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Taxonomic Revision of the Genera *Achiroides, Brachirus, Dexillus, and Paradicula* (Pleuronectiformes: Soleidae)

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Taxonomic Revision of the Genera *Achiroides*, *Brachirus, Dexillus*, and *Paradicula* (Pleuronectiformes: Soleidae)

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Thesis submitted to the
Faculty of Graduate Studies and Postdoctoral Studies
University of Ottawa
in partial fulfillment of the requirements for the
M.Sc. degree in the

Ottawa-Carleton Institute of Biology

Thèse soumise à
Faculté des etudes supérieures et postdoctorales
Université d'Ottawa
en vue de l'obtention de la maîtrise ès sciences

L'Institut de biologie d'Ottawa-Carleton

Your file Votre référence
ISBN: 978-0-494-49231-4
Our file Notre référence
ISBN: 978-0-494-49231-4

Acknowledgements

I would like to thank Dr. François Chapleau for his supervision, guidance and support, and Dr. Martine Desoutter for providing me with valuable advice, many important documents, and x-rays. I would also like to thank the members of my advisory committee, Dr. Gabriel Blouin-Demers, Dr. Claude Renaud, and Dr. Jeff Skevington for providing direction and clarity. In addition, I owe a great deal of thanks to my fellow graduate students and lab mates: Josiane Vachon, René Duplain and Holly Stephens for their support, encouragement, questions and answers, and for making this research project so enjoyable. Noel Alfonso and Brian Coad provided me with help and guidance in creating geographical distribution maps, and a place to conduct research and learn so much more than I would have otherwise.

I would like to acknowledge those individuals and institutions that provided me with the materials for my study: AMNH – B. Brown; ANSP – M. Sabaj; Australian Museum – M. McGrouther; BMNH – P. Campbell; MNHN – M. Desoutter; Queensland Museum – J. Johnson; USNM – T. Munroe; ZMA – R.Vonk; and a special thanks to Mark McGrouther, Patrick Campbell, Martine Desoutter and Tom Munroe for their help and guidance during my visits. This research was funded through a NSERC discovery grant to François Chapleau that provided financial support and an opportunity to travel to the United States (Washington D.C.), France (Paris), England (London), and Australia (Sydney).

Finally, I thank my parents Jenn and Charlie for their enormous amount of support and encouragement.

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Abstract

The objective of this study was to taxonomically revise the 41 nominal species found within the *Brachirus* species complex (Order Pleuronectiformes; Family Soleidae). This complex is recognizable by a combination of characters: the structure of the supracranial portion of the dorsal fin which lack pterigiophores with their proximal ends directly over the cranium, by the joined dorsal, anal and caudal fins, and by the anterior tip of the dorsal fin almost reaching the upper jaw. This revision is based on the morphological and meristic examination of 34 type and 717 non-type specimens for all available nominal species. The type material was examined for twenty species. The remaining species were assessed from the original type description. It was found that the *Brachirus* species complex is made up of four genera including 19 valid species: *Brachirus* (14), *Achiroides* (1), *Dexillus* (3), and *Paradicula* (1). Eight of the nominal species do not belong to the *Brachirus* species complex and have been removed from the scope of this study. *Achiroides*, characterized by the rudimentary pectoral fins, contains a single valid species, *A. melanorhynchus* (Bleeker 1851) and three synonyms (*Synaptura aenea* Smith 1931, *Anisochirus harmandi* Sauvage 1878, and *Plagusia leucorhynchos* Bleeker 1851). *Dexillus*, characterized by the close proximity of the eyes, contains three valid species: *D. macrolepis* (Bleeker 1858), *D. megalepidoura* (Fowler 1934), and *D. muelleri* (Steindachner 1879). *D. muelleri* is a senior synonym of the nominal species *Synaptura arafurensis* Günther 1880. *Paradicula*, unique in having the gill openings restricted to the base of the pectoral fins, contains a single valid species, *P. setifer* Paradice & Whitley 1927. The remaining *Brachirus* species cannot yet be defined as being monophyletic. *Brachirus* contains 14 valid species: *B. aspilos* (Bleeker 1852)

(synonyms: *Synaptura heterolepis* Bleeker 1856, *S. marmorata* Bleeker 1853, and *S. sorsongonensis* Evermann & Seale 1907), *B. sundaicus* (synonyms: Bleeker 1870-75) (*Synaptura cinerea* De Vis 1883 and S. *nigra* MacLeay,1880), *B. selheimi* (Macleay 1882) (synonyms: *B. salinarum* Ogilby 1910, and *Synaptura villosus* Weber 1907), *B. foliacea* (Günther 1862) (synonym: *Synaptura filamentosa* Sauvage 1878), *B. siamensis* (Sauvage 1878) (synonyms: *Synaptura krempfi* Durand 1940 and *Chabanaudetta smithi* Joglekar 1971), *B. breviceps* Ogilby 1910, *B. cinerascens* (Günther 1862), *B. fitzroiensis* (De Vis 1882), *B. orientalis* (Bloch & Schneider 1801), *B. pan* (Hamilton 1822), *B. panoides* (Bleeker 1851), *B. dicholepis* Peters 1877, *B. swinhonis* Steindachner 1867, and *B. canus* Gray 1854. An identification key of valid species belonging to the *Brachirus* species complex is provided.

Résumé

L'objectif de cette étude consiste à effectuer une révision taxonomique des 41 espèces nominales du complexe d'espèce *Brachirus* (Ordre Pleuronectiformes; Famille Soleidae). Ce complexe peut être reconnu par le fait qu'aucun ptérygiophore proximal de la région supracrânienne de la nageoire dorsale ne s'articule directement sur le crâne, par les nageoires dorsale, caudale et anale qui sont continues et unies, et par l'extrémité antérieure de la nageoire dorsale qui s'étend antérieurement jusqu'à la mâchoire supérieure. Cette révision est fondée sur l'examen morphologique de 34 spécimens types et 717 spécimens non-types des espèces nominales disponibles. Les spécimens types de vingt espèces ont été examinés. La validité des autres espèces a été définie par l'étude des descriptions originales. Huit espèces nominales décrites dans le genre *Brachirus* n'appartiennent pas au complexe des espèces de *Brachirus* et ont été éliminées de l'étude. Il a été déterminé que le complexe d'espèces *Brachirus* pouvait être subdivisé en quatre genres : *Brachirus* (14), *Achiroides* (1), *Dexillus* (3) et *Paradicula* (1), incluant 19 espèces valides. *Achiroides* possède des nageoires pectorales rudimentaires et contient une seule espèce valide, *Plagusia melanorhynchus* Bleeker 1851 (synonymes : *Synaptura aenea* Smith 1931, *Anisochirus harmandi* Sauvage 1878, et *Plagusia leucorhynchos* Bleeker 1851). *Dexillus* présente des yeux contigus et contient trois espèces valides : *D. macrolepis* (Bleeker 1858), *D. megalepidoura* (Fowler 1934) et *D. muelleri* (Steindachner 1879) (synonyme : *Synaptura arafurensis* Günther 1880). *Paradicula* montre un opercule fusionné au corps sauf pour une petite ouverture près des nageoires pectorales et contient une seule espèce valide, *P. setifer* Paradice & Whitley 1927. Les autres espèces de *Brachirus* ne peuvent être encore être définies comme étant

monophylétiques. *Brachirus* comprend 14 espèces valides : *B. aspilos* Bleeker 1852 (synonymes : *B. heterolepis* Bleeker 1856, *B. marmorata* Bleeker 1853, et *B. sorsongonensis* Evermann & Seale 1907), *B. sundaicus* Bleeker 1870-75 (synonymes : *B. cinerea* DeVis 1883 et *B. nigra* MacLeay,1880), *B. selheimi* (Macleay 1882) Weber 1907 (synonyme: *B. salinarum* Ogilby 1910, et *S. villosus* Weber 1907), *B. foliacea* Richardson 1846 (synonyme : *B. filamentosa* Sauvage 1878), *B. siamensis* Sauvage 1878 (synonymes : *B. krempfi* Durand 1940 et *B. smithi* Joglekar 1971), *B. breviceps* Ogilby 1910, *B. cinerascens* Gunther 1862, *B. fitzroiensis* DeVis 1882, *B. orientalis* Bloch & Schneider 1801, *B. pan* Hamilton 1822, *B. panoides* Bleeker 1851, *B. dicholepis* Peters 1877, *B. swinhonis* Steindachner 1867 et *B. canus* Gray 1854. Une clé d'identification des espèces valides appartenant au complexe d'espèces *Brachirus* est présentée.

