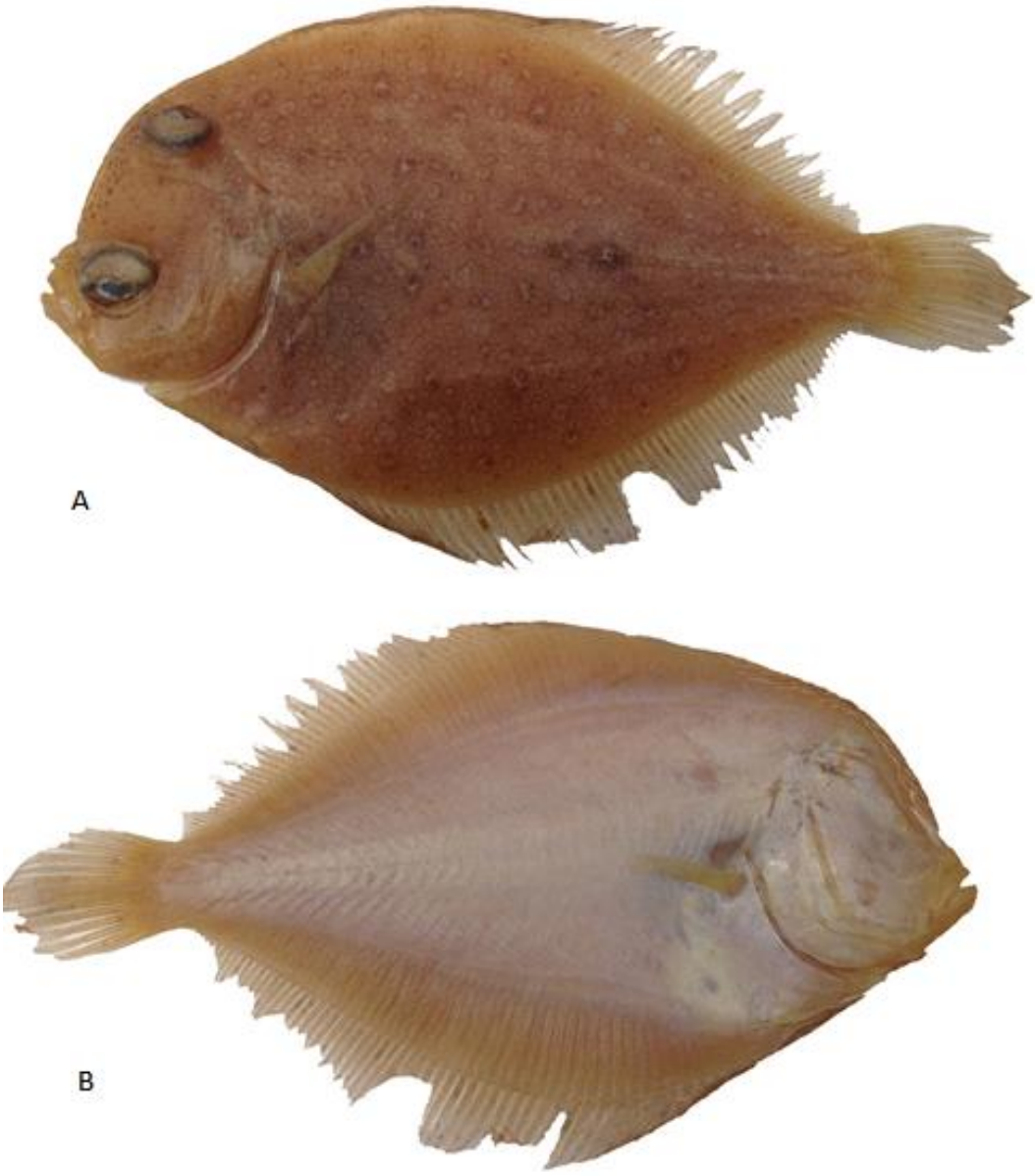


Figure 81. *Bothus thompsoni* (Fowler, 1923) BPBM 20792, 89.07 mm SL, adult male, from Wailua, Hawaii. Ocular and blind sides.

Synonym(s): None.

Common name(s): None.

Material examined: *Bothus thompsoni,* 12 specimens (83.74-138.91 mm SL)

Type material: Holotype BPBM 3398 (not allowed to leave museum). Analyses based on Fowler, 1923. New or little-known Hawaiian fishes. Occasional Papers of the Bernice Pauahi Bishop Museum of Polynesian Ethnology and Natural History v. 8 (no. 7): 373-392.

Non-type material: BPBM 25470 (87.18 mm SL), Kauai, Hawaii; BPBM 24412 (10) (83.74-138.91 mm SL), Oahu, Hawaii; BPBM 20792 (138.91 mm SL).

Diagnosis: A species of *Bothus* with the following characters: bulging anterior profile of head (Fig 81, 83); over 103 scales in lateral line; 12—16 of gill-rakers on lower limb of first gill arch; arrangement of three dark pigmentations running vertically across medial section of body just posterior to curve in later line system (Figs. 82, 83).

Description: A species of *Bothus* reaching a maximum standard length of 131.91 SL mm (in examined specimens). Meristic and morphometric characters are indicated in Table 47; body fairly ovate, body depth reaching 44%–78% of SL; head length 25%– 29% of SL, head depth 47%–69% of SL; profile of head very convex, protruding, bulging, well defined notch above snout (Figs. 81, 83); spine on snout in males, absent in females; interorbital distance concave and wide, 23%–41% of HL, spine rarely present on orbitals in males; ventral eye large with diameter 30%–34% of HL, no dorsal or ventral-eye appendages present; 9– 10 hourglass shaped supracranial pterygiophores, 13 – 15 dorsal-fin pterygiophores before first elongated neural spine; mouth ocular-side 21%–27% of HL; blind side 24%—29% of HL; teeth shape conical, set far from one another, 2 incomplete rows; 12–16 gill-rakers on lower limb of first gill arch; 5–

8 gill-rakers on upper limb of first gill arch; lateral line with 103–110 scales, ending with no split of lateral line, or bifurcated supratemporal branch; scales small, finely ctenoid or cycloid on ocular side; cycloid on blind side; asymmetrical pectoral-fin rays 12 –14 on ocular side and 11– 12 on blind side; ocular-side fin slightly rays longer 9%–21% of SL, blind side 14%—16% of SL; 82–89 dorsal-fin rays, 61–68 anal-fin rays, 16–17 caudal-fin rays; 10 precaudal vertebrae, 27–29 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: Ocular-side of body light reddish orange to pale white (Figs. 63, 64), with blind side pale white tan; small speckles running along anterior profile of head; grouping of three brown pigmentations with white pigmentations in the center (Fig. 64), traversing vertically across medial section of body, just posterior to base of pectoral fin-ray; two more dark diffuse blotches evenly spaced along lateral line system towards posterior of body, dark and light pigmentations speckled throughout body, dorsal, anal, caudal rays; ocular and blind side pectoral fins without pigmentation, on blind side.

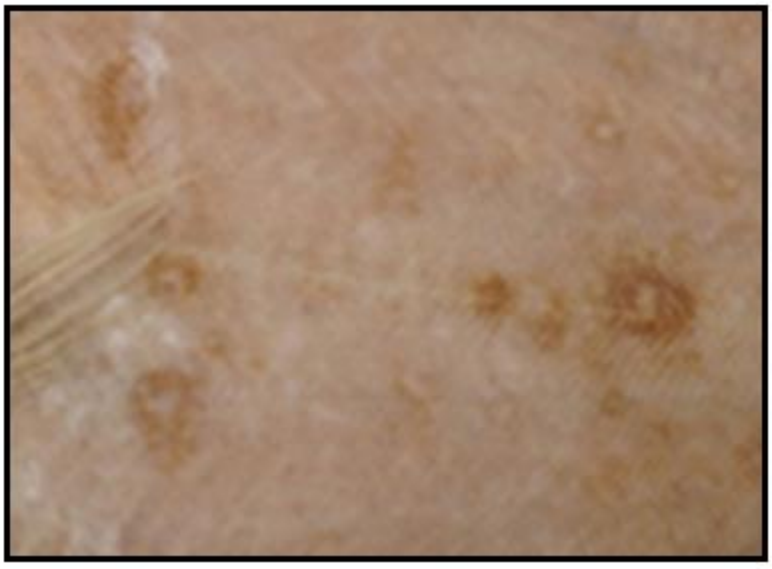


Figure 82. Magnification of pigmentation pattern on ocular side, taken from medial section of body of *Bothus thompsoni* (Fowler, 1923) FSBC 7931 (Spec. 2). Exhibiting grouping of three brown pigmentations with white pigmentation in center, just posterior to pectoral-fin ray.

A

B

Figure 83. *Bothus thompsoni* (Fowler 1923) from FSBC 7931 (Spec. # 2) non-type specimen. 76.14 mm SL, adult female. Ocular (A) and blind (B) sides.

Table 47. Meristics and morphometrics of the original description and examined non-type specimens of *Bothus thompsoni* (Fowler 1923). Data for *Bothus thompsoni was* obtained from original species description and compared against non-type material (n= 12; 7 male, 5 female). All measurements and abbreviations are described in Appendix B.

	Original *B. thompsoni* description (Fowler 1923)	*B. thompsoni* non-type specimens (n=12)
Standard length	134	31.34-138.91 (87.86;23.07)
Total length		39.11-170.26 (107.66;28.07)
Counts		
Dorsal-fin ray	86	82-89 (86.25;1.82)
Anal-fin ray	62	61-68 (64.5;2.11)
Caudal-fin ray		16-17 (16.08;0.29)
Precaudal vertebrae		10 (10;0)*
Caudal vertebrae including urostyle		27-29 (28.25;0.62)*
Hourglass shaped pterygiophores of dorsal-fin		9-10 (9.64;0.5)*
Dorsal-fin pterygiophores anterior to first elongated neural spine		13-15 (14;0.63*
Gill rakers on lower limb of first gill arch		12-16 (14.;1.18)*
Gill rakers on upper limb of first gill arch		5-8 (6.18;0.87)*
Pectoral-fin rays o.s.	11	12-14 (12.27;0.65)*
Pectoral-fin rays b.s.		11-12 (11.82;0.4)*
Pelvic-fin rays o.s.		6 (6;0)
Pelvic-fin rays b.s.		6 (6;0)
Lateral-line scales	132	103-110 (107.82;2.56)*
Measurements		
%SL		
Body Depth	0.28	0.6-0.79 (0.64;0.05)
Head length	0.6	0.25-0.29 (0.28;0.01)
Head depth		0.47-0.69 (0.54;0.07)
Length of pectoral fin o.s.		0.09-0.21 (0.18;0.03)
Length of pectoral fin b.s.		0.14-0.16 (0.15;0.01)
Length of pelvic fin o.s.		0.09-0.12 (0.1;0.01)
Length of pelvic fin b.s.		0.08-0.13 (0.1;0.01)
Length of base of pelvic fin o.s.		0.1-0.12 (0.11;0.01)
Length of base of pelvic fin b.s.		0.03-0.05 (0.04;0.01)
Length of first dorsal-fin ray		0.04-0.07 (0.06;0.01)
Length of first anal-fin ray		0.06-0.09 (0.07;0.01)
Depth of caudal peduncle		0.1-0.11 (0.11;0.004)
%HL		
Preorbital length		0.15-0.47 (0.37;0.09)
Postorbital length		0.2-0.32 (0.27;0.03)
Predorsal distance b.s.		0.12-0.2 (0.16;0.02)
Dorsal eye distance from anterior edge of head		0.1-0.14 (0.13;0.01)
Snout length (o.s.)		0.09-0.22 (0.18;0.04)
Snout to nostril distance (o.s.)		0.08-0.21 (0.16;0.03)
Length of mouth o.s.		0.21-0.27 (0.23;0.02)
Length of mouth b.s.		0.24-0.29 (0.26;0.01)
Ventral eye diameter		0.3-0.34 (0.32;0.01)
Width of dorsal orbital		0.35-0.4 (0.38;0.02)
Interorbital Distance		0.23-0.41 (0.33;0.06)

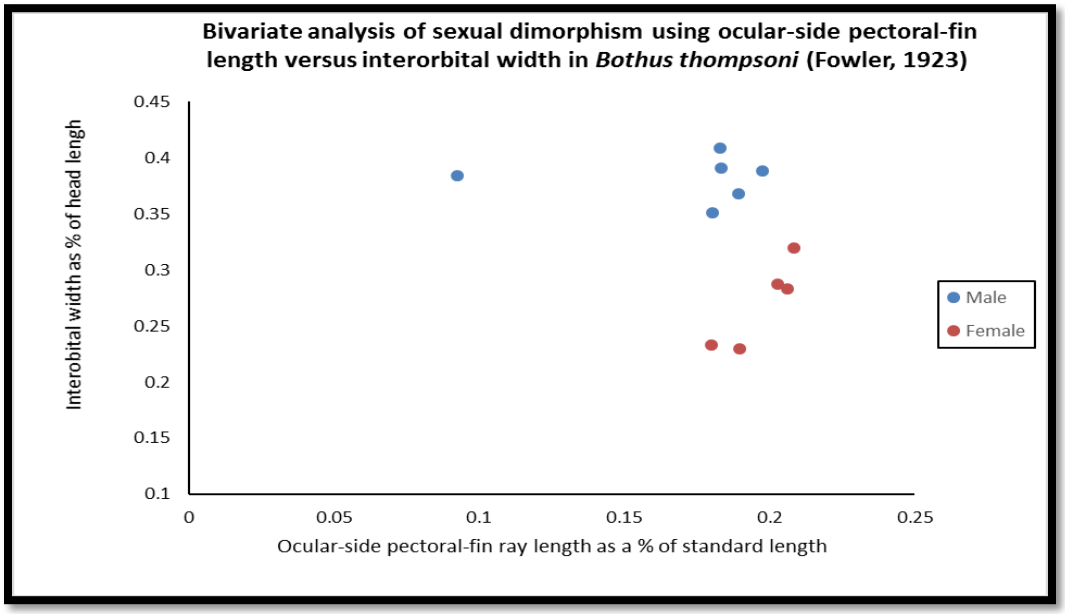
*indicates a character could not be collected for some specimens
Blank space indicates where data could not be obtained

Sexual dimorphism: Sexual dimorphism is characterized in *Bothus thompsoni* (Table 48, Figs. 81,83) by the following characters: males with larger body size; males with spine on snout; females without spine on snout; some males with spines on orbitals; male pigmentation pattern more apparent. Male's larger interorbital space was found to be highly significant ($t(10) = 4.32$, $p < 0.01$) when discriminating sex.

Table 48: Morphometric comparison and bivariate analysis of males and females of *Bothus thompsoni* (Fowler 1923) non-type material (N= 12, 7 males, 5 females). All measurements and abbreviations are described in Appendix B.

	B. thompsoni non-type specimens (n=12)	
Character	Male, n=7	Female, n=5
Standard length	31.34-91.7 (80.67;21.8)	83.74-138.91
Count		
Number of spines on orbitals	0-1 (0.5;0.55)	
Measurements		
%SL		
Head length	0.25-0.28 (0.27;0.01)	0.27-0.29 (0.28;0.01)
Head depth	0.47-0.69 (0.53;0.07)	0.51-0.65 (0.55;0.06)
Length of pectoral-fin ray o.s.	0.09-0.2 (0.17;0.04)	0.18-0.21 (0.2;0.01)
%HL		
Interorbital distance	0.35-0.41 (0.38;0.02)	0.23-0.32 (0.27;0.04)

*indicates a character could not be collected for one specimen



Geographic distribution: *Bothus thompsoni* has only been reported in the Hawaiian seas (Fowler 1923), primarily off the coast of Kauai and Oahu (Honolulu).

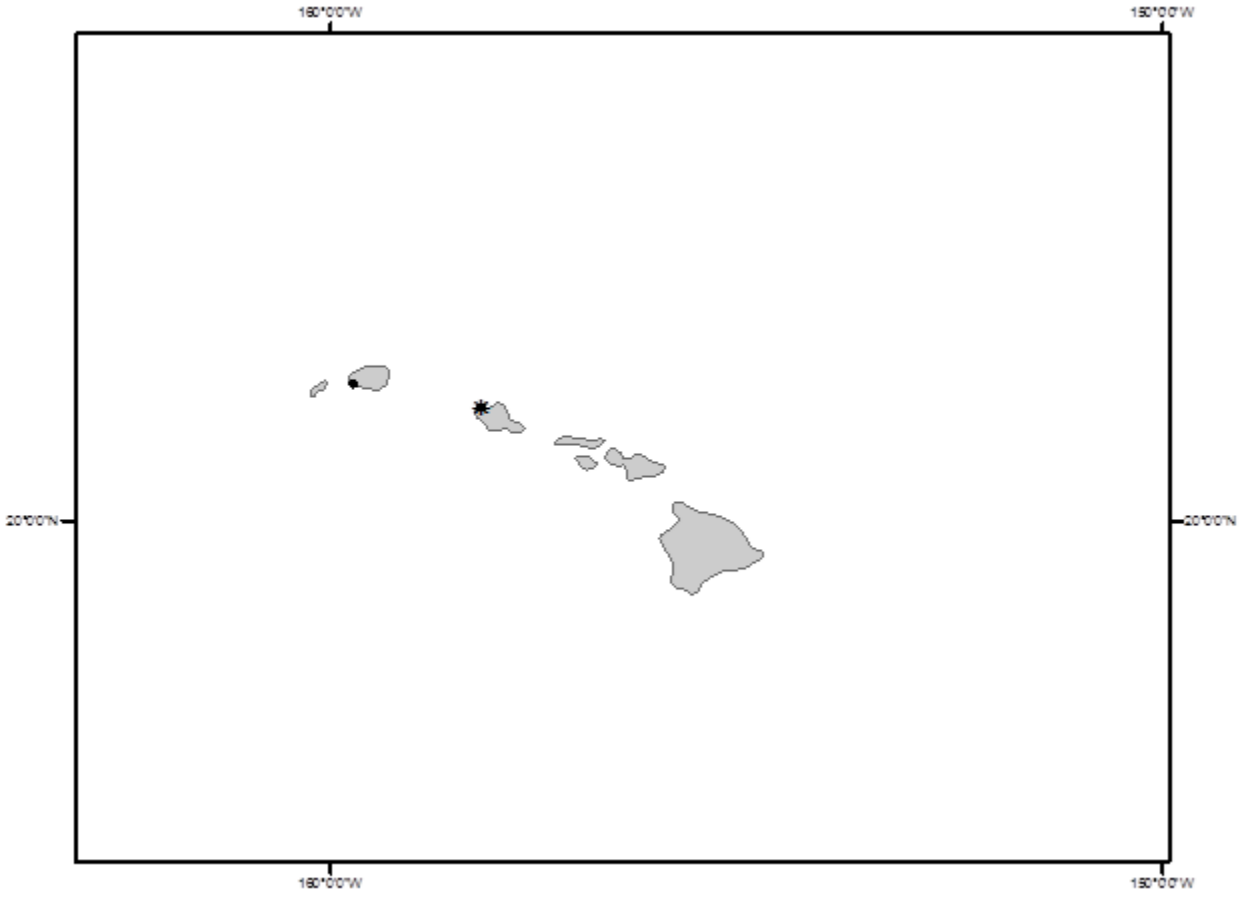


Figure 84. Geographical distribution of Holotype BPBM 3398 (not examined) and examined non-type specimens of *Bothus thompsoni*. Asterisk denotes the locality of *Bothus thompsoni* holotype BPBM 3398.