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General Introduction

Flatfishes (Order Pleuronectiformes)

Pleuronectiformes were first named in 1758 by Linnaeus; *pleuro* meaning "on side" and *necto* meaning "swim". Eighteen species of flatfish were described and grouped into the genus *Pleuronectes* which was divided into multiple genera, including *Synaptura* and *Solea*, by Cuvier (1816). The first revision of the Pleuronectiformes species, conducted by Jordan & Goss (1889), resulted in the creation of seven subfamilies and numerous subgenera. The first cladistic analysis occurred nearly a century later by Chapleau (1993), in which the monophyletic status of the Pleuronectiformes was established based on three characteristics: the dorsal fin which extends onto the head, the asymmetrical development of the skull which results in asymmetrical eyes, and the *recessus orbitalis* which permits the protrusion of the eyes.

Pleuronectiformes are also characterized by their laterally compressed bodies and asymmetrical appearance, both of which develop during metamorphosis from larval to juvenile form. They range widely in size, from a couple centimeters to upwards of two meters, and can be found in the majority of intertidal and coastal regions around the world. Larval flatfish are pelagic and bilaterally symmetrical, but during metamorphosis they transition from pelagic to benthic and undergo drastic morphological changes, including the migration of one eye from one side of the head to the other, which is characteristic of all adult flatfish (Brewster 1987). In addition to having both eyes on the same side of the head, adults have the following asymmetry: pigmentation is usually more pronounced on the ocular side and in some species can be changed to match the substrate (Norman 1963), pectoral and pelvic fins are usually asymmetrical, as is the

mouth, and the swim bladder is missing. The Pleuronectiformes are made up of 15 families of flatfish with 121 nominal genera and about 716 nominal species (Munroe in Gibson, 2005).

Pleuronectiformes are a commercially important group of fishes. In 2005 they made up 3.9 percent of the Canadian fisheries by live weight (Statistics Canada online database www.statcan.gc.ca), whereas 1.3 percent of global marine fisheries (by live weight) was derived from flatfish captures (FAO online database http://www.fao.org/figis, 2005). They are found distributed around the globe in marine and estuarine waters and occasionally in freshwater environments. By better understanding their taxonomy it will be possible to better manage these important fisheries.

Soleidae

Ahlstrom et al. (1984) proposed three suborders within the order Pleuronectiformes: the Psettoidei, the Pleuronectoidei, and the Soleoidei. Chapleau & Keast (1988) suggested that the Pleuronectoidei should include the Soleoidei in order to be considered a monophyletic taxon. Originally, Hensley & Ahlstrom (1984) classified two families within the Soleoidei: the Cynoglossinae and the Soleidae (subfamilies Achirinae and Soleinae). However, Chapleau & Keast (1988) indicated that the Soleidae were not monophyletic and suggested that the Achirinae and Soleinae be raised to the family levels (Achiridae and Soleidae) (Chapleau 1993). Chapleau & Keast (1988) defined the monophyletic Soleidae on six synapomorphies: 1) vomer protruding ventrally, 2) metapterygoid having high perpendicular lamina along its posterodorsal

margin, 3) ascending process of the blind side (b.s.) premaxilla always directed towards the ocular side (o.s.) and extending in front of rostral cartilage and opposing premaxilla, 4) maxillary spike of o.s. maxilla covering rostral cartilage dorsally, 5) b.s. lateral ethmoid having posteroventral process attached to sphenotic, and 6) basioccipital having two distinct ventral processes for articulation of branchial arches.

There are approximately 29 valid genera and 139 valid species (227 nominal) of Soleidae and they range widely around the world in marine, estuarine, and freshwater habitats (Munroe in Gibson, 2005).

Despite the commercial importance of these fish, only recently have scientists been focused on revising their taxonomy. In the late 1800s and early 1900s there were numerous new species described. In the 20th century, Paul Chabanaud was a prolific taxonomist who did exhaustive studies on identifying and classifying flatfish, including the Soleidae (Chabanaud 1934a, b, 1937, 1938, 1948...). Chabanaud identified many new species and subspecies for reasons that were difficult to follow or understand. He also created and employed a new method of examining specimens, but was vague in explaining his methodology. This resulted in many synonyms, non-valid taxonomical classifications, and indiscernible descriptions on which to base future works.

Recently, the focus has shifted to clarify the validity and taxonomic standing of fishes within the Soleidae. Chapleau & Desoutter (1996) examined the phylogenetic relationships of a species of *Dagetichthys* within the Soleidae; Desoutter & Chapleau (1997) reevaluated the taxonomic status of *Bathysolea*; Desoutter-Meniger (1997) revised the genera of Soleidae found along the coast of the Mediterranean Sea and east-Atlantic Ocean; Vachon *et al.* (2006a, in press) conducted a taxonomic revision and phylogenetic

assessment of *Dagetichthys*, *Solea*, and *Barnardichthys*. Other Soleidae studies have included reexamining the structure of the lateral line scales (Voronina 2007), analyzing population structures in certain geographical ranges (Rolland et al. 2007, Mérigot et al. 2007), and evaluating the taxonomic validity of *Solea* species (Vachon et al. 2005).

By revising each species and genus, the aim of this study was to identify the valid species and thus release valid taxonomic information that could be used for ecological studies, fisheries, and conservation. This project is a step towards the overall goal of providing accurate and realistic flatfish taxonomy.

Brachirus

Brachirus was first described by Swainson (1839) as a subgenus of *Solea* Cuvier 1816. It has long been unclear what defines a *Brachirus*. *Brachirus* species have been, at times, considered as belonging to *Synaptura* Cantor 1849 or *Euryglossa* Kaup 1858. Desoutter et al. (2001) were able to accurately clarify the nomenclatural status of these three genera and concluded that only *Brachirus* is valid, while the latter two are not. A definition of *Brachirus* was still lacking, however. The *Brachirus* species complex contains 41 nominal species. Species from this complex share similar characteristics: the united dorsal, caudal and anal fins, the short predorsal length, small head, eyes and mouth, the pectoral fins which are free of the opercular membrane, and the structure of the supracranial portion of the dorsal fin which lacks pterigiophores with their proximal ends articulating directly over the cranium. This supracranial complex formula has been shown by Chapleau (1989) to be shared with only five other genera: *Typhlachirus* Hardenberg 1931, which has rudimentary eyes, *Zebrias* Jordan & Snyder 1900, which

has a larger predorsal length and distinct stripes, and *Bathysolea* Roule 1916, *Heteromycteris* Kaup 1858, and *Aseraggodes* Kaup 1858 which have a distinct caudal fin. The *Brachirus* species complex is made up of the remaining nominal species and thus its monophyletic status cannot yet be verified. A phylogenetic study is required to assess the placement of *Brachirus* and its affiliated genera within the Soleidae.

During the study of *Brachirus* and its affiliated genera a number of nominal species were excluded as follows:

Brachirus annularis Fowler 1934 and *Synaptura hediste* Mees 1964 were excluded from this study and are suspected of belonging to *Zebrias*. Both species have a supracranial complex that shares similarities with the structure observed in *Zebrias* (Chapleau 1989).

Solea ovalis Richardson 1846 is indicated as being a synonym of *Brachirus foliacea* in Günther (1862). *Solea ovalis*, however, has no known types according to Eschmeyer (2006). The type description is based upon a drawing by Reeves in Whitehead (1969) which was created in 1846. Based on this drawing, I have concluded that *Solea ovalis* is not a *Brachirus* due to the large predorsal length (the distance between the base of the most anterior dorsal ray and the upper lip), the mouth extending to the posterior edge of the ventral eye and the lateral line continuing straight along the head. In *Brachirus,* the first dorsal fin ray begins between the upper lip and the ventral edge of the dorsal eye, the mouth extends no further than halfway along the ventral eye, and the lateral line is heavily curved about the head.

Brachirus bellus Jordan & Hubbs 1925 is not a pleuronectiform but belongs in the Scorpaenidae based on the lack of pleuronectiform features.

Synaptura callizona Regan 1903 and *S. cancellata* McCulloch 1916 have characteristics similar to *Zebrias* such as the large predorsal length, distinct thick dark bars across the body, and pectoral fins continuous with the opercular membrane.

Synaptura lipothalama Karoli 1882 has rudimentary eyes and is therefore likely a member of *Typhlachirus.* Pellegrin (1940) supports this hypothesis.

Synaptura smithii Regan 1903 does not have the dorsal, anal and caudal fins joined and therefore cannot be a *Brachirus*. Faint bars are also present across the body suggesting that it may also belong to *Zebrias*; however further examination is required.