Remarks: There is discrepancy between the original description (Fowler 1923) and examined non-type specimens in regards to the lateral line count, body depth in relation to SL, and head length in relation to SL (Table 47). All of the non-type specimens and the holotype of *Bothus thompsoni* BPBM 3398 were collected from the same geographic locality in the Hawaiian Islands. Their pigmentation patterns, meristic, and morphometric values are otherwise similar. The larger than normal body depth to SL ratio and head length to SL ratio can be explained by the maturity of the specimens examined. *Bothus* larval

forms have different body shapes and morphology (Fukui 1997) that change drastically during ontogeny and maturation. All but one of the 12 non-type specimens examined in this study has a SL smaller than the SL of the holotype *Bothus thompsoni* BPBM 3398. Therefore, Fowler (1923) could have simply described a more mature adult as the holotype, in comparison to the less mature non-type specimens examined in the study. The discrepancy in lateral-line scale count is harder to account for. Firstly, some of the specimens examined were degraded which could explain a small difference with some scales falling off over time, however a difference of 20 scales is most likely not a result of specimen degradation. Unfortunately, the type specimen was not available for loan or examination. Therefore, the high lateral-line scale count of 132 is viewed as a descriptive feature of the species and not the diagnostic feature of different species.

Comparisons: *Bothus thompsoni* most closely resembles *Bothus mancus* and *Bothus myriaster*. *Bothus mancus* has a similar broad interorbital space (14%–32% of HL in *B. mancus,* versus 23%–41% of HL in *B. thompsoni*), geographic distribution (Pacific Ocean), and general appearance. *B. thompsoni* can be distinguished from *B. mancus* by the anterior profile of the head (Fig. 85), with *B. thomsponi* exhibiting a large bulging anterior profile and *B. mancus* exhibiting a slightly concave profile. *B. mancus* also has large white blotches all over the body and a low lateral-line scale count of 75–89 scales. *B. myriaster* resembles *B. thompsoni* with a rounded upper anterior profile of the head (Fig 85) and high lateral-line scale count of over 90 scales. *B. myriaster* can be differentiated by the presence of a flap like appendage on the eyes in males and dark bars running vertically across the median of the blind side.

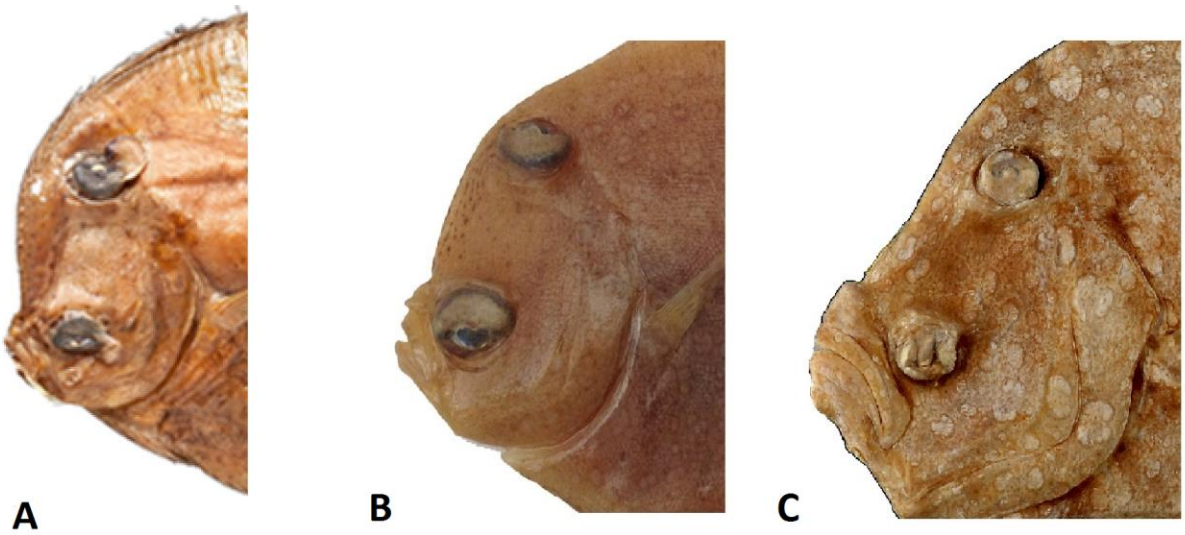


Figure 85. Different head morphologies of *Bothus myriaster* (Temminck and Schlegel 1846) BMNH 1935.3.12, 161 mm SL, French Indo- China (**A**); Bothus *thompsoni* BPBM 20792, adult male 89.07 mm SL, Hawaii, (**B**); *Bothus mancus* (Broussonet 1782) from SMF 6002, Adult male, 204 mm SL, from Pacific Marshall Islands, Bikini Atoll, Nama Inlet (**C**).

Bothus tricirrhitus Kotthaus, 1977

Figures 86, 87; Table 49

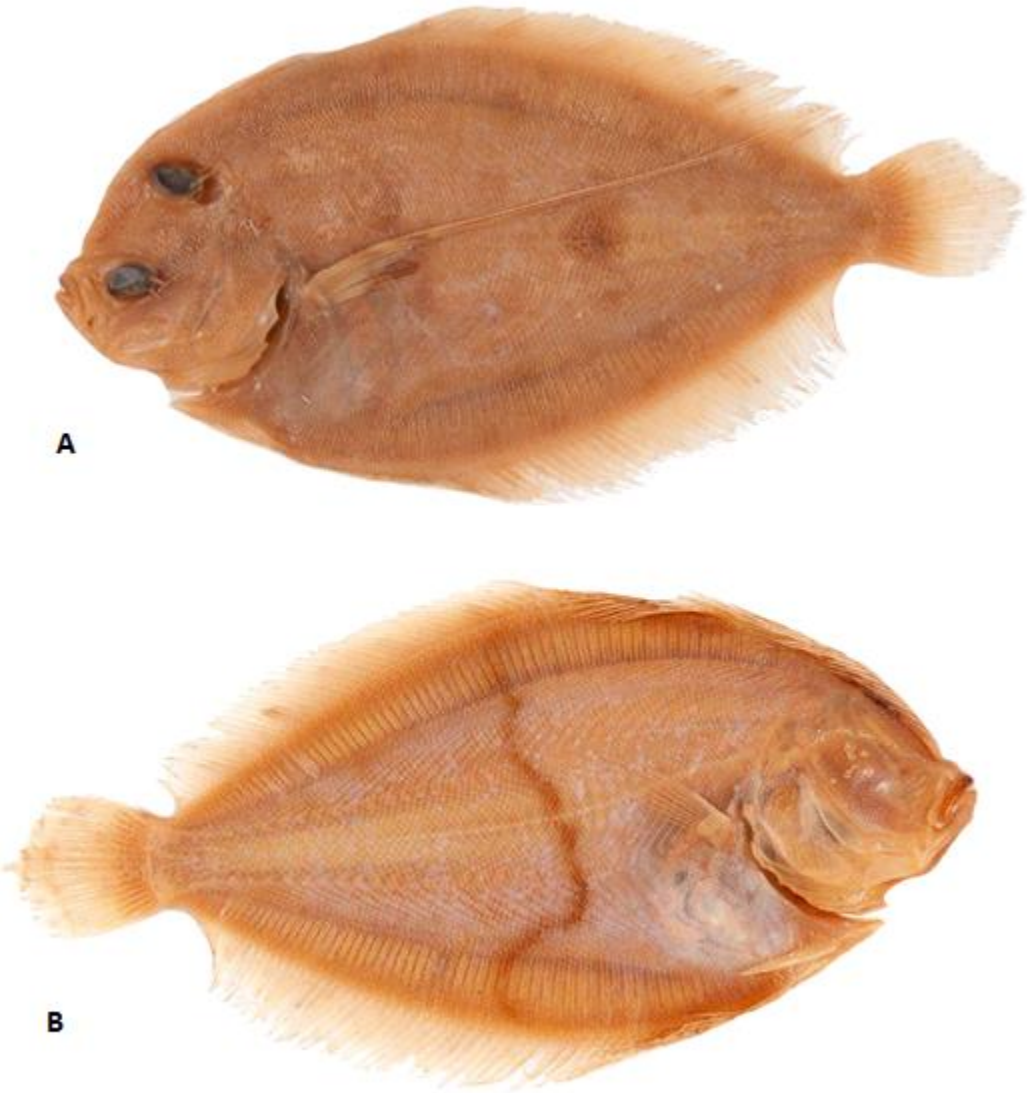


Figure 86. *Bothus tricirrhitus* Kotthaus, 1977, ZMH 5561, Holotype. Ocular and Blind side of adult male, 117.38 SL from Gulf of Aden.

Synonym(s): None.

Common name(s): None.

Material examined: *Bothus tricirrhitus,* 1 specimen (117.38 mm SL)

Type material: *Bothus tricirrhitus* Kotthaus 1977, Holotype ZMH 5561. (117.38 mm SL), Gulf of Aden

Non-type material: None

Diagnosis: A species of *Bothus* with the following combination of characters: 3 slender eye appendages on the posterior edge of both the ventral and dorsal eye, one thick distinct band running vertically across medial region of blind side.

Description: A species of *Bothus* reaching a maximum standard length of 117.38 mm (in examined specimen). Meristic and morphometric characters are indicated in Table 49; body semi ovate / tear drop shaped, body depth reaching 55% of SL; head length 27% of SL, head depth 43% of SL; anterior profile of head convex, with notch above snout (Fig. 86); males with spine on snout; interorbital distance wide concave, 28% of HL, anterior edge of dorsal eye in line with median of ventral eye; ventral eye diameter 25% of HL, 3 appendages located on posterior of each eye; 9 hourglass shaped supracranial pterygiophores, 15 dorsal-fin pterygiophores before first elongated neural spine; mouth ocular-side 25% of HL, blind side 27%; teeth shape conical, organized in two incomplete rows; 7 gill-rakers on lower limb of first gill arch, no gill-rakers on upper limb of first gill arch; lateral line with 78 scales, ending in bifurcated supratemporal branch; scales ctenoid on ocular side, cycloid on blind side; asymmetrical pectoral-fin rays with 11 rays on ocular side and 11 rays on blind side; second to fourth pectoral-fin rays on ocular-side greatly elongated 75% of SL, blind side 14% of SL; 87 dorsal-fin rays, 64 anal-fin rays, 17 caudal-fin rays, pointed; 10 precaudal vertebrae, 27 caudal vertebrae including the urostyle.

Pigmentation of preserved specimens: Ocular-side of body light tan (Fig. 86, A), with blind side same base color; dark small blotches the diameter of eye or smaller, around edges of body; dark speckles on dorsal, anal, and caudal rays; two dark blotches in the lateral line; anterior blotch located posterior to junction of lateral line curve, posterior blotch located in posterior one fourth of body before caudal peduncle; distinct dark wavy band running vertically across median of body on blind side (Fig. 86, B).

Table 49. Meristic and morphometric data for the holotype specimen of *Bothus tricirrhitus* Kotthaus, 1977. All measurements and abbreviations are described in Appendix B.

	B. tricirrhitus ZMH 5561 holotype
Standard length	117.38
Total length	140.32
Counts	
Dorsal-fin ray	87
Anal-fin ray	64
Caudal-fin ray	17
Precaudal vertebrae	10
Caudal vertebrae including urostyle	27
Hourglass shaped pterygiophores of dorsal-fin	9
Dorsal-fin pterygiophores anterior to first elongated neural spine	15
Gill rakers on lower limb of first gill arch	7
Gill rakers on upper limb of first gill arch	0
Dorsal-eye appendage	3
Ventral-eye appendage	3
Pectoral-fin rays o.s.	11
Pectoral-fin rays b.s.	11
Pelvic-fin rays o.s.	6
Pelvic-fin rays b.s.	6
Lateral-line scales	78
Measurements	
%SL	
Body Depth	0.55
Head length	0.27
Head depth	0.43
Length of pectoral fin o.s.	0.75
Length of pectoral fin b.s.	0.14
Length of pelvic fin o.s.	0.12
Length of pelvic fin b.s.	0.1
Length of base of pelvic fin o.s.	0.11
Length of base of pelvic fin b.s.	0.05
Length of first dorsal-fin ray	0.06
Length of first anal-fin ray	0.07
Depth of caudal peduncle	0.11
%HL	
Preorbital length	0.51
Postorbital length	0.25
Predorsal distance b.s.	0.14
Dorsal eye distance from anterior edge of head	0.20
Snout length (o.s.)	0.21
Snout to nostril distance (o.s.)	0.15
Length of mouth o.s.	0.25
Length of mouth b.s.	0.27
Ventral eye diameter	0.25
Width of dorsal orbital	0.31
Interorbital Distance	0.28

Sexual dimorphism: Sexual dimorphism of *Bothus tricirrhitus* can only be speculated as ZMH 5561 is a male specimen. Therefor I assume that a female would have a shorter pectoral-fin ray length, and smaller interorbital space.

Geographic distribution: *Bothus tricirrhitus* has been described in the west of the Gulf of Aden, and at Bab-el Mandeb, between the tip of Yemen and Djibouti.

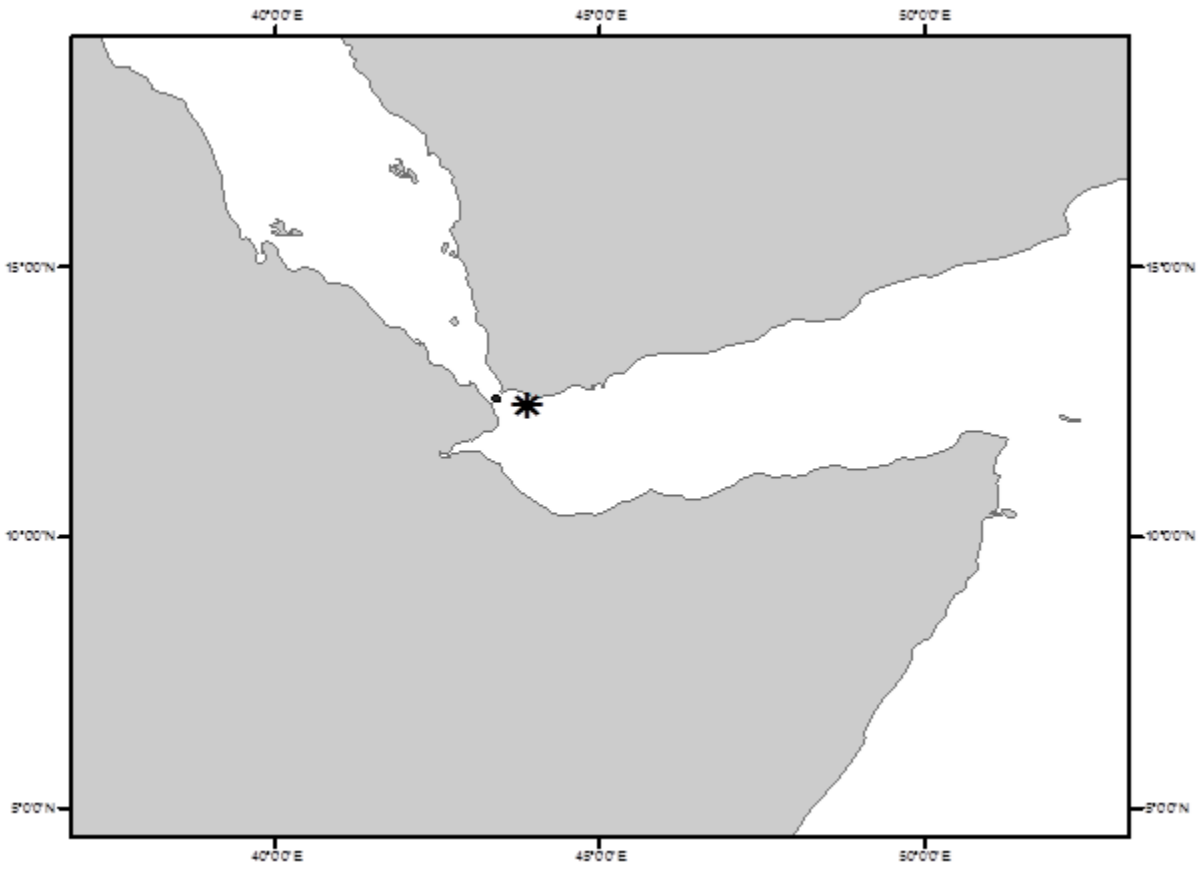


Figure 87. Geographical distribution of examined specimens of *Bothus tricirrhitus*. Asterisk denotes the locality of *Bothus tricirrhitus* holotype ZMH 5561 at a depth of 65 meters; Paratype ZMH 5562 at 174 meters (Kotthaus 1977).

Remarks: *Bothus pantherinus* is the only other species of *Bothus* found in the Gulf of Aden. *Bothus pantherinus* and *Bothus tricirrhitus* do resemble each other via their general appearance, which could there for propose a possible relationship with a common ancestor. *B. myriaster* is the only other species of *Bothus* that exhibits pigmentation on the blind side of the body, however it has no similar diagnostic characters and does not resemble *B. tricirrhitus.*

Comparisons: *Bothus tricirrhitus* can be further distinguished from all species of *Bothus* by its convex head shape with notch above the snout, elongated pectoral fins on the ocular side, and its 12–14 ocular-side pectoral-fin rays. *Bothus tricirrhitus* most closely resembles *Bothus pantherinus* and *Bothus guibei* because of their similar elongated slightly oval body shape (body depth averaging 53%–55% of SL in all species examined), extended pectoral-fin rays (up to 70% of SL in males of all species), presence of eye appendages (0-3 in all species), geographical distribution, and general appearance. Neither *B. pantherinus* nor *B. guibei* exhibit exactly 3 slender appendages on both eyes and the presence of banding or pigmentation on the blind side of the body. *B. pantherinus* can further be distinguished by its larger interorbital distance (12%–21% of HL in *B. pantherinus* versus 28% of HL in *B. tricirrhitus*), whereas *B. guibei* can further be distinguished by its higher anal-fin ray count of 71–75, compare to 64 anal rays in *B. tricirrhitus*. *B. pantherinus* has a geographic distribution of the Pacific, Indo-Pacific, Indian Ocean, and Red sea, whereas *B. guibei* is distributed in the Atlantic along the west coast of Africa. *B. tricirrhitus* has only been recorded in the Gulf of Aden and Bab-el Mandeb.