The purpose of this study was to reevaluate the validity of the nominal species within the *Brachirus* species complex. An improved taxonomic understanding of these fish is at the basis of any assessment associated with conservation and fisheries management.

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CHAPTER 1

Taxonomic revision and redescription of *Achiroides* (Pleuronectiformes: Soleidae)

Abstract

Achiroides (Soleidae; Pleuronectiformes) includes *Brachirus*-like nominal species that have rudimentary pectoral fins. There are currently four nominal species with this unique attribute: *A. aenea* Smith 1931, *A. harmandi* Sauvage 1878, *A. leucorhynchos* Bleeker 1851b, and *A. melanorhynchus* Bleeker 1851b. Based on the examination of two type and 199 non-type specimens belonging to this species complex, thid study supports the existence of only one species - *A. melanorhynchus.* The other nominal species are junior synonyms. A formal description of *Achiroides* and its valid species is provided.

Keywords

Achiroides, *Brachirus*, taxonomy, *melanorhynchus*, *leucorhynchos*, *aenea*, *harmandi*

Résumé

Achiroides (Soleidae; Pleuronectiformes) regroupe les espèces nominales du complexe d'espèces *Brachirus* qui ont des nageoires pectorales rudimentaires. Il y a actuellement quatre espèces nominales qui ont ce dernier caractère: *A. aenea, A. harmandi, A. leucorhynchos* et *A. melanorhynchus*. Dans cette étude, l'examen de deux spécimens types et 199 spécimens non-types a permis de déterminer que *A. melanorhynchus* est la seule espèce valide alors que les autres espèces nominales sont des synonymes juniors. Une description formelle d'*Achiroides* et de l'espèce valide est faite.

Mots clés

Achiroides, *Brachirus*, taxinomie, *melanorhynchus*, *leucorhynchos*, *aenea*, *harmandi*

Introduction

Achiroides (Soleidae; Pleuronectiformes) was first placed in Soleidae by Bleeker (1851a). Eschmeyer (2006) indicated that the diagnosis was written in Bleeker (1851b) with the description of *A. leucorhynchos.* In the same publication, Bleeker (1851c) also included the species *melanorhynchus* in *Achiroides*. Bleeker had previously described *melanorhynchus* as a *Plagusia* (Bleeker 1851c). *Achiroides* was described as being unique because of its rudimentary pectoral fins (Bleeker 1851a).

Kaup (1858) suggested *Eurypleura* as a replacement name for *Achiroides* because its general body form was more in agreement with that of *Euryglossa* than *Achiroides*; however, because of the absence of pectoral fins, he modified the name to *Eurypleura*. This replacement was deemed unneeded (Eschmeyer 2006) because the name *Achiroides* was never shown to be invalid. Günther (1862) proposed *Achiroides* as a subgenus of *Synaptura,* and characterized it by the lack of pectoral fins, with species *S. leucorhyncha* and *S. melanorhynchus.* However, the pectoral fins are not absent in the latter two species but are rather rudimentary. *Synaptura harmandi* Sauvage (1878) was placed in the subgenus *Anisochirus* of Günther (1862) because of the distinguishing feature of having the left pectoral fin longer than the right. *Synaptura harmandi* has asymmetrical pectoral fins though rudimentary. Thus, this species should be trates as a species of *Achiroides*.

Kottelat (1984) showed that the difference in pectoral fin length was significant, but stated: "I tentatively follow Chabanaud (1930, 1931, 1938) in considering S.

harmandi as a member of *Euryglossa*" (p.817). An examination of the literature indicated that Chabanaud (1930, 1931) considered *Achiroides* as a synonym of *Brachirus* and thus *Synaptura harmandi* was classified within *Brachirus.* Chabanaud 1938 also considered *Brachirus* as a synonym of *Euryglossa* Kaup 1858. However, *Euryglossa* and *Synaptura* were recently found to be invalid as soleid names (Desoutter et al., 2001). Only *Brachirus* was maintained as a valid name.

Smith (1931) described *Synaptura aenea*, a species with the same rudimentary pectoral fins observed in the three other nominal *Achiroides* species.

Kottelat (1989) used *Achiroides*, instead of *Synaptura*, to characterize two nominal species with rudimentary pectoral fins (*Achiroides melanorhynchus* Bleeker 1851c and *A. leucorhynchus* Bleeker 1851b), but he kept *aenea* and *harmandi* in *Euryglossa* while suggesting that both species might be synonyms (see also Chabanaud, 1931). With *Euryglossa* not being a valid soleid name (Desoutter et al. 2001), it is logical and valid to utilize *Achiroides* as the genus name for these four nominal species.

A. melanorhynchus is found in Borneo, while *A. leucorhynchos* is present in Java. The holotype for *B. aenea* was found in the Lop Buri River, Thailand, and *B. harmandi* was first discovered in the Revu Stouch, Vietnam.

The purpose of this study was to provide a definition of *Achiroides* and assess the validity of the four nominal species that share the unique features of the genus.

Materials and methods

Two hundred and one specimens were examined (see list of specimens in species description). Counts and measurements are explained in Appendix 1. Measurements were done following Hubbs and Lagler (1958), with the exception of eye diameter, which was taken on the ventral eye. Dorsal, anal and caudal fin rays, precaudal and caudal vertebrae counts and the structure of the supracranial complex were taken from radiographs. The formula for the supracranial complex was first proposed by Chapleau (1989). It is based on: [the number of pterigiophores on the most anterior neural spine] – [the number of pterigiophores with their proximal ends articulating directly over the cranium] – [the number of pterigiophores on the second most anterior neural spine][the number of pterigiophores that are between the second and third neural spine, but which are not attached to the second neural spine or touching the anterior edge of the third neural spine]. Types for *B. melanorhynchus* and *B. harmandi* were examined. The type of *B. aenea* is lost and that of *B. leucorhynchos* could not be obtained for examination. Original descriptions were consulted for all four nominal species. Abbreviations o.s. and b.s. are used for ocular side and blind side, respectively.

Diagnosis of the genus *Achiroides* Bleeker 1851

Achiroides Bleeker 1851b (type species by subsequent designation *Plagusia melanorhynchus* Bleeker 1851c)

Eurypleura Kaup 1858 (type species by original designation *Plagusia melanorhynchus* Bleeker 1851c)

Achiroides is characterized by having rudimentary pectoral fins. This genus shares many characteristics with *Brachirus* such as the joined dorsal, anal and caudal fins, the short predorsal length and the structure of the supracranial complex which is lacking pterigiophores with their proximal ends directly articulating on the cranium.

Remarks

Achiroides is a monotypic genus with the type species being *Achiroides melanorhynchus*.

The shape and presence of the pectoral fins have been the subject of conflicting views in the literature. Smith (1931) described *Synaptura aenea* as having rudimentary fins, while he referred to *Achiroides* as having pectorals which were entirely absent. Sauvage (1878) and Kottelat (1984) both described *S. harmandi* as having pectoral fins though Kottelat (1984) indicated that the length of the o.s. fin was 11.5 times in head length, not 8.5 times in head length as indicated by Sauvage (1878). In fact, *Achiroides* was created as a subgenus of *Synaptura* (Günther 1862) to regroup fish lacking pectoral fins. I support Kottelat's change since the rudiments in the present study fit 11.5 times within head length (HL). However, the pectoral fins are rudimentary and lack fin rays.

Relationship to *Brachirus*

Achiroides belongs to the *Brachirus* species complex due to a number of similarities it shares with *Brachirus, Dexillus* and *Paradicula:* oval body shape joined vertical fins, shape and location of the anterior blind nostril, and the supracranial complex lacking pterigiophores over the cranium. Without a proper phylogenetic study, however, it is difficult to define the interrelationships of these four genera.

Achiroides melanorhynchus (Bleeker 1851)

Plagusia melanorhynchus Bleeker 1851c

Achiroides leucorhynchos Bleeker 1851b

Anisochirus harmandi Sauvage 1878

Synaptura aenea Smith 1931

Material examined

Anisochirus harmandi: MNHN 0000-9517, Holotype(72.20 mm SL), Revu Stouch, Vietnam.