Bothus ypsigrammus *Kotthaus,* 1977

Figures 88 - 91; Tables 50, 51

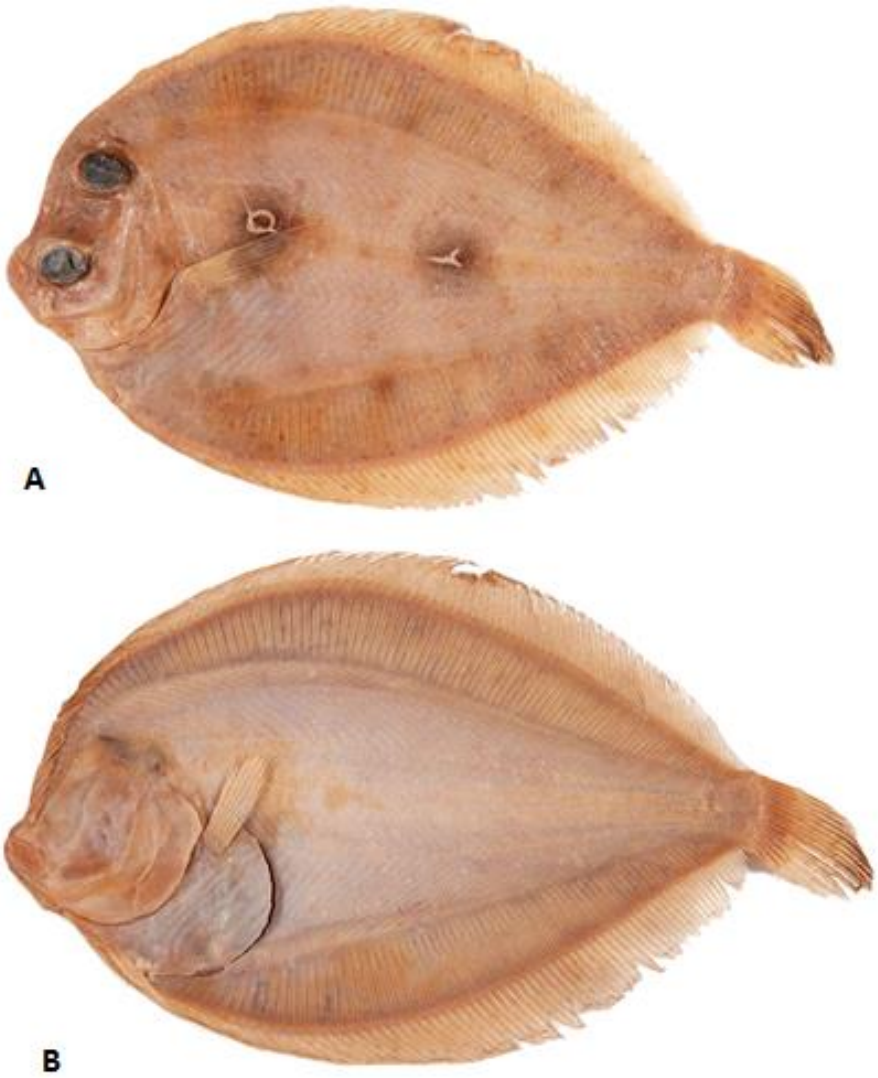


Figure 88. *Bothus ypsigrammus Kotthaus,* 1977, ZMH H5559 holotype, 154.3 mm SL, adult female, Somalia.

Synonym(s): None.

Common name(s): None.

Material examined: *Bothus ypsigrammus,* 8 specimens (56.25-156.03 mm SL)

Type material: *Bothus ypsigrammus* holotype ZMH H5559 (154.43 mm SL), Somalia. Paratype ZMH PT5560 (156.03 mm SL), Somalia

Non-type material: USNM 307544 (6) (56.25-108.61 mm SL), Mauritius

Diagnosis: A species of *Bothus* with the following combination of characters: large dark pigmentation with a white ocelli in the center, approximately 50 % the diameter of ventral orbit, located posterior to the curve of the lateral line system; dark pigmentation with white 'Y' shape, approximately 75% diameter of ventral orbit, located on the lateral-line in the posterior two thirds of the body (Figs. 88, 89).

Description: A species of *Bothus* reaching a maximum standard length of 154.43 mm (in examined specimens). Meristic and morphometric characters are indicated in Table 50. Body circular, deep; body depth reaching 58%–64% SL; head length 25%– 30% of SL; head depth 42%–54% of SL. Profile of head convex, with notch above snout (Figs. 88, 89). Spine on snout in some males; absent in females. Interorbital distance concave; 16%–34% of HL. Ventral eye diameter 23%–29% of HL. 9–11 hourglass shaped supracranial pterygiophores; 15–17 dorsal-fin pterygiophores before first elongated neural spine. Mouth ocular-side 20%–27% of HL, blind side 22%—28%; Teeth shape conical, biserial; 7– 8 gill-rakers on lower limb of first gill arch; 0–6 gill-rakers on upper limb of first gill arch; Lateral line with 104–124 scales, ending in a trifurcated or bifurcated supratemporal branch, Scales mainly cycloid with ctenoid scales around ventral edges of ocular side, all cycloid on blind side; Asymmetrical pectoral-fin rays with 9–11 on ocular side and 9– 10 on blind side; ocular-side fin rays longer 21%–33% of SL; blind

side 10%—16%; 89–106 dorsal-fin rays; 67–78 anal-fin rays; 17–18 caudal-fin rays; 10–11 precaudal vertebrae; 26–30 caudal vertebrae.

Pigmentation of preserved specimens: Ocular-side of body tan yellow to orange brown, blind side similar. Two well defined dark blotches on ocular-side arranged horizontally across medial region of body; pigmentation pattern unique to species. First pigmentation is around 50% diameter of ventral eye, dark with a distinct white ocelli in the center; located posterior to posterior to junction of curve in lateral line; lateral line running beneath or through the inferior portion of the ocelli; second pigmentation is dark with white "Y" shaped in center, located in posterior medial portion of body on lateral line; before the caudal peduncle. Small dark speckles throughout body, dorsal, anal, caudal rays. Smaller dark brown pigmentations asymmetrically arranged close to both edges of body. Blind side without pigmentation. (Figs. 88, 89).

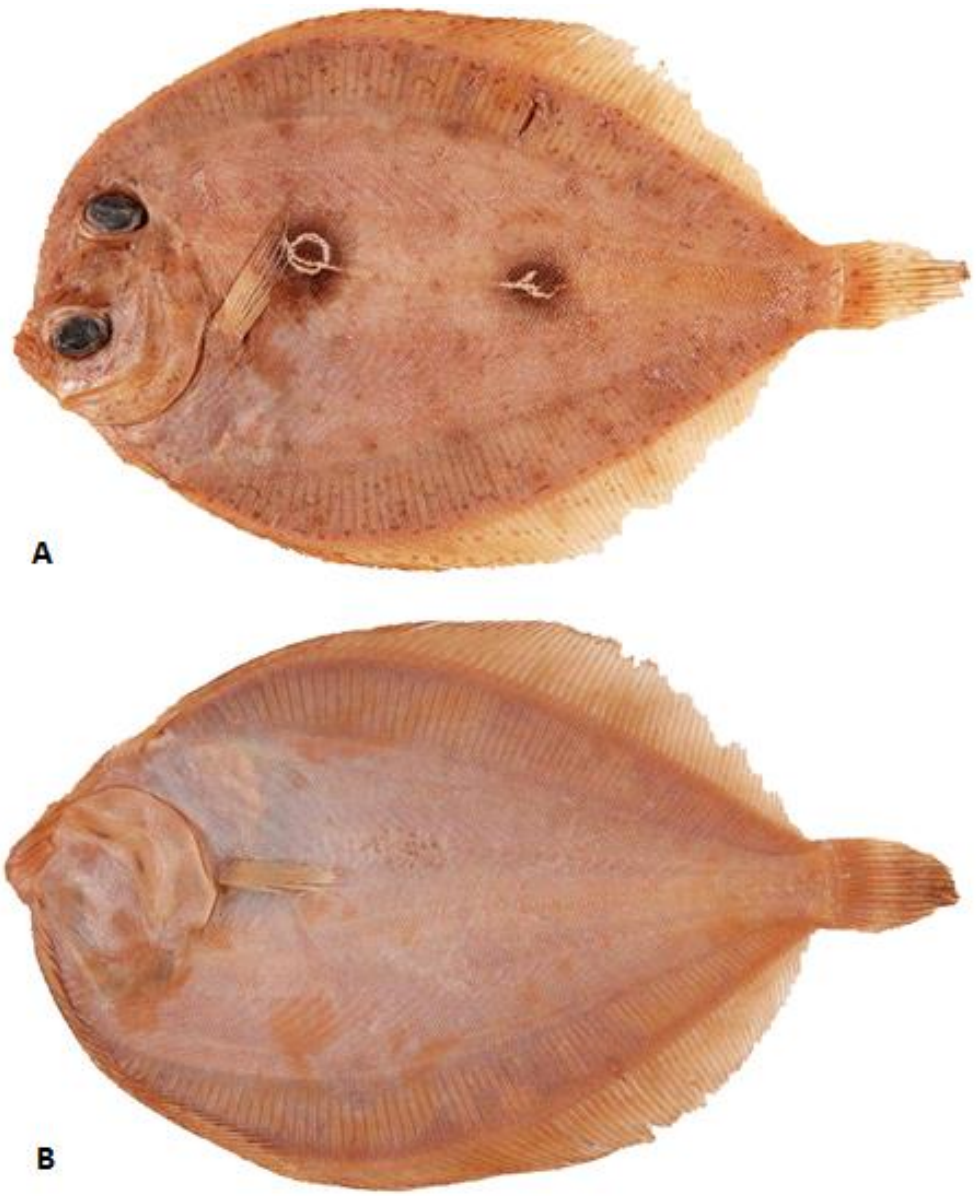


Figure 89. *Bothus ypsigrammus Kotthaus,* 1977 ZMH 5560 paratype, 156.03 mm SL, adult male. Ocular and blind sides. Depicting lateral line running through inferior portion of prominent white ocelli.

Table 50. Meristic and morphometric data for the type and non-type specimens of *Bothus ypsigrammus* Kotthaus 1977. Data for *Bothus ypsigrammus* ZMH 5559 holotype and ZMH 5560 paratype and were obtained from original type specimens and compared against non-type material (n= 4; 1 male, 3 female). All measurements and abbreviations are described in Appendix B.

	B. ypsigrammus ZMH 5559 holotype	*B. ypsigrammus* ZMH 5560 paratype	*B. ypsigrammus* USNM 307544 non-type specimens (n=3)
Standard length	154.43	156.03	83.68-108.61 (96.15;17.63)
Total length	181.89	183.98	101.68-131.12 (116.4;20.82)
Counts			
Dorsal-fin ray	106	102	89-92 (90.5;2.12)
Anal-fin ray	78	75	67-76 (71.5;6.36)
Caudal-fin ray	17	17	17-18 (17.5;0.71)
Precaudal vertebrae	10	10	10-11 (10.5;0.71)
Caudal vertebrae including urostyle	31	30	27-28 (27.5;0.71)
Vertebrae total including urostyle	41	40	37-38 (37.5;0.71)
Hourglass shaped pterygiophores of dorsal-fin	10	11	9-9 (9.;0.)
Dorsal-fin pterygiophores anterior to first elongated neural spine	16	17	15-15 (15.;0.)
Gill rakers on lower limb of first gill arch	7	8	7-7 (7.;0.)
Gill rakers on upper limb of first gill arch	6	5	0-6 (3.;4.24)
Dorsal-eye appendage	0	0	0-2 (1.;1.41)
Ventral-eye appendage	0	0	0-1 (0.5;0.71)
Pectoral-fin rays o.s.	10	9	10-11 (10.5;0.71)
Pectoral-fin rays b.s.	9	9	10-10 (10.;0.)
Pelvic-fin rays o.s.	6	6	6-6 (6.;0.)
Pelvic-fin rays b.s.	6	6	6-6 (6.;0.)
Lateral-line scales	118	124	104-104 (104.;0.)
Measurements			
%SL			
Body Depth	0.62	0.64	0.58-0.59 (0.59;0.01)
Head length	0.26	0.25	0.28-0.3 (0.29;0.01)
Head depth	0.45	0.48	0.42-0.54 (0.48;0.08)
Length of pectoral fin o.s.	0.21	0.21	0.2-0.33 (0.26;0.09)
Length of pectoral fin b.s.	0.14	0.1	0.14-0.16 (0.15;0.01)
Length of pelvic fin o.s.	0.1	0.14	0.11-0.12 (0.11;0.)
Length of pelvic fin b.s.	0.08	0.07	0.1-0.1 (0.1;0.)
Length of base of pelvic fin o.s.	0.10	0.09	0.09-0.12 (0.11;0.02)
Length of base of pelvic fin b.s.	0.05	0.04	0.05-0.06 (0.05;0.)
Length of first dorsal-fin ray	0.04	0.05	0.06-0.09 (0.07;0.02)
Length of first anal-fin ray	0.06	0.07	0.08-0.1 (0.09;0.01)
Depth of caudal peduncle	0.1	0.11	0.09-0.1 (0.1;0.01)
%HL			
Preorbital length	0.38	0.4	0.38-0.47 (0.43;0.04)
Postorbital length	0.23	0.25	0.24-0.31 (0.26;0.04)
Predorsal distance b.s.	0.16	0.18	0.17-0.23 (0.19;0.03)
Dorsal eye distance from anterior edge of head	0.17	0.19	0.16-0.18 (0.17;0.01)
Snout length (o.s.)	0.18	0.21	0.23-0.28 (0.25;0.02)
Snout to nostril distance (o.s.)	0.09	0.16	0.15-0.19 (0.18;0.03)
Length of mouth o.s.	0.2	0.2	0.2-0.27 (0.23;0.04)
Length of mouth b.s.	0.23	0.23	0.22-0.28 (0.24;0.03)
Ventral eye diameter	0.29	0.29	0.23-0.28 (0.25;0.03)
Width of dorsal orbital	0.33	0.32	0.29-0.34 (0.31;0.03)
Interorbital Distance	0.29	0.34	0.16-0.27 (0.21;0.06)

*indicates a character could not be collected for one specimen

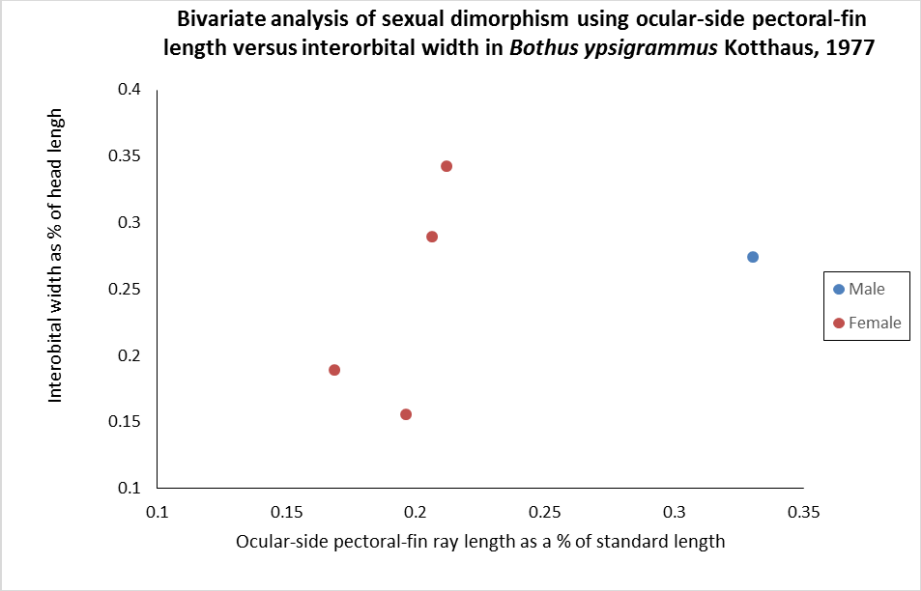
Sexual dimorphism: Gender of males and females in *Bothus ypsigrammus* is not apparent. The original description and type material do not state any features that can distinguish gender. Furthermore, one observed female within the non-type specimens has the presence of eye appendages with no spine present on the snout (Fig. 88). In all other cases of the species examined, a spine or eye appendage could be used to conclude the gender of a specimen without a dissection, and they generally refer to the specimen being a male. This presents an interesting feature of the species examined in that they would also be the only species with the presence of ocular appendages in females with the character lacking in males. Unfortunately, the type material of the genus has no ocular appendages, and the sample size of examined specimens for *Bothus ypsigrammus* is too small (due to the rarity of species in institution collections) to make a strong conclusion about this character and its relation to sexual dimorphism. The analyses and determination of sexual dimorphism of *Bothus ypsigrammus* was proposed based on from morphology in other related species within *Bothus*.

Table 51. Morphometric comparison and bivariate analysis of males and females of *Bothus ypsigrammus* Kotthaus 1977 of non-type material (n= 4, 1 male, 3 females). Means and standard deviations are shown in parenthesis. All measurements and abbreviations are described in Appendix B.

	B. ypsigrammus ZMH 5559 holotype	*B. ypsigrammus ZMH 5560 paratype*	*B. ypsigrammus USNM 307544 non-type specimens (n=3)*	
Character	Female	Female	Male, n=1	Female, n=2
Standard length	154.43	156.03	108.61	70.51-83.68 (77.1;9.31)
Count				
Number of eye appendages	0	0	0	2.-3. (2.5;0.71)
Measurements				
%SL				
Head length	0.26	0.25	0.28	0.3-0.3 (0.3;0.)
Head depth	0.45	0.48	0.54	0.41-0.42 (0.42;0.01)
Length of pectoral-fin ray o.s.	0.21	0.21	0.33	0.17-0.2 (0.18;0.02)
%HL				
Interorbital distance	0.29	0.34	0.14-0.27 (0.21;0.09)	0.16-0.19 (0.17;0.02)

*indicates a character could not be collected for one specimen
Blank space indicates where data could not be obtained

(Table 51. Continued)



Geographic distribution: *Bothus ypsigrammus* has been reported off the northern coast of Somalia, in the Gulf of Aden ,*Kotthaus* 1977, as well as Mauritius.

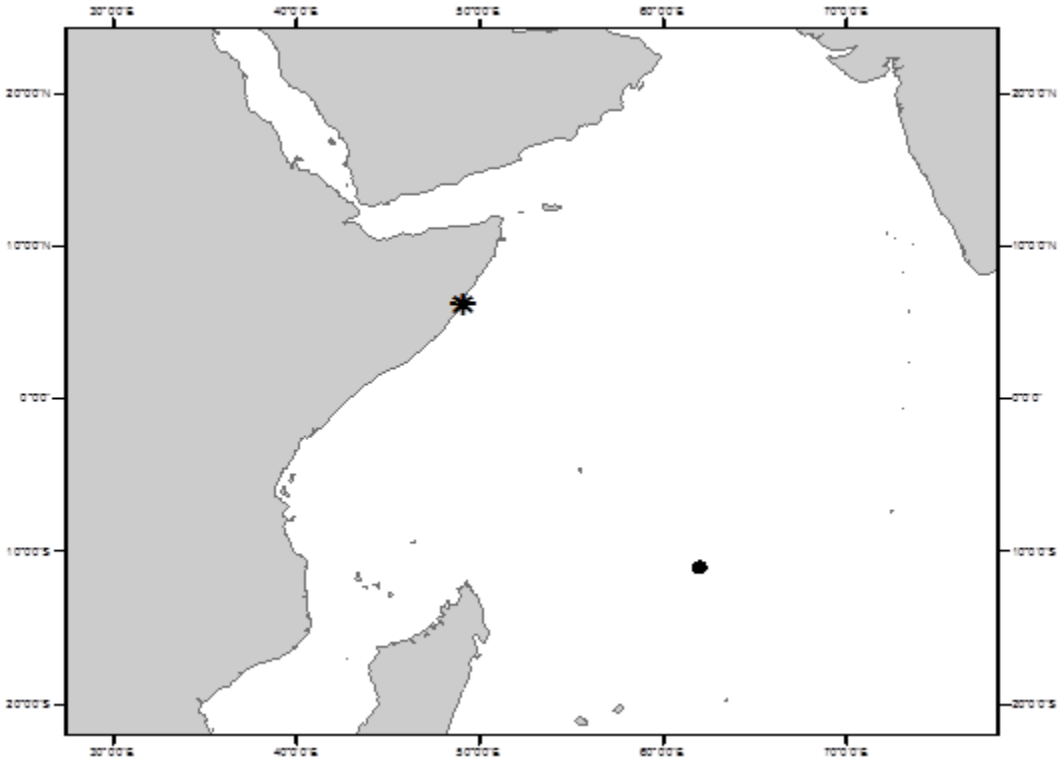


Figure 90. Geographical distribution of examined specimens of *Bothus ypsigrammus*. Asterisk denotes locality of ZMH 5559 Holotype and ZMH 5560 Paratype.