Plagusia melanorhynchus: BMNH 1880.4.21.186, Holotype(43.37 mm SL), Borneo. AMI 43747-015, 9(50.67-73.76 mm SL), 12 15' N 104 45' E, Tonle Sap River, Cambodia, ANSP 59716, 6(20.83-37.66 mm SL), Chieng Mai, on Me Nam Ping, North Siam., Thailand, ANSP 59722, 4(31.57-46.51 mm SL), Chieng Mai, on Me Nam Ping, North Siam., Thailand, ANSP 59726, 1(58.35 mm SL), Chieng Mai, on Me Nam Ping, North Siam., Thailand, ANSP 59727, 4(31.33-46.99 mm SL), Chieng Mai, North Siam, on Me Nam Ping, 450 mi. N. of Bangkok, 75 mi. E. of Karenni (Burma), Thailand, ANSP 59731, 3(28.93-45.25 mm SL), Chieng Mai, North Siam; on Me Nam Ping, 450 mi. N. of Bangkok, 75 mi. E. of Karenni (Burma), Thailand, ANSP 59734, 7(27.66-47.8 mm SL), Chieng Mai, on Me Nam Ping, North Siam., Thailand, ANSP 59741, 1(45.22 mm SL), Chieng Mai, on Me Nam Ping, North Siam., Thailand, ANSP 59742, 11(34.29-57.45 mm SL), Chieng Mai, on Me Nam Ping, North Siam., Thailand, ANSP 87231, 3(27.25-37.61 mm SL), 16 03' N 105 13' E, Kemrat, Siam, Thailand, ANSP 158460,

1(53.67 mm SL), Baram River, North Borneo, Malaysia, ANSP 178863, 1(79.58 mm SL), 15 27'14" N 100 08'03" E, Mae Nam Chao Phraya [river] and tribs in vicinity of Phayuha Khiri, Thailand, Nakhon Sawan, BMNH 61.4.12.42, 1 (34.76 mm SL), unknown, BMNH 1931.2.27.3-4, 2(61.93-74.52 mm SL), Kelantan, Malay Peninsula, Malaysia BMNH 2000.6.10.5831, 1(75.31 mm SL), Xayphouthong, Savannakhet, Laos, CAS 61939, 30(31.12- 76.81 mm SL), Mekong River Basin, Thailand, Ubon, CMK 5160, 1(21.49 mm SL), 8 34' N 99 15' E, Mae Nam Tapi near Phraseng, Surat Thani, Thailand, CMK 10450, 1(103.98 mm SL), 1 37' N 109 11'E, Kalimantan Barat, Bornea, Indonesia, CMK 10471, 11(11.98-32.25 mm SL), 0 37'35" N 112 03'58" E, Sangai Kapuas, Kalimantan Barat, Borneo, Indonesia, CMK 13497, 51(33.00-66.26 mm SL), 16 05'11" N 105 21'3" E, Xe Bang Liang, Savannakba, Laos, MNHN 1965-0458-64, 12(33.79-86.74 mm SL), Snoc Trou, Cambodia, MNHN 0000-4462, 1(63.45 mm SL), 12 30' N 112 30' E, Cochinchine, Vietnam, MNHN 1965-0468, 2(44.49-49.00 mm SL), Stung Tong Hong, Cambodia, NMW 43054, 1 of 3(54.03 mm SL), Borneo, NMW 43071, 7(22.17- 33.96 mm SL), Soloplub, Java, Indonesia, NMW 92025, 1(41.47 mm SL), QMI.23406, 10(44.02-66.53 mm SL), Thailand, USNM 109795, 8(45.98-82.88 mm SL), Meping R. at Chiengmai, N. Siam, USNM 230355, 4(30.62-65.2 mm SL), West Kalimantan, Indonesia, USNM 230356, 3(25.55-30.88 mm SL), Rocky Ledge In Middle of Sungai Melawi Near Confluence With Kapuas Mainstream, About .5 km Upstream From Sintang, West Kalimantan, Indonesia, USNM 305762, 4(27.93-48.92 mm SL), Thailand: Ubon Ratchathani Province, bought in Warinchamrap Market

Common Names

Pa pe (Taki, 1974)

Trey andat chhke (Rainboth, 1996)

Diagnosis

Achiroides melanorhynchus can be distinguished by the combined characteristics of having rudimentary pectoral fins and the joined dorsal, caudal, and anal fins.

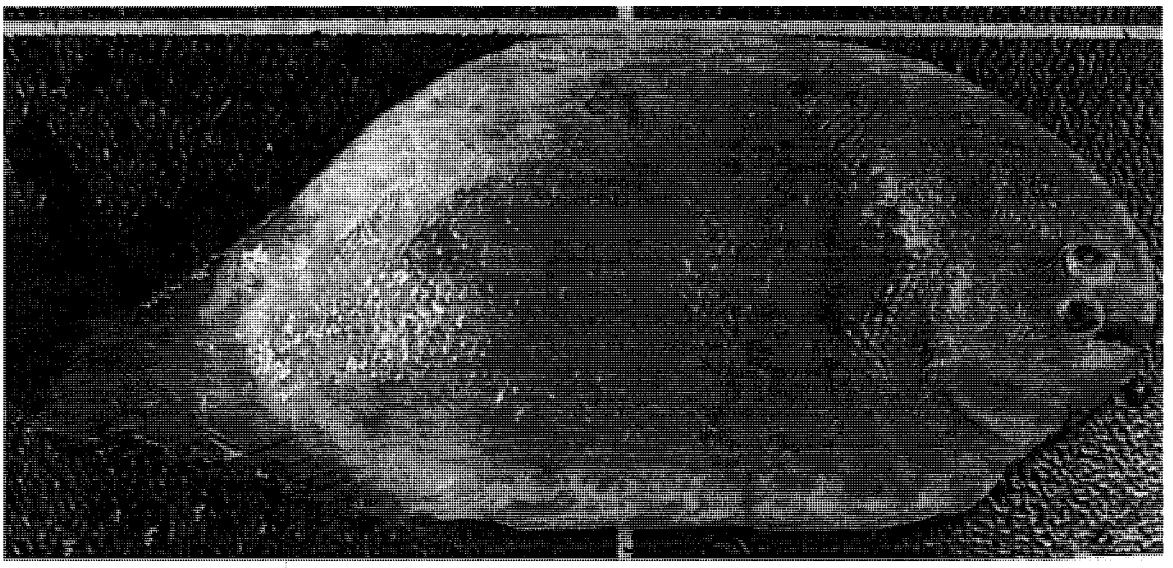

Figure 1. Photo of *Achiroides melanorhynchus* holotype BMNH 1880.4.21.186. 43.37 mm Standard Length (SL).

Description

Refer to table 1. Body small and oval; head short and deep. Posterior corner of mouth on o.s. terminating under anterior quarter of ventral eye. O.s. anterior nostril a short tube; posterior nostril a short, wide tube lying against anterior edge of ventral eye. B.s. anterior nostril is a hole with an intricate fringe of cirri; posterior nostril more dorsal than anterior and slightly more posterior than corner of mouth. Few thickened cirri restricted to snout region of b.s. of head. Scales ctenoid; free of cirri and found on proximal half of vertical rays. Lips devoid of cirri. Minute teeth found on a wide band on b.s. upper jaw. Dorsal eye slightly in advance of ventral eye by about ¼ of its diameter; interorbital space generally equal to eye diameter. Anus located along ventral mid-line, directly anterior to last anal fin ray, urinary papillae slightly anterior of anus on o.s. Dorsal fin rays 51-61, anal fin rays 39-46, caudal fin rays 13-17, pelvic fin rays 3-5, pectoral fins rudimentary flaps of skin on both sides, left one longer than right. Dorsal, anal and caudal fins united, anterior end of dorsal fin approaching anterior edge of upper lip. Upper lip overhangs lower, bluntly pointed. Total vertebrae 31-34: 22-25 caudal and 7-9 precaudal, lateral line scales 40-70. Average supracranial pterigiophores 8 of the formula 4-0-3(1) [Range of 6-10 (2-6)-0-(2-5)(0-2)].

Table 1. Morphometrics and meristics for *Synaptura aenea*, *Achiroides melanorhynchus* holotype BMNH 1880.4.21.186, *Anisochirus harmandi* holotype MNHN 0000-9517, and all non-type material. Abbreviations are defined in Appendix 1; characters 2 to 10, 14-15 are expressed in hundredths of HL, characters 1, 11-13, 16 are expressed in hundredths of SL, unless otherwise stated, and 17-24 are meristics.

		aenea	*harmandi*		*melanorhynchus*		
	Character	Smith, 1931	Sauvage, 1878	Holotype	Bleeker, 1851	Holotype	non-type
1.	HL	3.8	4 TL	3.9	4.5-5 TL	3.9	3.6(3-4.2)
2.	E	6.0		10.9		4.9	6.6(3.7-9)
3.	S	3.0		3.0		3.1	3.1(2.5-4.2)
4.	DNS			4.5		5.4	4.2(2.8-6)
5.	Mos			3.3		3.2	3.3(2.3-4.9)
6.	Mbs			4.1		3.3	3.9(2.9-5.9)
7.	Pred			5.2		3.5	4.8(2.7-10.7)
8.	Pelos		8	3.3		3.7	3.4(2.5-5.7)
9.	Pelbs		8.5	3.5		4.0	3.4(2.6-6.1)
10.	OD			3.6		4.6	4(3.1-5.8)
11.	H1	1.8	2.3 TL	1.8	2.5 TL	2.3	2(1.5-2.4)
12.	H2			2.7		3.3	2.9(2.2-4.3)
13.	HCP			10.3		10.5	10.9(7-17.4)
14.	LDR			1.3		1.7	1.8(1.2-2.7)
15.	LAR			1.4		1.7	1.7(0.8-2.5)
16.	Hdep			2.7		3.0	2.8(2.2-3.5)
17.	DR	54	48			55	56(51-61)
18.	AR	45	38			41	43(39-46)
19.	CR	16				16	15(13-17)
20.	PelOR	4		4		4	4(3-5)
21.	PelAR	4		4		4	4(3-5)
22.	CV					22	24(22-25)
23.	PCV					9	8(7-9)
24.	LL	66	54	54		54	55(40-70)

Colour in Alcohol

O.s.: body golden with light brown speckled spots covering outer edge of body, with much paler central spots; dorsal and anal fin rays and skin darkly spotted, tips pale; caudal fin and head speckled; right pectoral fins darkly tipped, pelvic fins pale. B.s.: body pale with a gradient of pale brown darkening towards caudal fin; very thin, pale lateral bars along both sides of body; dark spot occasionally on snout; white spot, with an anterior and posterior dark spot on chin, situated on the o.s. close to median.

Geographic Distribution

Freshwater; Asia: Mekong basin in Laos, Thailand and Cambodia; Chao Phraya basin and Malay Peninsula. Reported from the South China Sea, Western Pacific: South China Sea; Revu Stouch, Vietnam (see Fig.2). Found in large rivers and tributaries on sandy to muddy bottom (Kottelat, 2001).

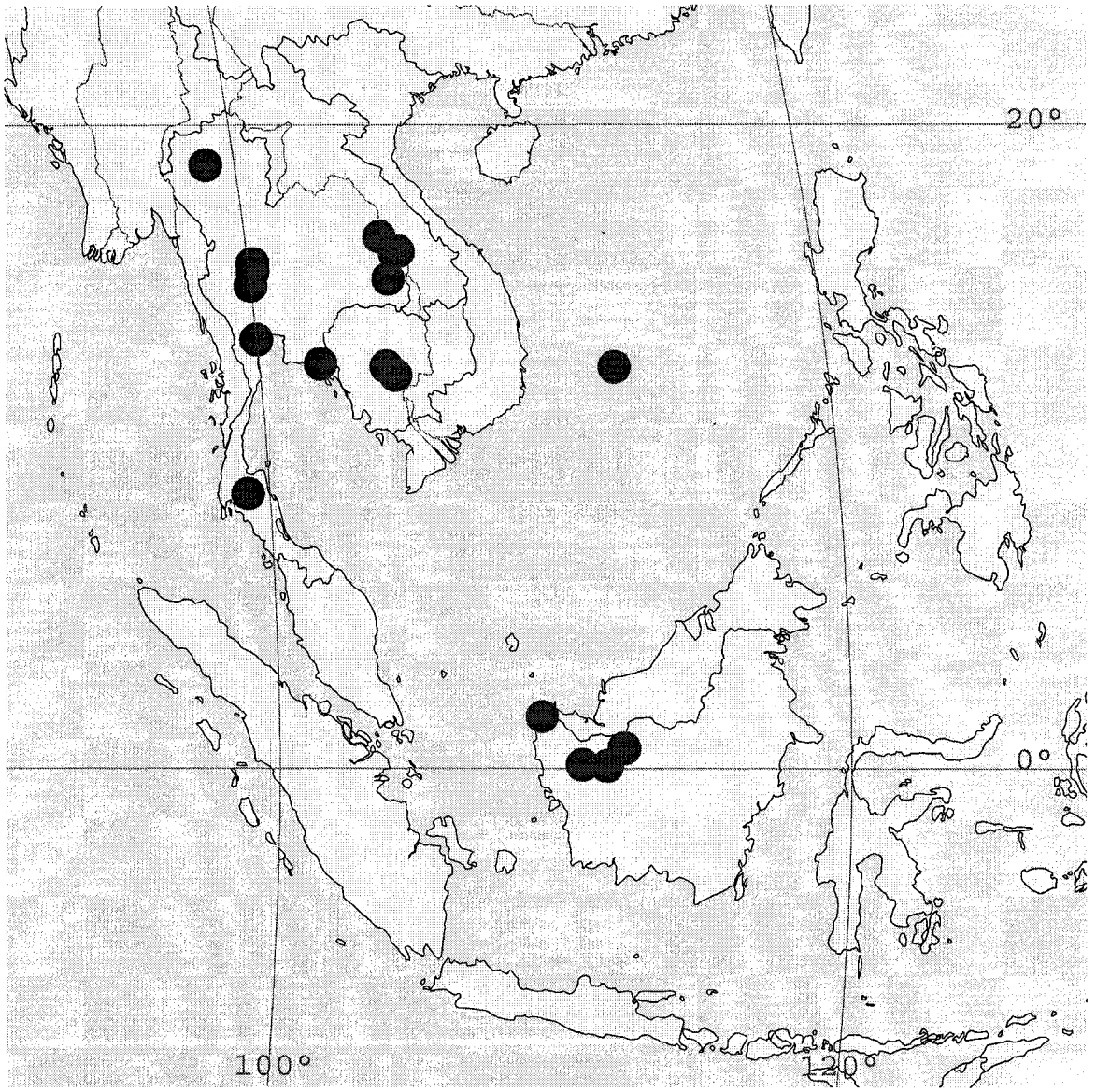

Figure 2. Geographical distribution of *Achiroides melanorhynchus* based on available coordinates of specimens examined.

Remarks

This species is unique among the *Brachirus* species complex in having rudimentary pectoral fins.

The type description of *A. melanorhynchus* (Bleeker, 1851) states that the pectoral fins are absent, while that of *Synaptura harmandi* (Sauvage, 1878) states that they are present, though small; while lengths are given, pectoral fin ray counts are not. Finally, Smith (1931) defined *Synaptura aenea* as being a transition species between *Synaptura* and *Achiroides* due to the reduction of the fins "to mere rudiments", where *Achiroides* is described as having no pectoral fins. A careful comparison of type and non-type specimens reveals similar rudimentary pectorals in all specimens and they are neither completely absent, nor present as true pectoral fins.

According to Bleeker (1870-75), *A. melanorhynchus* differs from *A. leucorhynchos* in having a black spot on the snout and a superior ray count for the dorsal (56 vs. 54) and anal fins (42 vs. 36). The first character is variable while the counts are clearly overlapping in specimens with and without the black spot.

Günther (1862) adds that *A. leucorhynchos* has a narrower interorbital space (less than the diameter of the eye) than in *A. melanorhynchus* (nearly equal to the diameter of the eye). However, the type specimen of *A. melanorhynchus* has an interorbital space that is less than the diameter of the eye, invalidating this distinguishing character. Moreover,

Günther (1862) indicates that the dorsal eye is described as being considerably in advance of the ventral eye in *A. leucorhynchos,* while only slightly in advance in *A. melanorhynchus*. This character was found to be variable in specimens that have distinct snout spotting patterns. Finally, *A. leucorhynchos* is said to have a brownish body, clouded with darker pigmentation, whereas *A. melanorhynchus* has distinct spots along the periphery of the body. Again, the examined specimens showed a great deal of variability in pigmentation patterns that could possibly be attributed to different level of alcohol bleaching.

As mentioned in Remarks, Kottelat (1984) rightly corrected errors in the original description of *Synaptura harmandi*. Kottelat (1989) identified *Synaptura achira* (Duncker 1904) as an inappropriate replacement name for *A. melanorhynchus* and *A. leucorhynchos.*

Stauch & d'Aubenton (1966) and Chabanaud (1930) have brought attention to the two distinct geographical distributions within this group, and suggested the possibility of subspecies. The geographical distribution of examined specimens supports this finding, and warrents further study due to specimens from Indonesia being somewhat geographically separated from those in Thailand, Cambodia, and Vietnam.