Remarks: There is discrepancy between the examined type and non-type specimens of *Bothus ypsigrammus* in regards to the dorsal-fin ray count, caudal vertebrae, and lateral line counts (Table 50). The holotype and paratype of *B. ypsigrammus* are substantially larger in SL than the non-type material examined in this study however, this would not account for a difference in meristic data. The type material and non-type were collected in different geographic locations, however the locations are not substantially separated or isolated by a geographical barrier distance. All of the non-type specimens exhibit the white 'Y' shaped pigmentation in the center of a dark blotch near the posterior of the body, which is the diagnostic character of the species, thus confirming their proper identification. Therefor I view these as common ranges within the species description until further specimens are collected or new evidence is presented.

Comparison: *Bothus ypsigrammus* can be differentiated from all other species of *Bothus* by its deep body depth, anterior profile of head with a notch above maxillary, short pectoral fins, its high lateral-line scale count (102–124), and two dark diffuse blotches in the lateral line. *Bothus myriaster* (Temminck & Schlegel 1846) shares the closest resemblance with *B. ypsigrammus* based on their notched anterior profile of the head, the presence of an ocelli located posterior to the curve of the lateral-line, and lateral-line scale counts of over 95. *B. myriaster* is the only other species of *Bothus* to feature an ocelli posterior to the junction of the lateral line curve in generally the same location as *B. ypsigrammus* (Fig. 91). The two are easily distinguishable through the presence of large fleshy flaps on the posterior of each eye in *B. myriaster*, absent in *B. ypsigrammus.* They can further be distinguished by the longer pectoral-fin rays in males of *B. myriaster* (31%–59% of SL in *B. myriaster,* 21%–33% of SL in *B. ypsigrammus*) as well as a lower lateral-line scale count (95–106 in *B. myriaster,* 104–124 in *B. ypsigrammus*).

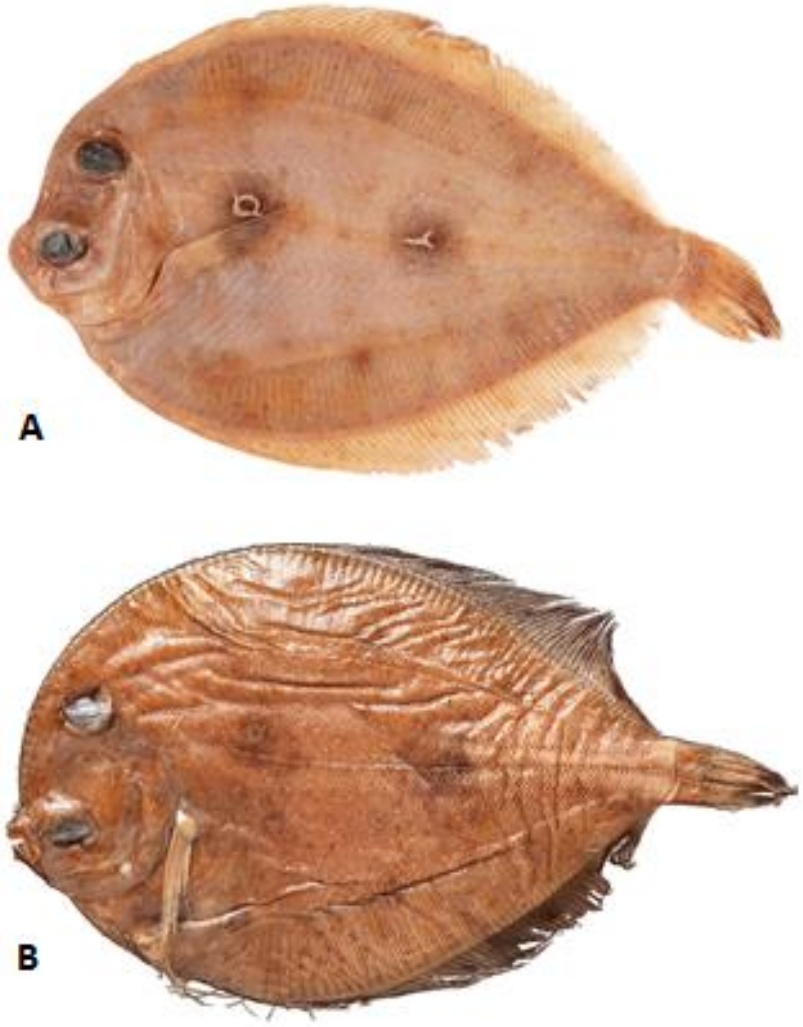


Figure 91. Picture of *Bothus ypsigrammus* Holotype ZMH 5559 (**A**), and *Bothus myriaster* BMNH 1933.6.12.4 (**B**) depicting similar morphology and ocelli located posterior to the posterior curve of lateral line in both species.

RESULTS and DISCUSSION

The phylogenetic species concept was used as the framework for the taxonomic revision of the genus *Bothus*. The monophyly of *Bothus* (pg.20-22) is proposed based on osteological diagnostic characters first identified by Amaoka and Hoshino (2006) that were observed in all species of the genus, except *B. swio*: a thick ventral expansion of the haemapophyses of the precaudal vertebrae and the bony expansion of the first haemal spine of the first caudal vertebrae (Fig. 15). The outgroups of *Bothus* (pgs. 13-19) have been hypothesized as *Engyprosopon* and *Crossorhombus* based on their shared character only observed in these three genera: an anterior extension of the sciatic part of the urohyal past the main part of the urohyal (Fig. 7). Based on the hypothesized outgroups and the characters unique to all *Bothus* species, except *B. swio*, the genus has been hypothesized as natural. Nonetheless, both the monophyly of *Bothus* and its outgroup relationships remain unknown and future analyses need to test both of these hypotheses scientifically using objective cladistic methods.

This taxonomic revision allowed the re-designation of nominal *Bothus* species and the new classification of several synonyms and junior synonyms. *Rhombus heterophthalmus* Bennett 1831 has been synonymized with *Bothus guibei* (pg. 87). *Platotichthys chartes, Pleuronectes argus, Pleuronectes pictus, Pleuronectes lunulatus, and Pleuronectes spinosis* were deemed junior synonyms of *Bothus lunatus* (pg. 106). *Pleuronectes barfi* and *Rhombus macropterus* have been synonymized with *B. mancus* (pg. 125). *Rhombus parvimanus, Rhombus pavo*, and *Platophrys smithi* have been deemed junior synonyms of *Bothus mancus* (pg. 126). *Citharicthys aureus* was recognized as a synonym of *Bothus myriaster* (pg. 149). *Bothus bleekeri and Platophrys ovalis* were deemed junior synonyms of *Bothus myriaster* (pg. 145). *Platophrys nebularis*, *Rhomboidichtys spinosus*, and *Rhombus bahianus* have been recognized as synonyms of *Bothus ocellatus* (pg. 159). *Bothus rumolo, Bothus tappa* and *Rhombus gesneri* have been recognized as synonyms of *Bothus podas* (pg. 186, 196). *Bothus atlanticus, Rhombus*

rhomboides, *Rhombus serratus*, *Bothus diaphanus*, *Bothus diagrammus,* and *Bothus punctatus* have been deemed junior synonyms of *Bothus podas* (pg. 186, 190, 193, 195). *Bothus podas africanus* and *Bothus podas maderensis* have been recognized as sub-species of *Bothus podas* (pg. 187, 193).

Bothus ellipticus (pg. 77) has doubtedly been deemed a valid species of *Bothus*. The location of the type specimen of *Bothus ellipticus* is not known and literature (Poey, 1860) states it closely resembles *Bothus maculiferus* morphologically. The one differentiating character of *B. ellipticus* from *B. maculiferus* is the dorsal-fin ray count on 104, which was also not observed among any other species of *Bothus* in this study. The sample size of *B. maculiferus* observed in this study was small and it is possible that there could be other specimens of *B. maculiferus* exhibiting dorsal-fin ray counts equal or close to 104. The geographic distribution of the two species overlaps which also strengthens the probability that *Bothus ellipticus* is a synonym of *Bothus maculiferus*. Future studies should attempt to address discrepancy with *B. ellipticus* for a definitive identification. It is important to note that the original author (Poey, 1860) described both species *B. ellipticus* and *B. maculiferus* in the same publication and identified them as separate species. Therefore, without any type material or other species with a matching dorsal-fin ray count, *B. ellipticus* should remain a valid *Bothus* species.

Bothus swio (pg. 208) has with doubt, been recognized as a valid species of *Bothus*. Although it exhibits morphology and meristic traits common to species of *Bothus* (body depth in relation to SL, extended pectoral fins, orbital spines, dorsal/anal-fin ray counts, number of lateral line scales), it lacks a ventral expansion of the precaudal vertebrae haemapophyses and the bony expansion of the first haemal spine, which are diagnostic features of *Bothus* (pg. 213-215). When analyzing diagnostic characters of other Bothidae genera, *B. swio* only resembles the genera *Bothus* and *Grammatobothus* (Hensley 1997, Hoshino & Amaoka, 2006). *Bothus swio* was put in *Bothus* instead of *Grammatobothus* because it lacked a well-developed lateral line on the blind side, a diagnostic character of

Grammatobothus (pg. 15). This lack of diagnostic characters observed in both genera would in effect place *B. swio* as a new genus of Bothidae. When first described, the osteological morphology of *B. swio* had not been examined (Hensley 1997). This study examined the precaudal vertebrae of *Grammatobothus* species and found them to be similar to that of *B. swio* (Fig. 80, 81). A limited number of *Grammatobothus* were examined and did not allow for a definitive result, compounded with the fact that there are only two known specimens of *B*. *swio,* neither of which was available for examination. Therefore, in light of the observations I conclude *B. swio* should doubtfully remain a species of *Bothus* (as originally designated by Hensley 1997). The revision of *Bothus* suggests that future phylogenetic studies examining *B. swio* and other bothid genera may yield a new designation for *B. swio* or the designation of a new genus all together.

The geographic distribution of *Bothus* species has been established and is represented by the individual geographic collection points of valid species examined in this study (Fig. 92). Previous studies on *Bothus* (Norman 1934; Fukui 1997) have separated the genera into two groups of species based on their geographic distributions (Indo-Pacific or Atlantic-Mediterranean). *Bothus ocellatus, Bothus podas, Bothus mellissi, Bothus lunatus, Bothus maculiferus* and *Bothus ellipticus* were deemed to originate from the Mediterranean and Atlantic, whereas *Bothus mancus, Bothus leopardinus, Bothus constellatus, Bothus pantherinus, Bothus myriaster* and *Bothus assimilis* were deemed to originate from the Indo-Pacific region (Norman 1934; Fukui 1997). Based on the observations *Bothus ypsigrammus*, *Bothus tricirrhitus and Bothus thompsoni* were added to the Indo-Pacific group and *Bothus swio, Bothus guibei and Bothus robinsi* were added to the Mediterranean-Atlantic group. However, when constructing the species key of *Bothus* (pgs. 46-48), it was not split into two geographically separate groups as previously done, as there was no justification to do so.

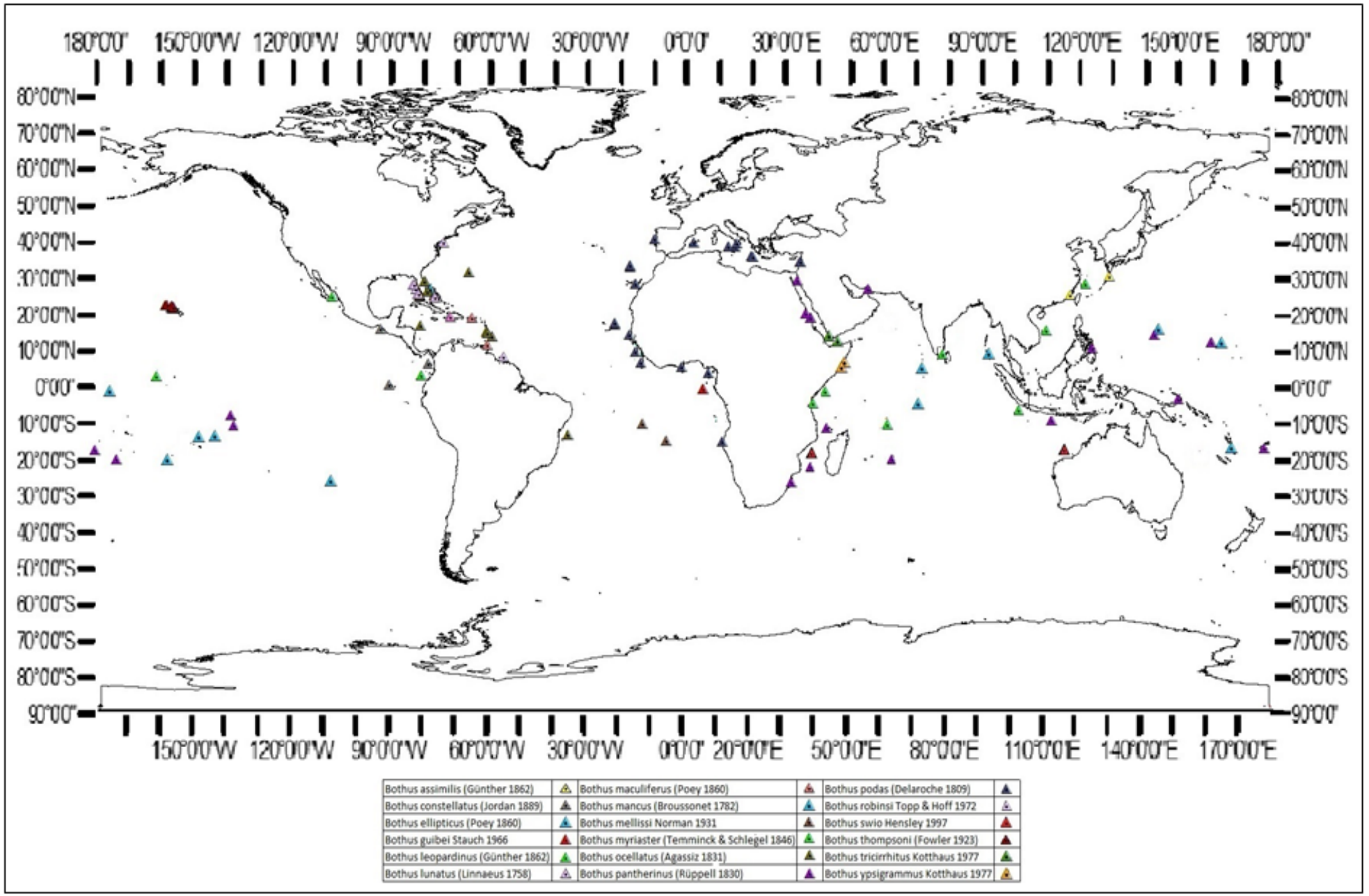


Figure 92. Geographical distribution of all examined species of *Bothus.*

Future Study of *Bothus*

Species of *Bothus* exhibit two common variations of body morphology (Fig. 21 and Fig. 22) that allow species of *Bothus* to be grouped together. One group (*B. ocellatus, B. podas, B. mellissi, B. lunatus, B. mancus, B. leopardinus, B. constellatus, B. assimilis, B. thompsoni, B. ypsigrammus*) exhibits a concave or flat anterior profile of the head with a prominent notch above the maxillary, greater interorbital distances in relation to heads length, more circular/deeply compressed body in relation to standard length, and short pectoral-fin rays in relation to standard length. The second group (*B. ellipticus, B. maculiferus, B. pantherinus, B. myriaster, B. tricirrhitus, B. swio, B. guibei*) exhibits a convex anterior profile of the head with little to no notch above the maxillary, a shorter interorbital space in relation to head length, a longer oval/less compressed body in relation to standard length, and greatly extended pectoral-fin rays in relation to standard length. Species with both variations of body morphology were found to have overlapping geographic distributions, and as such, no noticeable correlation was observed. An in-depth analysis of these two morphological variations among the genus could yield new results regarding relationships among species. A cladistical analysis using a larger sample size with multiple characters would lead to a better understanding of relationships in the genus. Moreover, a phylogenetic analysis of *Bothus* would be necessary to identify the polarity of uniquely derived character states among species and could help identify the source of the two types of body morphologies observed in the genus. In conclusion, this observation of distinct morphology within the genus and should be tested in any future study of *Bothus*.

Sample sizes of 320 specimens of Bothus were examined in this study. This led to conclusive results when species had an abundance of type and non-type material available. However, the study was left to rely on literature when large samples of type and non-type material were not available. Future studies should look to include more specimens when assessing species with particularly large

geographical distribution. As this genus is distributed in almost all oceans of the word, a larger sample size would strengthen the results, possibly unveil new characters unique to the genus, or even lead to the discovery of new species.

A phylogenetic study of *Bothus* or Bothidae has yet to be completed. The morphological variation observed among valid *Bothus* species overlaps with the hypothesized outgroups of *Bothus*: *Engyprosopon* and *Crossorhombus.* The similarity in morphology between the more compressed circular species of *Bothus* and the hypothesized outgroups (*Engyprosopon* and *Crossorhombus*) is intriguing and a proper phylogenetic analysis might reveal a closer relationship between species currently in *Bothus* with species in the presumed outgroups. This might lead to a reconsideration of the monophyly of *Bothus* as depicted in this study.

Moreover, the outgroups of *Bothus* have been hypothesized based on a single unique osteological character state (the extension of the sciatic part of the urohyal past the main part of the urohyal) shared by three genera: *Bothus, Engyprosopon*, and *Crossorhombus*. This is a weak hypothesis. A phylogenetic analysis examining multiple characters and including most bothid genera and species would undoubtedly yield a stronger sister-group hypothesis and would certainly offer a unique opportunity to determine if *Bothus swio* is a *Bothus*.

GENERAL CONCLUSIONS

A taxonomic review of the genus *Bothus* was done. It encompassed an examination of 320 specimens obtained from or observed in ichthyological collections worldwide. Of the 59 nominal *Bothus* species, 18 were found to be valid: *Bothus assimilis, Bothus constellatus, Bothus ellipticus, Bothus guibei, Bothus leopardinus, Bothus lunatus, Bothus maculiferus, Bothus mancus, Bothus mellissi, Bothus myriaster, Bothus ocellatus, Bothus pantherinus, Bothus podas, Bothus robinsi, Bothus swio, Bothus thompsoni, Bothus tricirrhitus,* and *Bothus ypsigrammus*. The phylogenetic species concept was used as a framework of the study to identify diagnostic features unique to a group of species that share a common ancestor. The revision utilized detailed morphological measurements, meristic counts, and osteological surveys to identify diagnostic features that could validate species of *Bothus*. The geographic distribution of *Bothus* and its valid species was achieved through the identification and mapping of all species examined. The monophyletic status of *Bothus* was hypothesized because characters previously proposed by Amaoka and Hoshino (2006) were found to be present in all species examined, except *Bothus swio*: the ventrally expansion of the haemapophyses of the precaudal vertebrae and the bony expansion of the haemal spine of the first caudal vertebrae. The outgroups of *Bothus* were also hypothesized as *Engyprosopon* and *Crossorhombus* based on a character shared by all three genera: the anterior extension of the sciatic part of the urohyal past the main part. However, the monophyly of *Bothus* and its outgroup relationships remain unknown and will have to be determined in future scientific analyses using objective scientific methods. Lastly, a newly revised species identification key to the genus *Bothus* was created.

The phylogenetic relationships of the genus *Bothus* and the family Bothidae remain unclear. Although there have been studies on interrelationships of some of Bothids, there is still a need for a full

phylogenetic analyses of the family. I believe this study will serve as a foundation for future studies pertaining to the phylogenetic relationships of both *Bothus* and Bothidae.

REFERENCES

Agassiz, L. 1831. Selecta genera et species piscium quos in itinere per Brasiliam annos MDCCCXVII-MDCCCXX jussu et auspiciis Maximiliani Josephi I.... colleget et pingendso curavit Dr J. B. de Spix.... Monachii. Part 1: i-xvi + i-ii + 1-82, Pls. 1-48; Part 2: 83-138, Pls. 49-101.

Afonso, P., Porteiro, M.F., Santos, R.S., Barreiros, J.P., Worms J., and Wirtz, P. 1999. Coastal Marine Fishes of São Tomé Island (Gulf of Guinea). Arquipélago: Boletim da Universidade dos Açores, 65-92.

Alcock, A.W. 1890 (1 Dec.) Natural history notes from H. M. Indian marine survey steamer `Investigator,' Commander R. F. Hoskyn, R. N., commanding. No. 20. On some undescribed shore-fishes from the Bay of Bengal. Annals and Magazine of Natural History. v. 6: 425-443.

Allen, G.R. & Adrim, M. 2003. Coral reef fishes of Indonesia. Zoological Studies, v. 42: 1-72.

Allen, G.R. & Erdmann, M.V. 2012 (Mar.) Reef fishes of the East Indies. Volumes I-III. Tropical Reef Research, Perth Australia. v. 2: 425-855, v. 3, 857-1260.

Allen, G.R. and Robertson, D.R. 1994. Fishes of the tropical eastern Pacific. Crawford House Press, Bathurst. 1-332.

Amaoka, K. 1969. Studies on the sinistral flounders found in the waters around Japan--taxonomy, anatomy and phylogeny. J. Shimonoseki Univ. Fish, 65-340.

Amaoka, K., Mihara, E. & Rivaton, J. 1993. Pisces, Pleuronectiformes: flatfishes from the waters around New Caledonia. - A revision of the genus *Engyprosopon*. Mémoires du Muséum National d'Histoire Naturelle, Paris (N. S.) (Série A) Zoologie. v. 158: 377-426.

Azevedo, M.F., Oliveira, C., Pardo, B.G., Martínez, P., & Foresti, F. (2008). Phylogenetic analysis of the order Pleuronectiformes (Teleostei) based on sequences of 12S and 16S mitochondrial genes. Genetics and Molecular Biology. v. 31: 284-292.

Bennett, E. T. 1831. Characters of new genera and species of fishes from the Atlantic coast of northern Africa presented by Captain Belcher, R.N. Proceedings of the General Meetings for Scientific Business of the Zoological Society of London, pt 1: 145-148.

Bennett, E. T. 1832. Observations on a collection of fishes from the Mauritius, presented by Mr. Telfair, with characters of new genera and species. Proceedings of the Committee of Science and Correspondence of the Zoological Society of London, pt 1: 165-169.

Berendzen, P.B. and Dimmick, W.W. 2002. Phylogenetic relationships of Pleuronectiformes based on molecular evidence. Copeia 2002. v. 3: 642-652.

Berg, L.S. 1940. Classification of fishes, both recent and fossil. Travaux de l'Institut Zoologique de l'Academie des Sciences de l'URSS. 87-517, Figs. 1-190.

Betancur, R. and Ortía, G. 2014. Molecular evidence for the monophyly of flatfishes (Carangimorpharia: Pleuronectiformes). Molecular Phylogenetics and Evolution. v. 73, Pages 18–22.

Betancur, R., Broughton, R.E., Wiley, E.O., Carpenter, K., López, J.A., Li, C., Holcroft, N.I., Arcila, D., Sanciangco, M., Cureton, II J.C., Zhang, F., Buser, T., Campbell, M.A., Ballesteros, J.A., Roa-Varon, A., Willis, S., Borden, W.C., Rowley, T., Reneau, P.C., Hough, D.J., Lu, G., Grande, T., Arratia, G., Ortí, G. 2013.The Tree of Life and a New Classification of Bony Fishes. PLOS Currents Tree of Life. Edition 1.

Bilecenoglu, M., Taskavak, E., Mater S., & Kaya, M. 2002. Checklist of the marine fishes of Turkey. Zootaxa. v. 113: 1-194.

Bleeker, P. 1855. Tweede bijdrage tot de kennis der ichthyologische fauna van de Batoe-eilanden. Natuurkundig Tijdschrift voor Nederlandsch Indië. v. 9: 65-72.

Bleeker, P. 1856. Beschrijvingen van nieuwe of weinig bekende vischsoorten van Manado en Makassar, grootendeels verzameld op eene reis naar den Molukschen Archipel in het gevolg van den Gouverneur Generaal Duymaer van Twist. Acta Societatis Regiae Scientiarum Indo-Neêrlandicae v. 6: 1-80.

Bloch, M.E. 1783. M. Marcus Elieser Bloch's, ausübenden Arztes zu Berlin, Oekonomische Naturgeschichte der Fische Deutschlands. Berlin. M. Marcus Elieser Bloch's, ausübenden Arztes zu Berlin, Oeconomische Naturgeschichte der Fische Deutschlands. v. 2: 1-192, Pls. 38-72.

Bloch, M.E. & J.G. Schneider 1801. M. E. Blochii, Systema Ichthyologiae iconibus cx illustratum. Post obitum auctoris opus inchoatum absolvit, correxit, interpolavit Jo. Gottlob Schneider, Saxo. Berolini. Sumtibus Auctoris Impressum et Bibliopolio Sanderiano Commissum. M. E. Blochii, Systema Ichthyologiae. i-lx : 1-584, Pls. 1-110.

Bonaparte, C.L. 1833. Iconografia della fauna italica per le quattro classi degli animali vertebrati. Tomo I-III. Pesci. Roma. Iconografia della fauna italica per le quattro classi degli animali vertebrati. Pesci. Fasc. 2-5, puntata 7-28, 12 pls.

Bonaparte, C.L. 1846. Catalogo metodico dei pesci Europei. Napoli: Stamperia e Cartiere del Fibreno. 47.

Bogorodsky, S.V., Alpermann, T. J., Mal, A. O. & Gabr, M. H. 2014. Survey of demersal fishes from southern Saudi Arabia, with five new records for the Red Sea. Zootaxa 3852 (no. 4): 401-437.

Broussonet, P.M.A. 1782. Ichthyologia, sistens piscium descriptiones et icones. Decas I. London. Ichthyologia, sistens piscium descriptiones et icones. Decas I.: 49 unnum. pages, incl. i-iv., Unnum. Pls. 1-11.

Campbell, M.A., Chen W.J., López J.A. 2013. Are flatfishes (Pleuronectiformes) monophyletic? Molecular Phylogenetics and Evolution, v. 69: Pages 664–673.

Campbell M.A., Chen W.J., López J.A. 2014. Molecular data do not provide unambiguous support for the monophyly of flatfishes (Pleuronectiformes): A reply to Betancur-R and Ortí. Molecular Phylogenetics and Evolution, v. 7: Pages 149–153.

Castelnau, F.L. 1855. Poissons In : Animaux nouveaux or rares recueillis pendant l'expédition dans les parties centrales de l'Amérique du Sud, de Rio de Janeiro a Lima, et de Lima au Para; exécutée par ordre du gouvernement Français pendant les années 1843 a 1847 ... Part 7, Zoology. Animaux nouveaux or rares recueillis pendant l'expédition dans les parties centrales de l'Amérique du Sud, de Rio de Janeiro a Lima. v. 2: i-xii + 1-112, Pls. 1-50.

Chabanaud, P. 1927. Les soles de l'Atlantique oriental nord et des mers adjacentes. Bulletin de l'Institut Océanographique (Monaco). No. 488: 1-67.

Chabanaud, P. 1943. Notules ichthyologiques. XVII. -- Additions à la faune de la mer Rouge. Bulletin du Muséum National d'Histoire Naturelle. (Série 2). v. 14 (no. 6): 396-402.

Chapleau, F. 1993 Pleuronectiform relationships: a cladistic reassessment. *Bulletin of Marine Science*. v. 52: 516-540.

Collette, B.B. & Klein-MacPhee, G. 2002. Bigelow and Schroeder's Fishes of the Gulf of Maine. Third edition. i-xxxiv + 1-748.

Collette, B. B., Williams J.T., Thacker C.E. & Smith M.L. 2003. Shore fishes of Navassa Island, West Indies: a case study on the need for rotenone sampling in reef fish biodiversity studies. aqua, Journal of Ichthyology and Aquatic Biology. v. 6 (no. 3): 89-131.

Cooper J.A., Chapleau F. 1998. Phylogenetic status of *Paralichthodes algoensis* (Pleuronectiformes: Paralichthodidae). Copeia 1998: 477–481.

Cocco, A. 1844. Intorno ad alcuni nuovi pesci del mare di Messina. Giornale del Gabinetto Letterario di Messina Anno 3, Tomo 5: 21-30, Pl. 2.

Cope, E.D. 1871. Contribution to the ichthyology of the Lesser Antilles. Transactions of the American Philosophical Society (New Series). v. 14 (pt 3) (art. 5): 445-483.

Cracraft, J. 1983. Species concepts and the speciation analyses. Curr. Ornith. v. 1: 159-187.

Cunningham, J.T. 1910. On the marine fishes and invertebrates of St. Helena. Proceedings of the Zoological Society of London. (pt 1): 86-130, Pls. 4-7.

Curtiss, A. 1944. Further notes on the zoology of Tahiti. Further notes on the zoology of Tahiti. i + 1-30.

Cuvier, G. 1816. Le Règne Animal distribué d'après son organisation pour servir de base à l'histoire naturelle des animaux et d'introduction à l'anatomie comparée. Les reptiles, les poissons, les mollusques et les annélides. Edition 1. v. 2: i-xviii + 1-532, Pls 9-10, in v. 4.

Day, F. 1877. The fishes of India; being a natural history of the fishes known to inhabit the seas and fresh waters of India, Burma, and Ceylon. The fishes of India; being a natural history of the fishes known to inhabit the seas and fresh waters of India, Burma, and Ceylon. Part 3: 369-552, Pls. 79-138.

Delaroche, F.E. 1809. Suite du mémoire sur les espèces de poissons observées à Iviça. Observations sur quelques-uns des poissons indiqués dans le précédent tableau et descriptions des espèces nouvelles ou peu connues. Annales du Muséum d'Histoire Naturelle, Paris. v. 13: 313-361, Pls. 20-25.

Desoutter, M., Chapleau, F., Munroe, T.A., Chanet, B. & Beaunier, M. 2001 (31 Dec.). Catalogue critique des types de poissons du Muséum national d'Histoire naturelle (suite) Ordre des Pleuronectiformes. Cybium. v. 25 (no.4): 299-368.

Díaz de Astarloa, J. M. & Munroe, T. A. 1998. Systematics and ecology of commercially important paralichthys flounders occurring in Argentinean-Uruguayan waters (Paralichthys, Paralichthyidae): an overview. Journal of Sea Research. v. 39: 1-9.

DFO, 2008. Volume of Atlantic Coast Commercial Landings by Region. On-line version dated 23 February, 2013. http://www.dfo-mpo.gc.ca/stats/commercial/land-debarq/sea-maritimes/s2008aq-eng.htm.

Edwards, A.J., Anthony, C.G. & Abohweyere, P.O. 2001. A revision of Irvine's marine fishes of tropical West Africa. Darwin Initiative Report. v. 2: 157.

Eldredge, N. & Cracraft, J. 1980. Phylogenetic Patterns and the Evolutionary Process. Columbia Univ. Press, New- York.

Emery C. 1878. Note Ittiologiche. Intorno a forme larvali di pesci:i° Fierasfer acus; 2° Khronius filamentosus Cocco; 3 Brosmius exiguus O. Costa; 4 Exocoetus exsiliens; 5 Centriscus Scolopax. In Atti Soc. Ital. Se. di Milano, voi. XXI, p. 37-46, 8°, con 1 tav.

Eschmeyer, W. 2015. Species of Fishes by family/subfamily. On-line version dated 23 July, 2014. http://research.calacademy.org/ichthyology/catalog/fishcatmain.asp.

Forster, J.R. 1844.Descriptiones animalium quae in itinere ad maris Australis terras per annos 1772 1773 et 1774 suscepto collegit observavit et delineavit Ioannes Reinoldus Forster nunc demum editae. Henrico Lichtenstein. Berlin. i-xiii + 1-424.

Fowler, H.W. 1923. New or little-known Hawaiian fishes. Occasional Papers of the Bernice Pauahi Bishop Museum of Polynesian Ethnology and Natural History. v. 8 (no. 7): 373-392.

Fowler, H.W. 1934. Descriptions of new fishes obtained 1907 to 1910, chiefly in the Philippine Islands and adjacent seas. Proceedings of the Academy of Natural Sciences of Philadelphia v. 85 (for 1933): 233-367.

Francis, M.P. 1993. Checklist of the coastal fishes of Lord Howe, Norfolk, and Kermadec Island, southwest Pacific Ocean. Pacific Science. v. 47 (no. 2): 136-170.

Friedman, M. 2008. The evolutionary origin of flatfish asymmetry. Nature. v. 454(7201): 209-212.

Fricke, R., Bilecenoglu, M. & Sari, H.M. 2007. Annotated checklist of fish and lamprey species (Gnathostomata and Petromyzontomorphi) of Turkey, including a Red List of threatened and declining species. Stuttgarter Beiträge zur Naturkunde. Serie A (Biologie). No. 706: 1-174.

Fricke, R. & Kulbicki, M. 2006. Checklist of the shore fishes of New Caledonia. Compendium of marine species from New Caledonia. Documents Scientifiques et Techniques. v. II7 (vol. spécial): 313-357, Pls 1-15.

Fricke, R., Durville, P., Bernardi, G., Borsa, P., Mou-Tham, G., & Chabanet, P. 2013. Checklist of the shore fishes of Europa Island, Mozambique Channel, southwestern Indian Ocean, including 302 new records. Stuttgarter Beiträge zur Naturkunde A, Neue Serie. v. 6: 247-276.

Fukui, A. 1997. Early Ontogeny and systematic of Bothidae, Pleuronectoidei. Bulletin of Marine Science. v. 60: 192-212.

Futch, C.R. 1977. Larvae of Trichopsetta ventralis (Pisces: Bothidae), with comments on intergeneric relationships within the Bothidae. Bulletin of Marine Science. v. 27(4): 740-757.

Gibson, R.N. 2005. Introduction, in Flatfishes: Biology and Exploitation (ed R. N. Gibson), Blackwell Science Ltd, Oxford, UK. doi: 10.

Gilbert, C.H. 1905. II. The deep-sea fishes of the Hawaiian Islands. In: The aquatic resources of the Hawaiian Islands. Bulletin of the U. S. Fish Commission. v. 23 (pt 2): 577-713, Pls. 66-10.

Goode, G.B. & Bean, T.H. 1885. On the American fishes in the Linnaean collection. Proceedings of the United States National Museum. v. 8 (no. 510): 193-208.

Goren, M. & Dor, M. 1994. An updated checklist of the fishes of the Red Sea. CLOFRES II. The Israel Academy of Sciences and Humanities, Jerusalem. V. i-xii: 1-120, 2 maps.

Günther, A. 1862. Catalogue of the fishes in the British Museum. Catalogue of the Acanthopterygii, Pharyngognathi and Anacanthini in the collection of the British Muesum. Catalogue of the fishes in the British Museum. v. 4: i-xxi + 1-534.

Günther, A. 1880. Report on the shore fishes procured during the voyage of H. M. S. Challenger in the years 1873-1876. In: Report on the scientific results of the voyage of H. M. S. Challenger during the years 1873-76. Zoology. v. 1 (pt 6): 1-82, Pls. 1-32.

Gutherz, E.J. 1967. Field Guide to the flatfishes of the family Bothidae in the western North Atlantic. United States Fish and Wildlife Service Circular. No. 263: i-iv + 1-47.

Heemstra, E., Heemstra, P.C., Smale, M.J., Hooper, T., & Pelicier, D., 2004. Preliminary checklist of coastal fishes from the Mauritian island of Rodrigues. Journal of Natural History. v. 38: 3315-3344.

Heemstra, P.C. and Heemstra, E. 2004.Coastal fishes of southern Africa. NISC and SAIAB. i-xxiv + 1-488.

Hensley, D. A. 1977. Larval development of Engyophrys senta (Bothidae), with comments on intermuscular bones in flatfishes. Bulletin of Marine Science. v. 27 (4): 681-703.

Hensley, D.A. 1997. A new species of *Bothus* (Pleuronectiformes: Bothidae) from Mozambique. J.L.B. Smith Institute of Ichthyology Special Publication. No. 58: 1-8.

Hensley, D.A and Ahlstrom, E.H. 1984. Pleuronectiformes: Relationships. Pleuronectiformes: Development. In: Moser HG, Richards WJ, Cohen DM, Fahay MP, Kendall AW and Richardson SL (eds) Ontogeny and Systematic of Fishes. Special Publication n. 1. American Society of Ichthyology and Herpertology, Lawrence. 670-687.

Hensley, D.A. & Amaoka, K. 2001. - Bothidae. In: The Living Marine Resources of the Western Central Pacific. Vol. 6, Bony Fishes Part 4 (Labridae to Latimeriidae), Estuarine Crocodiles, Sea Turtles, Sea Snakes and Marine Mammals (Carpenter K.E. & V.H. Niem, eds.), pp. 3799-3841.

Hoshino, K. 2001. Monophyly of the Citharidae (Pleuronectoidei: Pleuronectiformes: Telostei) with considerations of pleuronectoid phylogeny. Ichthyological Research. v. 48: 231-246.

Hoshino, K. & Amaoka, K. 2006. New record of the rare flounder *Bothus* swio (Pleuronectiformes: Bothidae) from the eastern Indian Ocean (northwestern Australia) with consideration on its generic affiliations. Cybium. v. 30, 1.

Hubbs, C.L. 1945. Phylogenetic position of the Citharidae, a family of flatfishes. Miscellaneous Publications, Museum of Zoology, University of Michigan No. 63: 1-38.

Hubbs, C.L. & Lagler, K.F. Revised by Smith, G. R. 2004. The University of Michigan Press, Ann Arbor, Michigan USA. V. Xvii: 276, Pls 1-32.

Hubbs, C.L. & Lagler, K.F. 1958. Fishes of the Great Lakes Region, Revised Edition. Ann Arbor, MI. Univ. of Mich. Press. 213.

Jordan, D.S. 1885. A catalogue of the fishes known to inhabit the waters of North America, north of the Tropic of Cancer, with notes on species discovered in 1883 and 1884. United States Commission of Fish and Fisheries, Report of the Commissioner v. 13: 789-973.

Jordan, D.S. 1917. The Genera of Fishes, from Linnaeus to Cuvier, 1758-1833, seventy-five years, with the accepted type of each. A contribution to the stability of scientific nomenclature. (Assisted by Barton Warren Evermann). Leland Stanford Jr. University Publications, University Series No. 27: 1-161.

Jordan, D.S. & Gilbert, C.H. 1884. Descriptions of ten new species of fishes from Key West, Florida. Proceedings of the United States National Museum v. 7 (no. 402): 24-32.

Jordan, D.S. & Goss, D.K. 1889. A review of the flounders and soles (Pleuronectidae) of America and Europe. Report of the United States Fish Commission. v. 14: 225-342, Pls. 1-9.