Comparisons

Achiroides melanorhynchus is similar in general appearance to *Brachirus*: smaller number of dorsal (51-61 vs. 53-85) and anal rays (39-46 vs. 41-65), caudal vertebrae (22-25 vs. 23-35) and precaudal vertebrae (7-9 vs. 8-12) than all other species in this study, though ranges overlap. Lack of developed pectoral fins is the defining characteristic of these fish, as well as the colouration on the b.s. and the small body size.

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CHAPTER 2

Taxonomic revision and reestablishment of *Dexillus*

(Pleuronectiformes: Soleidae)

Abstract

Dexillus (Soleidae; Pleuronectiformes) regroups *Brachirus*-like nominal species that have protruding contiguous eyes covered by a translucent membrane. There are currently four nominal species in the Soleidae with this unique morphology: *Dexillus arafurensis* Gunther 1880, *D. muelleri* Steindachner 1879, *D. megalepidoura* Fowler 1934 and *D. macrolepis* Bleeker 1858. The examination of eight type and 15 non-type specimens belonging to this species complex resulted in the recognition of three valid species. *D. arafurensis* was established as being a junior synonym of *D. muelleri*. A formal description of *Dexillus* and of its three valid species is provided.

Keywords

Dexillus, *Brachirus*, taxonomy, *muelleri*, *arafurensis*, *megalepidoura*, *macrolepis*

Résumé

Dexillus (Soleidae; Pleuronectiformes) comprend les espèces nominales du complexe d'espèces *Brachirus* qui ont les yeux contigus et recouverts d'une membrane translucide. Il y a quatre espèces nominales qui ont ce caractère: *Dexillus arafurensis*, *D. muelleri*, *D. megalepidoura* et *D. macrolepis*. Dans cette étude, l'examen de huit spécimens types et de 15 spécimens non-types a permis l'identification de trois espèces valides. *D. arafurensis* est un synonyme junior de *D. muelleri*. Une description formelle de *Dexillus* et des trois espèces valides est proposée.

Mots clés

Dexillus, *Brachirus*, taxinomie, *muelleri*, *arafurensis*, *megalepidoura*, *macrolepis*

Introduction

Dexillus was created by Chabanaud (1930). The name means "cross-eyed" for the protruding contiguous eyes. It was created to include *Synaptura macrolepis* (Günther, 1862) which showed this peculiar morphology. Among other soleid nominal species, three have this unique character: *Synaptura muelleri* Steindacher 1879, *S. arafurensis* Günther 1880, and *Brachirus megalepidoura* Fowler 1934.

Whitley (1931) considered *Dexillus* preoccupied by *Dexills,* a Diptera, and proposed the name *Dexillichthys.* This replacement was unnecessary (Eschmeyer, 2006). Whitley (1937) created *Strandichthys* to distinguish *Synaptura muelleri* from other *Synaptura* species due to its deeper body, smaller teeth, long cirri, and fewer lateral line scales than *S. commersonii,* a species now identified as *Dagetichthys commersonii* (Vachon et al, in press). Chabanaud (1938) then placed *Brachirus megalepidoura* and *Synaptura muelleri* in the subgenus *Mischommatus* (meaning: eyes on a peduncle) of *Euryglossa.* He provided a brief description of the subgenus centered on the peculiar ocular morphology. *Euryglossa* and *Synaptura* were deemed invalid by Desoutter et al. (2001) and, by default, the associated species were placed in *Brachirus*. Recently, Vachon et al. (in press) reassigned five species traditionally assigned to *Synaptura* to *Dagetichthys* Stauch & Blanc 1964. The oldest genus name available for nominal species having the protruded contiguous eyes is *Dexillus*.

This marine genus is found in the Indo-West Pacific region, mainly on the coast of the Philippines, southern New Guinea and northern Australia. It inhabits sandy substrates in depths around 30 m.

The purpose of this study is to provide the first formal description of *Dexillus* and to assess the validity of the four nominal species that share the unique characteristics of the genus.

Materials and methods

Twenty-three specimens were examined (see list of specimens in species description). *Dexillus macrolepis* was not redescribed because the type specimen is lost and non-type specimens assigned to that species were found to be misidentifications of *D. muelleri*. Counts and measurements are explained in appendix 1. Measurements were done following Hubbs and Lagler (1958), with the exception of eye diameter, which was taken on the ventral eye. Dorsal, anal and caudal fin rays, precaudal and caudal vertebrae counts and the structure of the supracranial complex were taken from radiographs. The formula for the supracranial complex was first proposed in Chapleau (1989). It is based on: [the number of pterigiophores on the most anterior neural spine] – (the number of pterigiophores on the cranium] – [the number of pterigiophores on the second most anterior neural spine][the number of pterigiophores that are between the second and third neural spine, but which are not attached to the second neural spine or touching the anterior edge of the third neural spine]. Types for *D. arafurensis*, *D. muelleri* and *D. megalepidoura* were examined. Original descriptions were consulted for all four nominal species. Abbreviations o.s. and b.s. are used for ocular side and blind side respectively.

Genus *Dexillus* Chabanaud 1930

Dexillichthys Whitley 1931 (type species by original designation *Synaptura macrolepis* Bleeker 1858)

Strandichthys Whitley 1937 (type species by original designation *Synaptura muelleri* Steindachner 1879)

Dexillus is characterized by protruding, stalked eyes encased in a thin, translucent membrane. Eye size varies among species. Body is oval and scales are large. The mouth is heavily curved downwards, and the head is deep. This genus shares many characteristics with *Brachirus* such as the joined dorsal, anal and caudal fins, the short predorsal length and the formula of the supracranial complex.

Relationship to *Brachirus*

Dexillus belongs to the *Brachirus* species complex due to a number of similarities it shares with *Achiroides*, *Brachirus,* and *Paradicula:* oval body shape joined vertical fins, shape and location of the anterior blind nostril, and formation of the supracranial complex. It distinguishes itself, however, by the proximity of the eyes to each other. Eyes in *Brachirus* are usually separated by at least one eye diameter. Without a proper phylogenetic study, however, it is difficult to define the interrelationships of these four genera.

Dexillus macrolepis (Bleeker 1858)

Synaptura macrolepis Bleeker 1858

Material examined

Holotype lost; No specimens examined.

Diagnosis

D. macrolepis has contiguous eyes which are included 10 to 12 times in HL.

Description (as provided by Bleeker 1858 – roughly translated from Dutch by author. see Appendix 3 for original description)

Body oblong, height 2 ¾ in length; head length 1 ½ in height, 5 ¾ in body length. Dextral eyes with a contiguous cuticle; eye diameter 10 to 12 times in HL; snout not ciliated; teeth sinistral; lower lip ciliated; anterior nostril on o.s. a tube; lateral line on head not curved; lateral line scale count 65 on o.s., 75 on b.s.; dorsal, anal and caudal fins united; caudal peduncle 6 ½ times in body length; left pectoral in 7 times, right 5 ½ times in body length.

B.6. D.69-70. C. 16. A. 52. Right Pec. 3-4. Left 5. Pel.3.

Added note from Bleeker 1970-75:

"The actual species is imminently distinct due to the scales which are relatively large and highly ciliated, as well as the contiguity of the eyes which seem to be implanted on the

same base and surrounded by a common circular cutaneous fold. These characters join that of the inequality of the pectorals where that of the left is longer than that of the right, the numbers of the fin rays, the system of colouration, etc."

Table 2. Morphometrics and meristics for *Dexillus macrolepis* type description. Abbreviations are defined in Appendix 1; characters 2 to 12, 16-17 are expressed in hundredths of HL, characters 1, 13-15, 18 are expressed in hundredths of SL, and 19 to 28 are meristics.

	Character	Bleeker, 1858
1.	HL	
2.	E	
3.	S	
4.	DNS	
5.	Mos	
6.	Mbs	
7.	Pred	
8.	Pecos	
9.	Pecba	
10.	Pelos	
11.	Pelbs	
12.	OD	
13.	H1	2.8 LT
14.	H2	
15.	HCP	
16.	LDR	
17.	LAR	
18.	Hdep	
19.	DR	69
20.	AR	52
21.	CR	16
22.	PecOr	3
23.	PecAR	5
24.	PelOR	3
25.	PelAR	3
26.	CV	
27.	PCV	
28.	LL	65

Remarks

Although I was not able to examine any specimens of *D. macrolepis,* it is clear from the literature that it is a distinct species from *D. muelleri* and *D. megalepidoura* due to the small eyes 10-12 times in HL. All other species of *Dexillus* have eyes that are less than 8 times in HL.

Dexillus megalepidoura (Fowler 1934)

Brachirus megalepidoura Foweler 1934

Material examined

D. megalepidoura: USNM 93081, Holotype(196.99 mm SL), 11 04' 18" N 125 05' 30" E, Off east coast of Leyte Is. Mariquitdaquit Id., N. 88 degreegs E., 350 miles, 27.4 m. USNM 93552, 2 Paratypes(201.68- 218.94 mm SL), 13 57' 42" N 123 06' 42" E, East coast of Luzon. san Bernardino strait to San Miguel Bay, Caringo Id. (W.), N. 12 deg. W., 4.9 miles, 20.1m, USNM 93553, 2 Paratypes(103.24- 155.17 mm SL), 11 04' 18" N 125 05' 30" E, Off east coast of Leyte Is. Mariquitdaquit Id., N. 88 degreegs E., 350 miles, 27.4 m, USNM 93554, Paratype(101.33 mm SL), 11 45' 25" N 124 48' 05" E, Western Samar: Taratara Id. (N.), S. 53 degrees W., 1.80 miles, 36.6 m. CAS 139266, 2(117.87-168.96 mm SL), Dagat-Dagatan Exp. Station, Navones, Rizal Provence, Philippines

Diagnosis

D. megalepidoura can be distinguished from other *Dexillus* species by the large scales on the o.s. just posterior to the middle of the body, by the smaller height of the caudal peduncle (17.5 time in standard length), by the shape of the anterior nostril on the b.s. which is surrounded by an intricate fringe of cirri, and by the large eyes (5.5 times in HL).

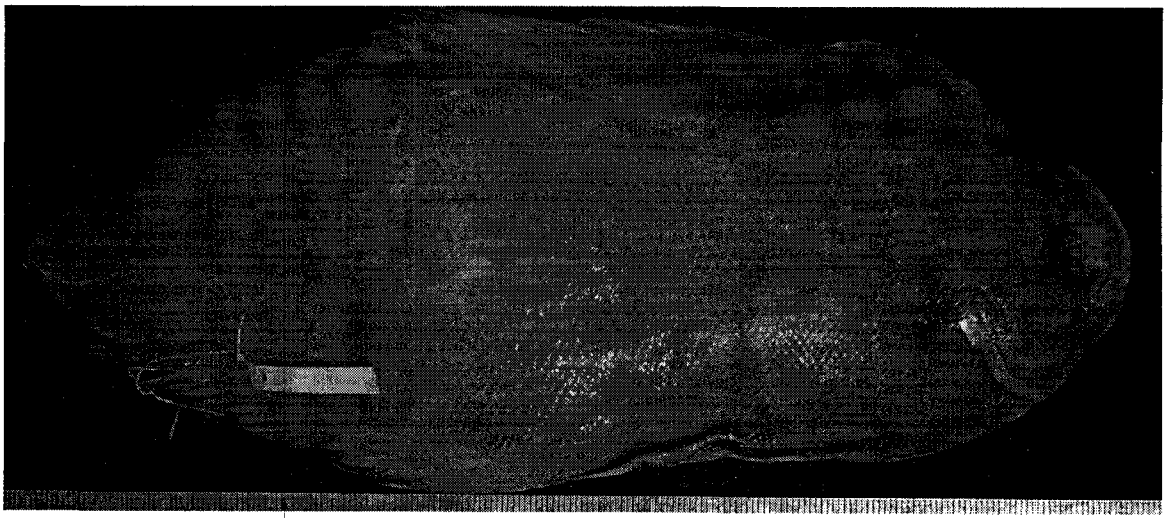

Figure 3. Photo of *Dexillus megalepidoura* CAS139266. 168.76 mm SL.

Description

Refer to table 3. Body large and oblong, head short and slightly pointed. O.s. corner of mouth reaches anterior edge of ventral eye. O.s. anterior nostril a thick, fleshy tube of medium length; posterior nostril a short thin tube lying against anterior edge of ventral eye. B.s. anterior nostril a hole surrounded by intricate fringe of cirri; posterior nostril a simple hole slightly posterior and dorsal to anterior but not surpassing corner of mouth. Few, thickened cirri restricted to snout region of b.s. of head. Scales ctenoid; found on proximal half of vertical rays. Larger scales located just posterior to mid-body on both b.s. and o.s. Dark, long, thickened cirri present in patches on o.s. excluding head; prominent patch of cirri located half way down and on lateral line. Small cirri present on lips, more commonly on bottom lip and corner of mouth though sometimes found on upper lip. Teeth minute and found only on b.s. lower jaw. Large eyes, raised on stalks, joined under a common clear membrane, no scales present between them. Anus located at base of last pelvic ray on b.s.; urinary papillae located slightly on o.s. and just anterior of first anal ray. Dorsal fin ray count 61-65, anal fin ray count 45-50, caudal fin ray

count 14, pectoral fin ray count 5 on right side, 3-5 on left; pelvic fin ray count 5 on right, 3-5 on left. Dorsal, anal and caudal fins united, anterior end of dorsal fin approaching anterior edge of upper lip. Total vertebrae 40-41: 31-32 caudal and 9 precaudal, lateral line scales 65-80. Average supracranial pterigiophores 8 of the formula 4-0-3(1) (range of [(3-4)-0-(3-4)(1)]) (for description of formula see Methods).

Table 3. Morphometrics and meristics for *Dexillus megalepidoura* holotype USNM 93081, paratypes USNM 93552, USNM 93553, USNM 93554, and all non-type material. Abbreviations are defined in Methods section; characters 2 to 12, 16-17 are expressed n hundredths of HL, characters 1, 13-15, 18 are expressed in hundredths of SL, and 19 to 28 are meristics.

	Character	Fowler, 1934	Holotype	Paratypes	non-type
1.	HL	4.9	6.4	4.8(4.7-5.1)	4.4(4.3-4.6)
2.	E	5.7	5.5	6.4(5.7-7.7)	7.6(7.2-7.9)
3.	S	3.6	2.6	3.5(3.2-3.9)	3.3(3.1-3.4)
4.	DNS		4.2	6.0(5.6-6.6)	5.3(4.8-5.9)
5.	Mos	2.8	2.4	3.4(3.1-3.8)	3.5(3.4-3.6)
6.	Mbs		3	3.7(3.6-3.8)	3.7
7.	Pred		3.7	5.6(4.6-6.7)	5.0(4.1-5.8)
8.	Pecos		5.3	7.4(6.7-8.6)	7.8(7.7-8.0)
9.	Pecba		5.7	7.3(5.5-8.6)	6.6(5.7-7.5)
10.	Pelos		2.4	2.7(2.4-3.0)	3.2(3.2-3.3)
11.	Pelbs		3	3.8(3.7-4.1)	4.3(4.1-4.6)
12.	OD		2.8	3.9(3.4-4.9)	3.5(3.5-3.6)
13.	H1	2.4	2.2	2.3(2.1-2.5)	2.2(2.2-2.3)
14.	H2		3.3	3.3(3.0-3.6)	3.4(3.1-3.7)
15.	HCP		15.3	17.5(14.7-19.9)	21.4(21.0-21.8)
16.	LDR		1.6	1.7(1.4-1.8)	1.6(1.6-1.7)
17.	LAR		1.3	1.7(1.6-2.1)	1.6(1.5-1.7)
18.	Hdep		3.9	3.9(3.7-4.0)	3.9(3.5-4.4)
19.	DR	60	61	63(61-65)	
20.	AR	49	45	48(46-50)	
21.	CR		14	14	
22.	PecOr		5	5	5
23.	PecAR		5	4(3-4)	4(3-4)
24.	PelOR		5	5	5
25.	PelAR		5	4(3-5)	4(3-5)
26.	CV		32	31(31-32)	
27.	PCV		9	9	
28.	LL	64	76	76(72-80)	70(65-75)

Colour in Alcohol

On o.s.: body a uniform golden to dark brown, patch of dark cirri just posterior to mid-body; five small black spots on the posterior where the vertical rays meet the body, two on the dorsal, one on the caudal and two on the anal. On b.s.: body pale golden, web of white lines covering head, fins uncoloured, basal edge of vertical fins white.

Geographic Distribution

Indo-West Pacific: The Philippines.