Jouan, H. 1861. Notes sur quelques espèces de poissons de la Nouvelle-Calédonie. Memoires de la Société Imperial des Sciences Naturelles Cherbourg. v. 8: 256.

Jutare, T.V. 1962. Studies on the biology of Bothus ocellatus with a description of a related new species (Doctoral dissertation, MS Thesis, Miami Univ).

Kotthaus, A. 1977. Fische des Indischen Ozeans. Ergebnisse der ichthyologischen Untersuchungen während der Expedition des Forschungsschiffes "Meteor" in den indischen Ozean, Oktober 1964 bis Mai 1965. A. Systematischer Teil, XX. Pleuronectiformes (Heterosomata). Meteor Forschungsergebnisse. Reihe D, Biologie No. 26: 1-20.

Kyle, H.M. 1913. Flat-fishes (Heterosomata). Report on the Danish oceanographical expeditions 1908-10 to the Mediterranean and adjacent seas. Dana Report No. 2. v. 2 (Biol.): 1-150, Pls. 1-4.

Lacepède, B.G.E. 1802. Histoire naturelle des poissons. Histoire naturelle des poissons. v. 4: i-xliv + 1-728, Pl. 1-16.

Lichtenstein, M.H.C. 1844. Descriptiones animalium quae in itinere ad Maris Australis terras per annos 1772 1773 et 1774 suscepto, collegit observavit et delineavit Ioannes Reinoldus Forster ... nunc demum editae ... Henrico Lichtenstein. Berlin. Descriptiones animalium quae in itinere ad Maris Australis terras per annos 1772 1773 et 1774 suscepto. i-xiii + 1-423.

Linnaeus, C. 1758. Systema Naturae, Ed. X. (Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima, reformata.) Holmiae. Systema Naturae, Ed. X. v. 1: i-ii + 1-824.

Lowe, R. T. 1834. A collection of fishes made in that island [Madeira]. Proceedings of the Zoological Society of London. Pt 1: 142-144.

McCosker, J.E. & Rosenblatt R.H. 2010. The fishes of the Galápagos Archipelago: an update. Proceedings of the California Academy of Sciences. v. 61 (supplement II) (no. 11): 167-195.

Melliss, J.C. 1875. St. Helena: A Physical, Historical, and Topographical Description of the Island, including its Geology, Fauna, Flora, and Meteorology. Reeve, London, 1875.

Menezes, N.A., Buckup, P.A., Figueiredo, J.L., & Moura, R.L, (eds). 2003. Catálogo das espécies de peixes marinhos do Brasil. Museu de Zoologia de Universidade de São Paulo. 1-159.

Miller, D.J. & Robert, N.L. 1972. Guide to the coastal marine fishes of California. Scripps Institution of Oceanography Library.

Manilo, L.G. & Bogorodsky S.V., 2003. Taxonomic composition, diversity and distribution of coastal fishes of the Arabian Sea. Journal of Ichthyology. v. 43: S75-S149.

McEachran, J.D. & Fechhelm, J.D. 2005. Fishes of the Gulf of Mexico. Volume 2: Scorpaeniformes to Tetraodontiformes. University of Texas Press, Austin. i-viii +1-100.

Mishra, S.S. & Krishnan S. 2003. Marine fishes of Pondichery and Karaikal. Records of the Zoological Survey of India. Miscellaneous Publication, Occasional Paper, No. 216: 1-5.

Munroe, T.A. 2003. Bothidae (Pp. 1885-1895), Scophthalmidae (Pp. 1896-1897), Paralichthyidae (Pp. 1898-1921), Poecilopsettidae (Pp. 1922-1923), Achiridae (Pp. 1925-1933), Cynoglossidae (Pp. 1934-1959).

Munroe, T.A. 2005. Systematic diversity of the Pleuronectiformes. In: Flatfishes Biology and Exploration. Fish and Aquatic Resources Series 9. Gibson, R. ed. Scottish Association for Marine Science. pp 10-41.

Munroe, T.A. 2006. New Western Indian Ocean Tonguefish (Pleuronectiformes: Cynoglossidae, Symphurus). Journal Information, 2006 (2).

Munroe, T.A. 2015. Flatfishes: Biology and Exploitation, Second Edition. Wiley- Blackwell. R.N. Gibson, R.D.M. Nash, A.J. Geffen, H.W. Van der Veer. 418-460.

Nelson, J.S. (2006) Fishes of the World. 4th ed. Wiley, New York, 601.

Nichols, J.T. 1921. A list of Turk Islands fishes, with a description of a new flatfish. Bulletin of the American Museum of Natural History v. 44 (art. 3): 21-24, Pl. 3. Nielsen, J. G. 1961. Psettodoidea and Pleuronectoidea (Pisces, Heterosomata). Atlantide Report No. 6: 101-127, Pl. 2.

Nielsen, J. G. 1961.Psettodoidea and Pleuronectoidea (Pisces, Heterosomata). Atlantide Report No. 6: 101-127, Pl. 2.

Nielsen, J.G., in Hureau, J.C., & Monod T. 1973. Check-list of the Fishes of the North eastern Atlantic and of the Mediterranean. CLOFNAM. Unesco, Paris. v. 1: i-xxii + 1-683.

Nixon, K.C. and Wheeler, Q.D. 1990. An Amplification of the Phylogenetic Species Concept. Cladistics. Blackwell Publishing Ltd. v. 6, Issue 3.

Norman, J.R. 1926 (15 June) A report on the flatfishes (Heterosomata) collected by the F.I.S. "Endeavour," with a synopsis of the flatfishes of Australia and a revision of the subfamily Rhombosoleinae. Biological Results Endeavour. v. 5 (pt 5): 219-308.

Norman, J.R. 1931. Notes on flatfishes (Heterosomata). I-lll. Notes on flatfishes of the family Bothidae in the British Museum, with descriptions of three new species. Annals and Magazine of Natural History. (Series 10) v. 8 (no. 47): 507-510, (no. 48): 597-604.

Norman, J.R. 1934 A systematic monograph of the flatfishes (Heterosomata). V. 1, London, Britain Museum of Natural History: 1-459.

Norman, J.R. 1966. A draft synopsis of the orders, families and genera of Recent fishes and fish-like vertebrates. Trustees British Museum (Natural History) London. 1-649.

Ohashi, Y. & Motomura, H. 2011. Pleuronectiform fishes of northern Kagoshima Prefecture, Japan. Nature of Kagoshima. v. 37: 71-118.

Pardo, B.G., Machordom, A., Foresti, F., Porto-Foresti, F., Azevedo, M.F.C., Banon, R., Sanchez, L, & Martinez, P. 2005. Phylogenetic analysis of flatfish (Order Pleuronectiformes) based on mitochondrial 16s rDNA sequences. Scientia Marina. v. 69: 531-543.

Platnick, N.I. 1981. Monotypy and the origin of higher taxa: a reply to E. 0. Wiley Systematic Zoology. v. 26: 355-357.

Poey, F. 1860. Memorias sobra la historia natural de la Isla de Cuba, acompañadas de sumarios Latinos y extractos en Francés. Tomo 2. La Habana. v. 2: 1-96, 97-336 (1860), 337-442, (1861), Pls. 1-19.

Poey, F. 1868 Various subtitles in: Repertorio fisico-natural de la isla de Cuba. La Habana. v. 2: 1-468.

Quoy, J.R.C. and Gaimard, J.P. 1824. Description des Poissons. Chapter IX. In: Freycinet, L. de, Voyage autour du Monde...exécuté sur les corvettes de L. M. "L'Uranie" et "La Physicienne," pendant les années 1817, 1818, 1819 et 1820. Paris. 192-401. Atlas pls. 43-65.

Rafinesque, C.S. 1810a. Caratteri di alcuni nuovi generi e nuove specie di animali e piante della Sicilia, con varie osservazioni sopra i medisimi. Sanfilippo, Palermo. Part 1, i-iv : 3-69.

Rafinesque, C.S. 1810b**.** Indice d'ittiologia siciliana; ossia, catalogo metodico dei nomi latini, italiani, e siciliani dei pesci, che si rinvengono in Sicilia disposti secondo un metodo naturale e seguito da un appendice che contiene la descrizione de alcuni nuovi pesci sicilian. Messina. Indice d'ittiologia siciliana; ossia, catalogo metodico dei nomi latini, italiani, e siciliani dei pesci. 1-70, Pls. 1-2.

Rafinesque, C.S. 1814. Précis des découvertes et travaux somiologiques de Mr. C. S. Rafinesque-Schmaltz entre 1800 et 1814; ou choix raisonné de ses principales découvertes en zoologie et en botanique, pour servir d'introduction à ses ouvrages futurs. Palerme. 1-55.

Ramachandran, V.S., Tyler, C.W., Gregory, R.L., Rogers-Ramachandran, D., Duensing, S., Pillsbury, C, & Ramachandran, C. 1996. Rapid adaptive camouflage in tropical flounders. Nature 379, 815 – 818.

Randall, J.E. & Lim, K.K.P. 2000. A checklist of the fishes of the South China Sea. Raffles Bulletin of Zoology Suppl. No. 8: 569-667.

Randall, J.E., Williams, J.T, Smith, D.G., Kulbicki, M., Mou Tham, G., Labrosse P. 2004.Checklist of the shore and epipelagic fishes of Tonga. Atoll Reseach Bulletin No. 502: ii + 1-35.

Randall, J.E. 2005. Reef and shore fishes of the South Pacific. New Caledonia to Tahiti and the Pitcairn Islands. i-xii + 1-70.

Randall, J.E. 2007. Reef and shore fishes of the Hawaiian Islands. Sea Grant College Program, University of Hawai'i, Honolulu. i-xivb + 1-546.

Regan, C.T. 1908. (May) Report on the marine fishes collected by Mr. J. Stanley Gardiner in the Indian Ocean. The Transactions of the Linnean Society of London. Second Series. Zoology. v. 12 (pt 3): 217-255, Pls. 23-32.

Regan, C.T. 1910. The origin and evolution of the teleostean fishes of the order Heterosomata. Annals and Magazine of Natural History (Series 8) v. 6 (no. 35): 484-496.

Regan, C.T. 1920 (25 Mar.) A revision of the flat-fishes (Heterosomata) of Natal. Annals of the Durban Museum. v. 2 (pt 5): 205-222.

Rendahl, H. 1921. The fishes of Easter Island. The Natural History of Juan Fernandez and Easter Island. Ed. by C. Skottsberg. The fishes of Easter Island. The Natural History of Juan Fernandez and Easter Island. v. 3 (pt 1): 59-68.

Risso, A. 1827. Histoire naturelle des principales productions de l'Europe méridionale, et particulièrement de celles des environs de Nice et des Alpes maritimes. F. G. Levrault, Paris & Strasbourg. Histoire naturelle des principales productions de l'Europe méridionale, ... v. 3: i-xvi + 1-480, Pls. 1-16.

Rüppell, W.P.E.S. 1830. Atlas zu der Reise im nördlichen Afrika. Fische des Rothen Meers. Frankfurt am Main (Heinrich Ludwig Brönner). Atlas zu der Reise im nördlichen Africa. Fische des Rothen Meeres.: 1-141 + 3 pp., col. Pls. 1-35.

Schreiber, A.M. 2013. Chapter 6- Flatfish: An Asymmetric Perspective on Metamorphosis in Current Topics in Developmental Biology (ed Y.-B Shi). Academic Press, Burlington, VT. v. 103, pp 167-194.

Smith, R. & Swain, J. 1882.Notes on a collection of fishes from Johnston's Island, including descriptions of five new species. Proceedings of the United States National Museum. v. 5 (no. 272): 119-143.

Smith, C.L., Tyler, J.C., Davis, W.P., Jones, R.S., Smith, D.G., & Baldwin, C.C. 2003. Fishes of the Pelican Cays, Belize. Atoll Reseach Bulletin. No. 497: ii + 1-88.

Smith-Vaniz, W. & Jelks, H.L. 2014. Marine and inland fishes of St. Croix, U. S. Virgin Islands: an annotated checklist. Zootaxa 3803 (no. 1): 1-120.

Spix, J.B. & Agassiz, L. 1829-31. Selecta genera et species piscium quos in itinere per Brasiliam annos MDCCCXVII-MDCCCXX jussu et auspiciis Maximiliani Josephi I.... colleget et pingendso curavit Dr J. B. de Spix.... Monachii. Part 1: i-xvi + i-ii + 1-82, Pls. 1-48; Part 2: 83-138, Pls. 49-101.

Stauch, A. 1966. Quelques données sur les *Bothus* de l'Atlantique et description d'une espèce nouvelle: *Bothus guibei* n. sp. (Pisces Teleostei, Heterosomata). Bulletin du Muséum National d'Histoire Naturelle (Série 2). v. 38 (no. 2): 118-125.

Steindachner, F. 1861. Ichthyologische Mittheilungen. (III.) Verhandlungen der K.-K. zoologisch-botanischen Gesellschaft in Wien. v. 11: 175-182, Pl. 5.

Struhsaker, P. & Moncrief, R.M. 1974. *Bothus* thompsoni (Fowler) 1923, a valid species of flatfish (Pisces: Bothidae) from the Hawaiian Islands. Fish. Bull., U. S. Dept. Comm. v. 72: 237-246.

Swainson, W. 1839. The natural history and classification of fishes, amphibians, & reptiles, or monocardian animals. Blotchtiswoode & Co., London. The natural history and classification of fishes, amphibians, & reptiles, or monocardian animals. v. 2: i-vi + 1-448.

Temminck, C. J. & Schlegel, H. 1846. Fauna Japonica, sive descriptio animalium quae in itinere per Japoniam ... Parts 10-14: 173-269.

Topp, R.W. & Hoff, F.H.Jr. 1972. Flatfishes (Pleuronectiformes). Memoirs of Hourglass Cruises. v. 4 (pt 2): 1-135.

Valenciennes, A. 1839. Ichthyologie des îles Canaries, ou histoire naturelle des poissons rapportés par Webb & Berthelot. In: P. B. Webb & S. Berthelot. Histoire naturelle des îles Canaries. Paris, 1835-1850. v. 2 (pt 2): 1-109, 26 pls. [For dates of individual pages and plates see Hureau & Monod 1973:v. 2: 157.

Valenciennes, A. 1846. Table + Ichthyology Pls. 1-10. In: A. du Petit-Thouars. Atlas de Zoologie. Voyage autour du monde sur la frégate "Vénus," pendant les années 1836-1839. Voyage autour du monde sur la frégate "la Vénus", pendant les années 1836-39. Gide, Paris.

Weber, M. 1913. Die Fische der Siboga-Expedition. E. J. Brill, Leiden. i-xii + 1-710, Pls. 1-12.

Weinstein, M.P., Heck, K.L., Davis, R.W. 1980. The Maculated Flounder *Bothus*-Maculiferus New-Record From The Caribbean Coast Of Central America. Proceedings of The Biological Society of Washington. v. 93: 311-313.

Winterbottom, R., Emery, A.R., & Holm, E. 1989. An annotated checklist of the fishes of the Chagos Archipelago, central Indian Ocean. Royal Ontario Museum Life Science Contributions. No. 145: 1-226, Pls. 1-8.

Wirtz, P., Bingeman, J., Fricke, R., Hook, T.J, & Young, J. 2014. The fishes of Ascension Island, central Atlantic Ocean -- new records and an annotated checklist. Journal of the Marine Biological Association of the United Kingdom: 1-16.

Wirtz, P., Ferreira, C.E.L., Floeter, S.R., Fricke, R., Gasparini, J.L., Iwamoto, T., Rocha, L.A., Sampaio, C.L.S., & Schliewen, U. 2007. Coastal fishes of São Tomé and Principe islands, Gulf of Guinea (eastern Atlantic Ocean) -- an update. Zootaxa No. 1523: 1-48.

Youn, C.H. 2002. Fishes of Korea, with pictorial key and systematic list. 2002: 1-747.

APPENDIX A

Valid and nominal *Bothus* species of the family Bothidae

Nominal Species, Author/Year	Current Status	Type Specimens	Nominal Reference	Comments
Rhomboidichthys assimilis	Valid as *Bothus assimilis*	Holotype BMNH	Günther, A. 1862 (8 Nov.)	Examined
Günther 1862			Catalogue of the fishes in the British Museum. Catalogue of the Acanthopterygii, Pharyngognathi and Anacanthini in the collection of the British Muesum. Catalogue of the fishes in the British Museum. v. 4: i-xxi + 1-534.	
Platophrys constellatus	Valid as *Bothus constellatus*	Syntypes MCZ	Jordan, D. S. and D. K. Goss 1889	Examined high definition photographs
Jordan 1889			A review of the flounders and soles (Pleuronectidae) of America and Europe. Report of the United States Fish Commission v. 14 [1886]: 225-342, Pls. 1-9. [Also as a separate, 1889.]	
Pleuronectes ellipticus	Valid as *Bothus ellipticus*	Possible types MCZ	Poey, F. 1858-61	
Poey 1860			Memorias sobra la historia natural de la Isla de Cuba, acompañadas de sumarios Latinos y extractos en Francés. Tomo 2. La Habana. [Sections have subtitles.]. Memorias sobre la historia natural de la Isla de Cuba, ... v. 2: 1-96 (1858), 97-336 (1860), 337-442, (1861)	
Bothus guibei	Valid as *Bothus guibei*	Holotype MNHN	Stauch, A. 1966	Examined
Stauch 1966		Paratypes MNHN	Quelques données sur les *Bothus* de l'Atlantique et description d'une espèce nouvelle: *Bothus guibei* n. sp. (Pisces Teleostei, Heterosomata). Bulletin du Muséum National d'Histoire Naturelle (Série 2) v. 38 (no. 2): 118-125.	Examined
Rhomboidichthys leopardinus	Valid as *Bothus leopardinus*	Holotype BMNH	Günther, A. 1862 (8 Nov.)	Examined
Günther 1862			Catalogue of the fishes in the British Museum. Catalogue of the Acanthopterygii, Pharyngognathi and Anacanthini in the collection of the British Muesum. Catalogue of the fishes in the British Museum. v. 4: i-xxi + 1-534.	

Nominal Species, Author/Year	Current Status	Type Specimens	Nominal Reference	Comments
Pleuronectes lunatus	Valid as *Bothus lunatus*	No types known	Linnaeus, C. 1758 (1 Jan.) [	
Linnaeus 1758			Systema Naturae, Ed. X. (Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima, reformata.) Holmiae. Systema Naturae, Ed. X. v. 1: i-ii + 1-824. [Nantes and Pisces in Tom. 1, pp. 230-338; a few species on later pages. Date fixed by ICZN, Code Article 3.]	
Pleuronectes maculiferus	Valid as *Bothus maculiferus*	Possible Syntypes	Poey, F. 1858-61	
Poey 1860		Cienfuegos, Cuba	Memorias sobra la historia natural de la Isla de Cuba, acompañadas de sumarios Latinos y extractos en Francés. Tomo 2. La Habana. [Sections have subtitles.]. Memorias sobre la historia natural de la Isla de Cuba, ... v. 2: 1-96 (1858), 97-336 (1860), 337-442, (1861)	
Pleuronectes mancus	Valid as *Bothus mancus*	Types lost BMNH	Broussonet, P. M. A. 1782	
Broussonet 1782			Ichthyologia, sistens piscium descriptiones et icones. Decas I. London. Ichthyologia, sistens piscium descriptiones et icones. Decas I.: 49 unnum. pages, incl. i-iv., Unnum. Pls. 1-11.	
Bothus mellissi	Valid as *Bothus mellissi*	Holotype BMNH	Norman, J. R. 1931 (1 Nov.)	Examined
Norman 1931		Paratypes BMNH	Notes on flatfishes (Heterosomata).-- I. Notes on flatfishes of the family Bothidae in the British Museum, with descriptions of three new species. Annals and Magazine of Natural History (Series 10) v. 8 (no. 47): 507-510. [Date of publication from Evenhuis 2003:46.]	Examined
Rhombus myriaster	Valid as *Bothus myriaster*	Holotype RMNH	Temminck, C. J. and H. Schlegel 1846	
Temminck & Schlegel 1843			Temminck & Schlegel 1843 . Fauna Japonica, sive descriptio animalium quae in itinere per Japoniam ... Parts 10-14: 173-269.	

Nominal Species, Author/Year	Current Status	Type Specimens	Nominal Reference	Comments
Rhombus ocellatus	Valid as *Bothus ocellatus*	No types known	Spix, J. B. von and L. Agassiz 1829-31	
Spix and Agassiz 1829-31			Selecta genera et species piscium quos in itinere per Brasiliam annos MDCCCXVII-MDCCCXX jussu et auspiciis Maximiliani Josephi I.... colleget et pingendso curavit Dr J. B. de Spix.... Monachii. Selecta genera et species piscium quos in itinere per Brasiliam annos MDCCCXVII-MDCCCXX jussu et auspiciis Maximiliani Josephi I.... colleget et pingendso curavit Dr J. B. de Spix....: Part 1: i-xvi + i-ii + 1-82, Pls. 1-48;, Part 2: 83-138, Pls. 49-101. [Part 1 published June 1829, part 2 Jan. 1831; see Kottelat 1988, Whitehead & Myers 1971, Pethiygoda & Kottelat 1998	
Rhombus pantherinus	Valid as *Bothus pantherinus*	Lectotype SMF	Rüppell, W. P. E. S. 1828-30	Examined
Rüppell 1830	Valid as *Bothus* panthernus	Lectotype 7550, Paralectotypes SMF	Atlas zu der Reise im nördlichen Afrika. Fische des Rothen Meers. Frankfurt am Main (Heinrich Ludwig Brönner).. Atlas zu der Reise im nördlichen Africa. Fische des Rothen Meeres.: 1-141 + 3 pp., col. Pls. 1-35. [Part 1 (1828): 1-26, Pls. 1-6; part 2 (1829): 27-94, Pls. 7-24; part 3 (1830):95-141, Pls. 25-35.]	Examined
Pleuronectes podas	Valid as *Bothus podas*	Holotype MNHN	Delaroche, F. E. 1809	Examined
Delaroche 1809			Suite du mémoire sur les espèces de poissons observées à Iviça. Observations sur quelques-uns des poissons indiqués dans le précédent tableau et descriptions des espèces nouvelles ou peu connues. Annales du Muséum d'Histoire Naturelle, Paris v. 13: 313-361, Pls. 20-25. [Also as a separate, pp. 27-75, Pl. 1-6. Names appeared without distinguishing features in Delaroche 1809.	
Bothus robinsi	Valid as *Bothus robinsi*	Syntypes FSBC	Topp, R. W. and F. H., Jr. Hoff 1972 (Apr.)]	
Topp and Hoff 1972			Flatfishes (Pleuronectiformes). Memoirs of Hourglass Cruises v. 4 (pt 2): 1-135.	
Bothus swio	Valid as *Bothus swio*	Holotype SAM	Hensley, D. A. 1997 (Feb.)	
Hensely 1997			A new species of *Bothus* (Pleuronectiformes: Bothidae) from Mozambique. J.L.B. Smith Institute of Ichthyology Special Publication No. 58: 1-8.	

Nominal Species, Author/Year	Current Status	Type Specimens	Nominal Reference	Comments
Platophrys thompsoni	Valid as *Bothus thompsoni*	Holotype BPBM	Fowler, H. W. 1923	
Fowler 1923			New or little-known Hawaiian fishes. Occasional Papers of the Bernice Pauahi Bishop Museum of Polynesian Ethnology and Natural History v. 8 (no. 7): 373-392.	
Bothus tricirrhitus	Valid as *Bothus tricirrhitus*	Holotype ZMH	Kotthaus, A. 1977 (Dec.)	Examined
Kotthaus 1977		Paratypes ZMH	Fische des Indischen Ozeans. Ergebnisse der ichthyologischen Untersuchungen während der Expedition des Forschungsschiffes "Meteor" in den indischen Ozean, Oktober 1964 bis Mai 1965. A. Systematischer Teil, XX. Pleuronectiformes (Heterosomata). Meteor Forschungsergebnisse. Reihe D, Biologie No. 26: 1-20. [English summary.]	
Bothus ypsigrammus	Valid as *Bothus ypsigrammus*	Holotype ZMH	Kotthaus, A. 1977 (Dec.)	Examined
Kotthaus 1977		Paratypes ZMH	Fische des Indischen Ozeans. Ergebnisse der ichthyologischen Untersuchungen während der Expedition des Forschungsschiffes "Meteor" in den indischen Ozean, Oktober 1964 bis Mai 1965. A. Systematischer Teil, XX. Pleuronectiformes (Heterosomata). Meteor Forschungsergebnisse. Reihe D, Biologie No. 26: 1-20. [English summary.]	Examined

Synonym species and other nominal species of the genus *Bothus:*

Nominal Species, Author/Year	Current Status	Type Specimens	Source Reference	Comments
Bothus podas africanus	Synonym of *Bothus* podas	Holotype ZMUC	**Nielsen, J. G. 1961** (20 May)	
Nielsen 1961		Paratypes BMNH	Psettodoidea and Pleuronectoidea (Pisces, Heterosomata). Atlantide Report No. 6: 101-127, Pl. 2.	Examined
Bothus diaphanous	Synonym of *Bothus podas*	No types known	**Rafinesque, C. S.** 1814	
Rafinesque 1814			Précis des découvertes et travaux somiologiques de Mr. C. S. Rafinesque-Schmaltz entre 1800 et 1814; ou choix raisonné de ses principales découvertes en zoologie et en botanique, pour servir d'introduction à ses ouvrages futurs. Palerme. Précis des découvertes et travaux somiologiques de Mr. C. S. Rafinesque-Schmaltz entre 1800 et 1814; 1-55.	
Rhombus bahianus	Synonym of *Bothus podas*	Holotype MNHN	**Castelnau, F.L.** 1855	
Castelnau 1855			Poissons. In: Animaux nouveaux or rares recueillis pendant l'expédition dans les parties centrales de l'Amérique du Sud, de Rio de Janeiro a Lima, et de Lima au Para; exécutée par ordre du gouvernement Français pendant les années 1843 a 1847 ... Part 7, Zoologie. Animaux nouveaux or rares recueillis pendant l'expédition dans les parties centrales de l'Amérique du Sud, de Rio de Janeiro a Lima, ... v. 2: i-xii + 1-112, Pls. 1-50.	
Peloria heckelii	Synonym of *Bothus podas*	No types known	**Cocco, A.** 1844	
Cocco 1844			Intorno ad alcuni nuovi pesci del mare di Messina. Giornale del Gabinetto Letterario di Messina Anno 3, Tomo 5: 21-30, Pl. 2. [Also as a separate, pp. 1-10, 1 pl. Reissued with corrections in 1888 in Naturalista Siciliano, e.g. 101-104, 125-128.]	
Rhombus heterophthalmus	Synonym of *Bothus podas*	No types known	**Bennett, E. T.** 1831 (6 Dec.)	
Bennett 1831			Characters of new genera and species of fishes from the Atlantic coast of northern Africa presented by Captain Belcher, R.N. Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1830-31 (pt 1): 145-148.	

Nominal Species, Author/Year	Current Status	Type Specimens	Source Reference	Comments
Rhombus maderensis	Synonym of *Bothus podas*	Location unknown	**Lowe, R. T.** 1834 (16 Apr.)	Examined non-type specimens
Lowe 1834			Characters of a new genus *Leirus*, and of several new species of fishes from Madeira. Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1833 (pt 1): 142-144.	
Solea rhomboide	Synonym of *Bothus podas*	No types known	**Rafinesque, C. S.** 1810	
Rafinesque 1810			Indice d'ittiologia siciliana; ossia, catalogo metodico dei nomi latini, italiani, e siciliani dei pesci, che si rinvengono in Sicilia disposti secondo un metodo naturale e seguito da un appendice che contiene la descrizione de alcuni nuovi pesci sicilian. Messina. Indice d'ittiologia siciliana; ossia, catalogo metodico dei nomi latini, italiani, e siciliani dei pesci, ...: 1-70, Pls. 1-2.	
Rhombus rhomboides	Synonym of *Bothus podas*	ANSP, USNM	**Bonaparte, C. L.** 1833	Examined paratype
Bonaparte 1833			Iconografia della fauna italica per le quattro classi degli animali vertebrati. Tomo III. Pesci. Roma. Iconografia della fauna italica per le quattro classi degli animali vertebrati. Tomo III. Pesci.: Fasc. 2-5, puntata 7-28, 12 pls.	
Bothus rumolo	Synonym of *Bothus podas*	No types known	**Rafinesque, C. S.** 1810	
Rafinesque 1810			Caratteri di alcuni nuovi generi e nuove specie di animali e piante della Sicilia, con varie osservazioni sopra i medisimi. (Part 1 involves fishes, pp. [i-iv] 3-69 [70 blank], Part 2 with slightly different title, pp. ia-iva + 71-105 [106 blank]). Caratteri di alcuni nuovi generi e nuove specie di animali e piante della Sicilia, con varie osservazioni sopra i medisimi.. Pls. 1-20.	

Nominal Species, Author/Year	Current Status	Type Specimens	Source Reference	Comments
Rhombus serratus	Synonym of *Bothus podas*	MNHN	**Valenciennes, A.** 1839	Examined
Valenciennes 1839		Type	Ichthyologie des îles Canaries, ou histoire naturelle des poissons rapportés par Webb & Berthelot. In: P. B. Webb & S. Berthelot. Histoire naturelle des îles Canaries. Paris, 1835-1850. Ichthyologie des îles Canaries, ou histoire naturelle des poissons rapportés par Webb & Berthelot. v. 2 (pt 2): 1-109, 26 pls.	Examined
Bothus diagrammus	Synonym of *Bothus podas*	No types known	**Rafinesque, C. S.** 1814	
Rafinesque 1814			Précis des découvertes et travaux somiologiques de Mr. C. S. Rafinesque-Schmaltz entre 1800 et 1814; ou choix raisonné de ses principales découvertes en zoologie et en botanique, pour servir d'introduction à ses ouvrages futurs. Palerme. Précis des découvertes et travaux somiologiques de Mr. C. S. Rafinesque-Schmaltz entre 1800 et 1814; ...: 1-55.	
Bothus punctatus	Synonym of *Bothus podas*	No types known	**Rafinesque, C. S.** 1814	
Rafinesque 1814			Précis des découvertes et travaux somiologiques de Mr. C. S. Rafinesque-Schmaltz entre 1800 et 1814; ou choix raisonné de ses principales découvertes en zoologie et en botanique, pour servir d'introduction à ses ouvrages futurs. Palerme. Précis des découvertes et travaux somiologiques de Mr. C. S. Rafinesque-Schmaltz entre 1800 et 1814; ...: 1-55.	
Bothus tappa	Synonym of *Bothus podas*	No types known	**Rafinesque, C. S.** 1810	
Rafinesque 1810			Caratteri di alcuni nuovi generi e nuove specie di animali e piante della Sicilia, con varie osservazioni sopra i medisimi. (Part 1 involves fishes, pp. [i-iv] 3-69 [70 blank], Part 2 with slightly different title, pp. ia-iva + 71-105 [106 blank]). Caratteri di alcuni nuovi generi e nuove specie di animali e piante della Sicilia, con varie osservazioni sopra i medisimi. Pls. 1-20.	
Pleuronectes barffi	Synonym of *Bothus mancus*	No types known	**Curtis, A.** 1944	
Curtis 1944			Further notes on the zoology of Tahiti. Further notes on the zoology of Tahiti.: i + 1-30.	

Nominal Species, Author/Year	Current Status	Type Specimens	Source Reference	Comments
Rhombus pavo	Synonym of *Bothus mancus*	Holotype unknown	**Bleeker, P.** 1855	
Bleeker 1885			Derde bijdrage tot de kennis der ichthyologische fauna van de Kokos-eilanden. Natuurkundig Tijdschrift voor Nederlandsch Indië v. 8: 169-180	
Pleuronectes pictus	Synonym of *Bothus mancus*	No types known	**Lichtenstein, M. H. C.** 1844	
Lichtenstein 1844			Descriptiones animalium quae in itinere ad Maris Australis terras per annos 1772 1773 et 1774 suscepto, collegit observavit et delineavit Ioannes Reinoldus Forster ... nunc demum editae ... Henrico Lichtenstein. Berlin. Descriptiones animalium quae in itinere ad Maris Australis terras per annos 1772 1773 et 1774 suscepto, ...: i-xiii + 1-423.	
Pleuronectes spinosus	Synonym of *Bothus mancus*	No types known	**Bloch, M. E. and J. G. Schneider** 1801	
Bloch and Schneider 1801			M. E. Blochii, Systema Ichthyologiae iconibus cx illustratum. Post obitum auctoris opus inchoatum absolvit, correxit, interpolavit Jo. Gottlob Schneider, Saxo. Berolini. Sumtibus Auctoris Impressum et Bibliopolio Sanderiano Commissum. M. E. Blochii, Systema Ichthyologiae.: i-lx + 1-584, Pls. 1-110.	
Passer marchionessarum	Synonym of *Bothus mancus*	Holotype MNHN	**Valenciennes, A.** 1846	
Valenciennes 1846			Table + Ichthyology Pls. 1-10. In: A. du Petit-Thouars. Atlas de Zoologie. Voyage autour du monde sur la frégate "Vénus," pendant les années 1836-1839. Voyage autour du monde sur la frégate "la Vénus", pendant les années 1836-39.	
Platophrys smithi	Synonym of *Bothus mancus*		**Rendahl, H.** 1921	
Rendahl 1921			The fishes of Easter Island. The Natural History of Juan Fernandez and Easter Island. Ed. by C. Skottsberg. The fishes of Easter Island. The Natural History of Juan Fernandez and Easter Island. v. 3 (pt 1): 59-68.	

Nominal Species, Author/Year	Current Status	Type Specimens	Source Reference	Comments
Platophrys circularis	Synonym of *Bothus myiaster*	Holotype BMNH	**Regan, C. T.** 1908 (May)	Examined
Regan 1908			Report on the marine fishes collected by Mr. J. Stanley Gardiner in the Indian Ocean. The Transactions of the Linnean Society of London. Second Series. Zoology v. 12 (pt 3): 217-255, Pls. 23-32.	
Platophrys ovalis	Synonym of *Bothus myiaster*	Holotype BMNH	**Regan, C. T.** 1908 (May)	Examined
Regan 1908			Report on the marine fishes collected by Mr. J. Stanley Gardiner in the Indian Ocean. The Transactions of the Linnean Society of London. Second Series. Zoology v. 12 (pt 3): 217-255, Pls. 23-32.	
Citharichthys aureus	Synonym of *Bothus myriaster*	Holotype (unique): ZSI	**Day, F. 1877** (Aug.)	
Day 1877			The fishes of India; being a natural history of the fishes known to inhabit the seas and fresh waters of India, Burma, and Ceylon. The fishes of India; being a natural history of the fishes known to inhabit the seas and fresh waters of India, Burma, and Ceylon. Part 3: 369-552, Pls. 79-138.	
Bothus bleekeri	Synonym of *Bothus myriaster*	Where abouts unknown	Steindachner, F. 1861	
Steindachner 1861			Ichthyologische Mittheilungen. (III.) [With subtitles I-V]. Verhandlungen der K.-K. zoologisch-botanischen Gesellschaft in Wien v. 11: 175-182, Pl. 5.	
Rhombus macropterus	Synonym of *Bothus lunatus*	No types known	**Quoy, J. R. C. and J. P. Gaimard**	
Quoy, J. R. C. and J. P. Gaimard			1824-25. 3574escription des Poissons. Chapter IX. In: Freycinet, L. de, Voyage autour du Monde...exécuté sur les corvettes de L. M. "L'Uranie" et "La Physicienne," pendant les années 1817, 1818, 1819 et 1820. Paris. 192-401 [1-328 in 1824; 329-616 in 1825], Atlas pls. 43-65.	
Pleuronectes lunulatus	Synonym of *Bothus lunatus*	No types known	**Jouan, H.** 1861	
Jouan 1861			Notes sur quelques espèces de poissons de la Nouvelle-Calédonie. Memoires de la Société Imperial des Sciences Naturelles Cherbourg v. 8: 256.	Non-type material examined

Nominal Species, Author/Year	Current Status	Type Specimens	Source Reference	Comments
Rhombus parvimanus	Synonym of *Bothus lunatus*	Holotype BMNH	**Bennett, E. T.** 1832 (2 Mar.)	
Bennet 1832			Observations on a collection of fishes from the Mauritius, presented by Mr. Telfair, with characters of new genera and species. Proceedings of the General Meetings for Scientific Business of the Zoological Society of London 1830-31 (pt 1): 165-169. [Publication date from Duncan 1937.	
Pleuronectes argus	Synonym of *Bothus lunatus*	No types known	**Bloch, M. E.** 1783	
Bloch 1783			M. Marcus Elieser Bloch's ..., ausübenden Arztes zu Berlin, Oekonomische Naturgeschichte der Fische Deutschlands. Berlin. v. 2: 1-192, Pls. 38-72. [Also a French edition, Icthyologie, ou Histoire naturelle des Poissons, v. 2, published 1785.]	
Platophrys nebularis	Synonym of *Bothus ocellatus*	Lectotype USNM	**Jordan, D.S. and C.H. Gilbert** 1884 (8 July)	
Jordan and Gilbert 1884		Paralectotypes BMNH	Descriptions of ten new species of fishes from Key West, Florida. Proceedings of the United States National Museum v. 7 (no. 402): 24-32.	
Bothus atlanticus	Synoynm of *Bothus ocellatus*	Syntypes, whereabouts unknown	**Kyle, H. M.** 1913	
Kyle 1913			Flat-fishes (Heterosomata). Report on the Danish oceanographical expeditions 1908-10 to the Mediterranean and adjacent seas. Dana Report No. 2, v. 2 (Biol.): 1-150, Pls. 1-4.	
Rhombus gesneri	Synonym of *Bothus robinsi*	MNHN, Lost	**Risso, A.** 1827 (22 Sept.)	
Risso 1827			Histoire naturelle des principales productions de l'Europe méridionale, et particulièrement de celles des environs de Nice et des Alpes maritimes. F. G. Levrault, Paris & Strasbourg. Histoire naturelle des principales productions de l'Europe méridionale, ... v. 3: i-xvi + 1-480, Pls. 1-16. [Fishes in vol. 3 of 5. Published in 1827.	

Species that have been previously reclassified as other species and verified as proper classification:

Nominal Species, Author/Year	Current Status	Type Specimens	Nominal Reference	Comments
Bothus brunneus	Valid as *Arnoglossus brunneus*	Holotype USNM	Fowler, H. W. 1934 (20 Jan.)	
Fowler 1934		Paratypes USNM	Descriptions of new fishes obtained 1907 to 1910, chiefly in the Philippine Islands and adjacent seas. Proceedings of the Academy of Natural Sciences of Philadelphia v. 85 (for 1933): 233-367.	
Bothus budkeri	Valid as *Parabothus budkeri*	Holotype MNHN	Chabanaud, P. 1943 [ref. 13168]	
Chabanaud 1943		Paratypes MNHN	Notules ichthyologiques. XVII. -- Additions à la faune de la mer Rouge. Bulletin du Muséum National d'Histoire Naturelle (Série 2) v. 14 (no. 6): 396-402. [Dated to 1843 by Desoutter *et al.* 2001:303,	
Pleuronectes commersonnii	Valid as *Synaptura commersonnii*	No types known	Lacepède, B. G. E. 1802 (6 Apr.)	
Lacepède 1802			Histoire naturelle des poissons. Histoire naturelle des poissons. v. 4: i-xliv + 1-728, Pl. 1-16. [Publication date: Hureau & Monod 1973, v. 2: 323.	
Bothus imperialis	Valid as *Arnoglossus imperialis*	No types known	Rafinesque, C. S. 1810	
Rafinesque 1810			Caratteri di alcuni nuovi generi e nuove specie di animali e piante della Sicilia, con varie osservazioni sopra i medisimi. (Part 1 involves fishes, pp. [i-iv] 3-69 [70 blank], Part 2 with slightly different title, pp. ia-iva + 71-105 [106 blank]). Caratteri di alcuni nuovi generi e nuove specie di animali e piante della Sicilia, con varie osservazioni sopra i medisimi.. Pls. 1-20.	

Nominal Species, Author/Year	Current Status	Type Specimens	Nominal Reference	Comments
Bothus obliquioculatus	Valid as *Engyprosopon obliquioculatum*	Holotype USNM	Fowler, H. W. 1934 (20 Jan.)	
Fowler 1934		Paratype USNM	Descriptions of new fishes obtained 1907 to 1910, chiefly in the Philippine Islands and adjacent seas. Proceedings of the Academy of Natural Sciences of Philadelphia v. 85 (for 1933): 233-367.	
Bothus variegates	Valid as *Psettina variegata*	Holotype USNM	Fowler, H. W. 1934 (20 Jan.)	
Fowler 1934		Paratype USNM	Descriptions of new fishes obtained 1907 to 1910, chiefly in the Philippine Islands and adjacent seas. Proceedings of the Academy of Natural Sciences of Philadelphia v. 85 (for 1933): 233-367.	
Bothus tchangi	Synonym of *Arnoglossus polyspilus*			
Fowler 1934			Report on the shore fishes procured during the voyage of H. M. S. Challenger in the years 1873-1876. In: Report on the scientific results of the voyage of H. M. S. Challenger during the years 1873-76. Zoology. v. 1 (pt 6): 1-82, Pls. 1-32.	

APPENDIX B

MEASUREMENTS, COUNTS, MORPHOLOGICAL CHARACTERISTICS

Measurements, counts, and morhphological characters adopted from Hubs and Lagler (1958), as well as new characters specific to the genus *Bothus*.

*Sexually dimorphic characters are identified as (**M**) for males and (**F**) for females.*
*Ocular side and blind side characters are identified as (**o.s.**) for ocular side, and (**b.s.**) for blind side.*
*Morphometrics are expressed as percentages of standard Length (**%SL**) or head length (**%HL**).*

Measurements:

Standard length (SL): The total horizontal length from the tip of the snout to posteriormost edge of hypural plate, measured on the blind side.

Total length (TL): The length from the tip of the snout to the tip of the longest caudal-fin ray.

Body depth (BD): The largest distance between dorsal-fin ray base and the anal-fin ray base (expressed as %SL).

Head length (HL): The length from the tip of the snout to the posterior edge of the operculum not including the membrane (expressed as %SL in M/F).

Head depth (HD): A vertical measurement from the dorsal fin base to the anal fin base at the posterior edge of the operculum (expressed as %SL in M/F).

Length of pectoral-fin ray o.s./b.s.: The length between the anteriormost edge of the longest pectoral-fin ray to the tip of the posteriormost tip of the ray on ocular/blind side (expressed as a % of SL in M/F).

Length of pelvic fin o.s./b.s.: Length between the base of the anteriormost pelvic fin ray to the tip of the posteriormost blind side pelvic fin ray on ocular/blind side (expressed as %SL in M/F).

Base of pelvic fin o.s.: The length of the base from the first to the last pelvic fin ray on the ocular/blind side (expressed as %SL).

Length of first dorsal-fin ray: The length from the base to the tip of the first dorsal-fin ray (expressed as %SL).

Length of first anal-fin ray: The length from the base to the tip of the first anal-fin ray (expressed as %SL).

Depth of caudal peduncle: The smallest vertical distance of the juncture between the caudal fin and body (expressed as %SL).

Preorbital length: The horizontal distance from anterior margin of anteriormost eye to snout (expressed as %HL).

Postorbital length: The horizontal distance from posterior margin of posteriormost eye to the posterior edge of the ocular-side operculum (expressed as %HL).

Predorsal distance b.s: The distance between the tip of snout and first dorsal-fin ray on the blind side (expressed as %HL).

Dorsal eye distance from anterior edge of head (OD): The horizontal distance from the eye to the anterior edge of the head (expressed as %HL).

Snout length: The horizontal distance from tip of the snout to most anterior edge of ventral eye orbit (expressed as %HL).

Snout to nostril distance: The distance form the tip of the snout to the anterior ocular-side nostril (expressed as %HL).

Length of mouth o.s./b.s.: The distance from the posteriormost point to anteriormost point inside the ocular-side mouth with the caliper inserted into the posterior mandible joint (expressed as %HL).

Ventral eye diameter: The horizontal distance from the anterior margin of the ventral eye to the posterior margin (expressed as %HL).

Width of dorsal orbit: The horizontal distance from posteriormost margin of dorsal orbital bone ridge to anteriormost margin (expressed as %HL).

Interorbital distance: The closest distance between the margins of the ventral and dorsal orbits (expressed as %HL in M/F).

Counts:

Dorsal rays: The number of dorsal-fin rays.

Anal rays: The number of anal-fin rays.

Caudal rays: The number of caudal-fin rays.

Precaudal vertebrae: The number of precaudal vertebrae.

Caudal vertebrae including urostyle: The number of caudal vertebrae including the urostyle.

Rows of Teeth: The number of rows of teeth present on the bottom jaw.

Hourglass-shaped pterygiophores: The number of hourglass-shaped pterygiophores along the dorsal fin.

Dorsal-fin pterygiophores before first neural spine: The number of pterygiophores along the dorsal fin anterior to the first elongated neural spine of the precaudal vertebrae.

Gill-rakers on the bottom limb of the first gill arch: The number of cartilaginous processes located on the lower limb of the first gill arch.

Gill-rakers on the upper limb of the first gill arch: The number of cartilaginous processes located on the upper limb of the first gill arch.

Dorsal-eye appendage: The number of slender appendages on the dorsal eye (M/F).

Ventral-eye appendage: The number of slender appendages on the ventral eye (M/F).

M number of spines on orbitals: The number of spines on orbital on a male (M).

Pectoral-fin ray o.s./b.s.: The number of pectoral-fin rays on the ocular/blind side.

Pelvic-fin ray o.s./b.s.: The number of pelvic-fin rays on the ocular/blind side.

Lateral line scales (LL): The number of pored scales located in the lateral line running down the horizontal median of the body on the ocular-side, ending at the bifurcated/ trifurcated supratemporal branch of the lateral line system.

Ocular Distance Scale Count (ODS): The number of scales between the ventral and dorsal eye.

Morphological Characteristics:

Teeth: Presence, size, orientation and shape of teeth.

Interorbital distance/ distance shape: Concave, convex, or flat.

Spines around the orbits: The number of spines surrounding the orbits.

Lateral line Split: The lateral line splits into a bifurcated/trifurcated supratemporal branch of LL system.

Lateral line Curves: The lateral line curves at a junction located above the pectoral fin.

Vent: Presence of urogenital papillae, located on blind side posterior to base of blind side pelvic fin

Pigmentation of ocular-side: Blotch patterns and pigmentation on the ocular side.

Pigmentation of blind side: Blotch patterns and pigmentation on the blind side.

Morphology precaudal haemapophyses: Presence of ventrally expanded haemapophyses.

Scales (o.s./b.s.): Type of scales; cycloid or ctenoid.

Dark bars blind side (b.s.): Number of dark bars running transversely across the blind side.

Blotch Pattern ocular-side (o.s.): Blotch pigmentation and spot pattern on ocular side.

Spine on snout ocular-side (o.s./b.s.): Number of spine(s) on snout and if spine is branching.

Nares (o.s./b.s.): Presence of flap, tubule on inner nostril on the ocular side.

Membrane between last pelvic-fin ray to anal ray (o.s./b.s.): Presence of a membrane between last pelvic ray to anal ray on ocular side.

Location of longest pectoral-fin ray (o.s./b.s.): The position of the pectoral-fin ray in relation to the other pectoral-fin rays of lesser length.

***Pigmentation Terminology in Reference to Species Bothus*:**

Blotch: an irregular patch or mark on the surface of the skin with no distinct shape or formation.

Complete ring: A full circle, anything resembling a circle or hoop on the surface.

Dark pigmentation: a small round or roundish mark, differing in color or texture from the surface around it by a stark dark contrast.

Incomplete ring: Anything that resembles an incomplete circle on the surface of the skin, including an crescent moon or half circle shapes.

Ocelli: an eyelike spot, or marking that resembles an eye present of the skin.

Ocellated: The specimen has one or more ocelli/ eyelike markings throughout the body or fins.

Pigmentation: coloration in species caused by the presence of pigments, showing any contrast between the general colour of the specimen.

Stellate: Pigmentations resembling a star shape, can be radiating from the centre in a stellate arrangement.

Spots: a small round or roundish mark, differing in color or texture from the surface around it.

Variegated: species exhibiting irregular patches or streaks distributed randomly on the body or fins.

Data Collection Sheet

Bothus Meristics and Morphometrics Sheet

Species / Institution / Catalogue # :

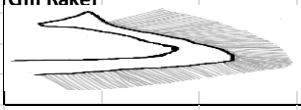
Location Collected/ Date/ Collector :

X-Ray File # :

Acronyms	**Measurements (mm)**
TL	
SL	
BD	
HL	
HD	
Thickness behind operculum	
Width of ventral eye	
Width of dorsal orbital	
Distance between posterior ventral and anterior dorsal eye	
Interorbital Distance	
Distance between nares (o.s.)	
Distance between nares (b.s.)	
Snout length	
Distance from nare to snout	
Length of mandible (o.s.)	
Length of mandible (b.s.)	
Length of upper jaw (o.s.)	
Length of lower jaw (o.s.)	
Length of upper jaw (b.s.)	
Length of lower jaw (b.s.)	
Pre-dorsal distance (b.s.)	
OD	
Length from anterior ventral eye to operculum	
Length from posterior of ventral eye to operculum	
Length first dorsal-fin ray	
Length first anal-fin ray	
Length longest pectoral fin (o.s.)	
Length longest pelvic-fin ray (o.s.)	
Width of pelvic fin base (o.s.)	
Length longest pectoral fin (b.s.)	
Length longest pelvic-fin ray (b.s.)	
Width of pelvic fin base (b.s.)	
Length of pigmneted bars (b.s.)	
Depth of caudal peduncle	
length of longest dorsal eye appendage	
Length of longest ventral eye appendage	
length of first pectoral-fin ray (o.s.)	
Length of first Pectoral-fin ray (b.s.)	
Suspected sex: M/F	

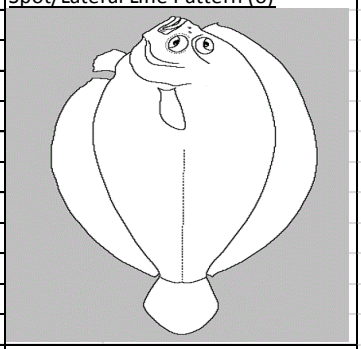
Notes:

Counts (superficial)			
LL		Gill-rakers on lower limb	
ODS		Gill-rakers on upper limb	
Pectoral rays(o.s.)		appendages on dorsal eye	
Pectoral rays (b.s)		appendages on ventral eye	
Pelvic fins (o.s.)		rows of teeth	
Pelvic fins (b.s.)		Bands on blind side	
Dorsal Rays		Vertical scale count	
Anal Rays			
Caudal Ray			
dorsal,anal,caudal			
Counts (x-ray)			
Precaudal vertebrae			
Caudal vertebrae			
total vertebrae including urostyle			
Hypural plates			
Pterygiophores			
Pterigiophres before first neural spine			
Gill Raker			

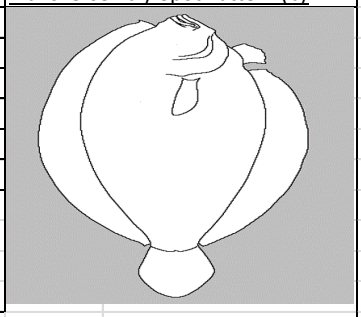


Descriptions		
Orientation of teeth:		
interorbital space:		
Spines on orbitals:		
Does the lateral line curve:		
Does the lateral line split:		
Vent:		
Location of urogential pappilae:		
Pigmentation of ocular side:		
Pigmentation of blind side:		
morphology of precaudal haemapophyses:		
Scales ctenoid or cycloid (o.s.):		
Scales ctenoid or cycloid (b.s.):		
Pigmented bars traversing blind side:		
Pigmentation/Spot pattern (o.s.):		
Spines on Snout (o.s.):		Spines on snout (b.s.)
description of nares (o.s.)		description of nares (b.s.)
Membrane attaching pelvic fin to body (o.s.):		Membrane attaching pelvic fin to body (b.s.):
Eye appendages:		
Location of longest pectoral-fin ray (o.s.)		
Location of longest pectoral-fin ray (b.s.)		

Spot/Lateral Line Pattern (o)



Transverse Bar/ Spot Pattern (b)



APPENDIX C

GLOSSARY OF TERMINOLOGY

The following definitions for the glossary were retrieved from *www.fishbase.org,* on August 5th, 2015 (except the ones identified by an asterisks which were retrieved from http://www.merriam-webster.com/)

Anal fin: The median, unpaired, ventrally located fin that lies behind the anus, usually on the posterior half of the fish.

Apomorphy: A state derived by evolution from an ancestral state (plesiomorphy); applied to a character, not a taxon.

Autapomorphy: A derived character or character state (apomorphy) that is restricted to a single terminal taxon in a data set.

Benthic: Dwelling on, or relating to, the bottom of a body of water; living on the bottom of the ocean and feeding on benthic organisms.

Biserial: In two rows or series.

Blind side (b.s.): Said of the side of flatfishes without eyes that rests on the bottom; also called lower surface but not ventral surface because it is one of the flanks of the fish. Opposite of eyed side.

Caudal fin: Often called the tail fin, it provides the main power for forward movement in fish. It may be square or slightly indented to deeply forked.

Caudal peduncle: The narrow part of the body between the posterior ends of the dorsal and anal fins and the base of the caudal fin, also: the wrist-like portion of the posterior part of the body between the end of the anal fin and the base of the caudal fin. Its length is measured between the insertion of the anal fin and the caudal flexure (the fold shown by the hind edge of the hypural plates when the caudal fin is flexed). Depth is measured vertically at the narrowest point.

Caudal vertebrae: Vertebrae that bear a haemal spine ventral to the vertebral centrum (central portion of the vertebra).

Circumglobal: Distributed around the world within a range of latitudes.

Ctenoid: Having the margin toothed like a comb; used to describe the free margins of the scales of some fishes, as in perciforms.

Cycloid: Having a smooth free margin; used to describe the scales of some fishes.

Dextral: Eyes located on the right side of the body or pertaining to the right. Antonym: sinistral.

Dorsal fin: A median fin along the back that is supported by rays. There may be two or more dorsal fins, in which case the anterior one is designated the first.

Gill-raker: Bony processes, finger-like projection of the gill arch on the opposite side from the red fill filaments, which function in retaining food organisms in order to divert them away from the gills; they vary greatly in number and length and are important in the classifications and identifications of fishes.*

Haemal spine: The ventral spine on the caudal vertebra.

Haemapophysis: Ventral projection of the centrum (central portion of the vertebra) of a precaudal vertebra.*

Holotype: The type specimen used in the original description of a species.

Lateral line: A sensory organ of fishes which consists of a canal running along the side of the body and communicating via sensory pores through scales to the exterior; functions in perceiving low frequency vibrations and pressure differences in general.

Lectotype: A syntype designated as the single name-bearing type specimen subsequent to the establishment of a nominal species or subspecies.

Monophyletic: Refers to a group of species that all have a single common ancestral species. A monophyletic taxon includes all descendants from the common ancestor of its members. A "monophyletic group" is synonymous with the word clade, i.e. an organism and all of its descendants.

Neural spine: The uppermost spine of a vertebra.

Nominal species: Scientific names of species defined by type-specimens.

Ocular side (o.s.): Sometimes called eyed side. The side in flatfishes bearing both eyes, the uppermost side when resting on the bottom, opposite to the blind side. Also called upper surface but not dorsal surface as it is a flank.

Operculum: Bony gill cover; comprised of four bones: opercle, preopercle, interopercle and subopercle.

Paratype: one of any number of specimens, in addition to the holotype, used by the original namer of a species in formulating his or her description of it; a specimen, other than the holotype, on which the description of a new species is based.

Pectoral fin (Fig. 4)**:** The fin usually found on each side of the body behind the gill opening; this pair of fins is found on the lower parts of the body in primitive forms of fish; corresponding to the forelimbs of higher vertebrates; united to form the disc in most rays.

Pelvic fin: The paired fin that is located posterior, ventral or anterior to the pectoral fins (abdominal, thoracic or jugular in position). Also called ischiopterygium. It functions to steer, brake and propel the fish and acts as a keel. In the pelvic-fin ray count usually all the rays are counted except a small ray preceding the first ray and usually bound so closely to it so as to require dissection to be seen. In some fishes with reduced pelvics, the spine and the first ray may be bound together by a membrane and appear as one; both are counted, e.g. in Cottidae. Abbreviated as P2 or V.

Precaudal vertebrae: Centra other than those of the caudal fin. All anterior vertebrae to the one immediately anterior to the first centrum bearing a haemal spine.

Preorbital region: Region of the head anterior to the dorsal eye.

Postorbital region: Region of the head posterior to the ventral eye.

Pterygiophores: The bones or cartilages with which the base of the rays of the median fins articulate; the connecting points for the dorsal and anal fin rays.

Sinistral: Eyes located on the left side of the body, referring to flatfishes having the left-hand side uppermost. Opposite of dextral.

Snout: The part of the head anterior to the eye; the distance from the eye to the anterior tip of the head above the upper jaw (normally the upper lip).

Synonym: An invalid scientific name of an organism proposed after the accepted name; each of two or more scientific names of the same rank used to denote the same taxon.

Syntype: One of the specimens on which a species description is based if no holotype was designated in a protologue.

Taxon: Any formal taxonomic unit or category of organisms (species, genus, family, order, class, etc.). Taxa (pl).

Transverse band: Bands of pigment that extend vertically across the body, usually extending onto the vertical fins. In fish, perpendicular to the long axis of the body; directed crosswise, across the width (the opposite of longitudinal).

Type species: The species of a genus with which the generic name is permanently associated; the description of a genus is based primarily on its type species, being modified and expanded by the features of other included species.

Type material: A collective term for all type specimens.

Type specimen: Specimen used in the original description of a given species or lesser group; this specimen fixes a name to a taxon and serves as the final criterion of the characteristics of that group.*

Urohyal: U-shaped median posterior bony element of the hyoid arch attached between the hypohyals of a fish (the second of seven bony V-shaped arches that support the gills of fish).*