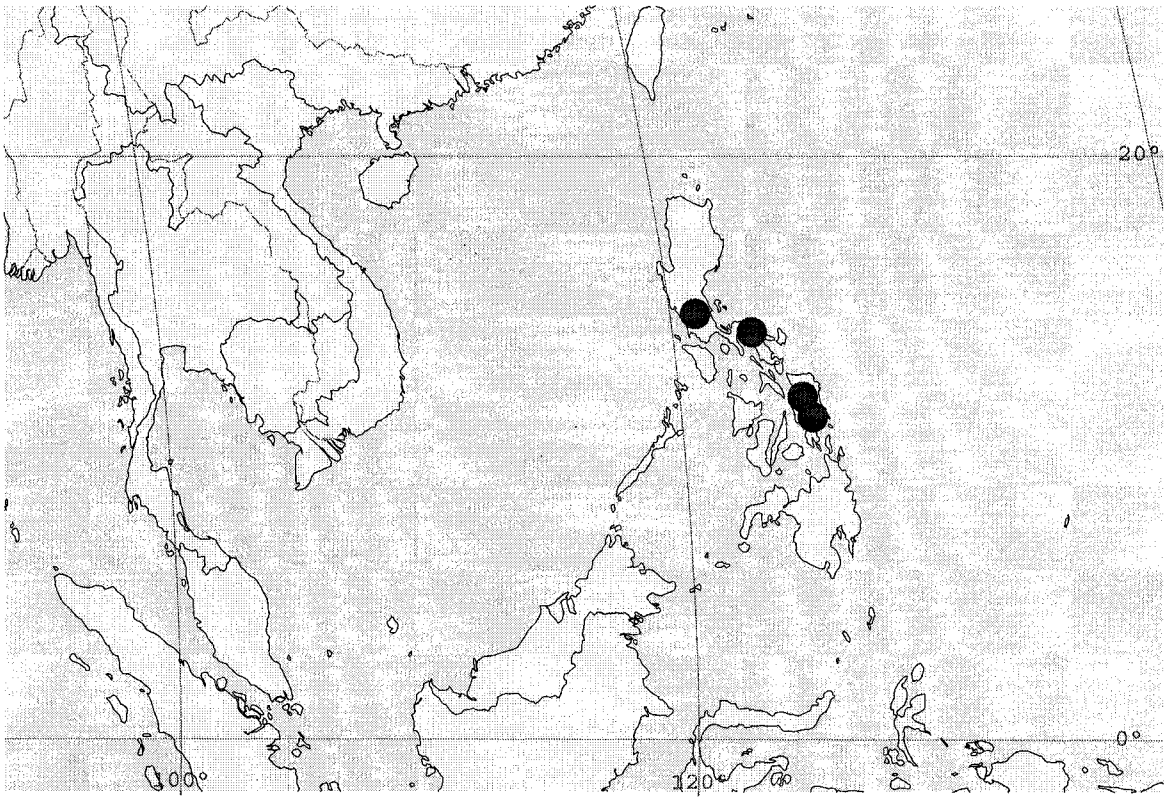

Figure 4. Geographical distribution of *Dexillus megalepidoura*

Comparisons

This species is most closely related to *Dexillus muelleri*; Chabanaud (1938) considered it as a subspecies of *Dexillus muelleri* based on three specimens. *D. megalepidoura* is distinguishable by the enlarged scales on the flank. The geographical locations of these species are distinct as well with *D. megalepidoura* located around the Philippines while *D. muelleri* is located around northern Australia and southern New Guinea.

This species can also be distinguished from *D. macrolepis* by the size of the eyes in relation to the head. The eyes of *D. macrolepis* are much smaller, according to the type description by Bleeker (1858). Bleeker (1870-75) describes *B. macrolepis* as highly ciliated, having the left pectoral longer than the right, and identifies differences in the number of fin rays, and in the colouration pattern (see species description).

Fowler (1934) draws a clear distinction between *Dexillus megalepidoura* and *D. macrolepis*. The former is described as having much smaller scales on the head, and large scales along the medial axis of the body. The scales on the lower half of the vertical fins are small and crowded, and the small dark spots on the right side of the body and on the fins are due to darkly coloured cirri.

Dexillus muelleri (Steindachner 1879)

Synaptura muelleri Steindachner 1879

Synaptura arafurensis Günther 1880

Material examined

Dexillus muelleri: SMNS 2278, Holotype (154.44 mm SL), 19 16'S, 146 48'E.

S. arafurensis: BMNH 1879.5.14.69, Holotype (91.19 mm SL), Arafura Sea, Papau New Guinea.

SMNS 2454, 1(133.75 mm SL), 16 50'S, 142 15'E, BMNH 1925.7.22.74-75, 2(119.43-155.29 mm SL), -20 miles North East of Gloucester Head, Queensland, Coral Sea, AMIB.5846, 1(145.32 mm SL), 19 S, 146 E, AMIA.1302, 1(102.71 mm SL), Bowen Harbour, AMIA.2998, 1(157.96 mm SL), Off Gloucester Head: 4-20 miles NE of Head, AMIA.2997, 1(169.32 mm SL), Off Gloucester Head: 4-20 miles NE of Head, AMIA.6714, 1(199.63 mm SL), Cumberland Is. Group: Shaw Is., AMIA.6740, 1(105.70 mm SL), Off Shaw Is., AMI.21640-009, 1(157.86 mm SL), N.W. Shelf, W.A., AMI.15557-068, 1(140.82 mm SL), 16 51'S, 139 32'E, AMIB.5439, 1(141.50 mm SL), 19 16'S, 146 49'E, AMI.21957-005, 1(221.44 mm SL), Arafura Sea, N.T., CAS 139266, 2(117.87-168.96 mm SL), Dagat-Dagatan Exp. Station, Navones, Rizal Provence, Philippines

Common Names

Dadale (Ganaden & Lavapie-Gonzales, 1999)

Tufted sole (Sainsbury, Kailola & Leyland, 1985)

Diagnosis

Dexillus muelleri can be distinguished from other *Dexillus* species by its small pectoral fins, eyes that are fit 5.4-8.0 times in HL, and uniform scale size.

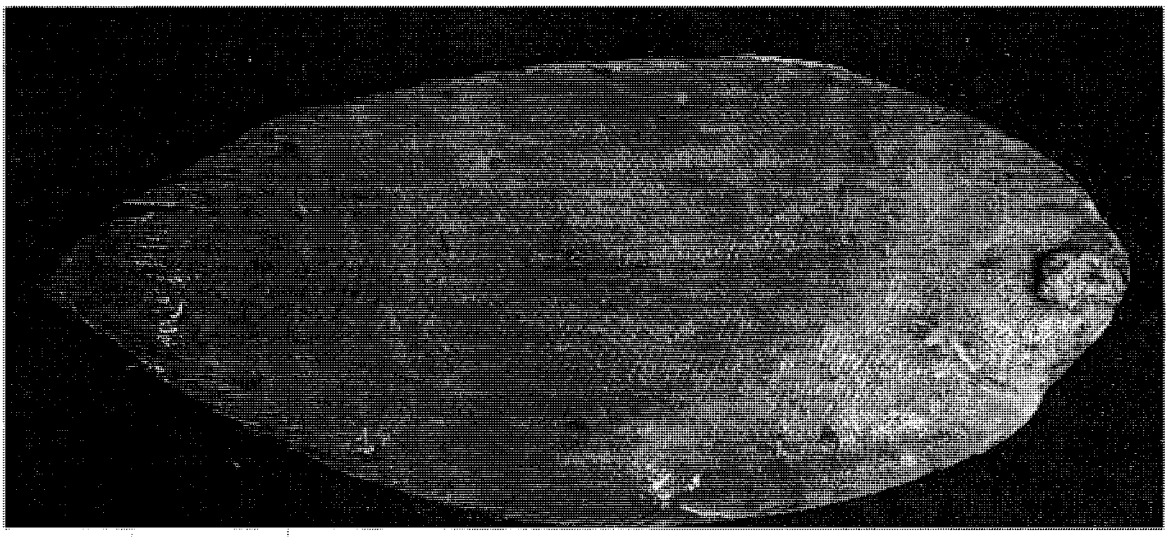

Figure 5. Photo of *Dexillus muelleri* holotype SMNS 2278. 154.44 mm SL.

Description

Refer to table 4. Body large (91-221 mm SL) and oval, head short and slightly pointed. O.s. corner of mouth reaches anterior edge of ventral eye. O.s. anterior nostril a thick, fleshy tube of medium length, posterior nostril a short thin tube lying on anterior edge of ventral eye. B.s.: anterior nostril is a hole surrounded by an intricate fringe of cirri; posterior nostril not easily identified, a simple hole slightly posterodorsal to anterior. Few thickened cirri restricted to snout region of b.s. of head. Scales ctenoid; found on proximal half of vertical rays. Scales of uniform size on body. Dark, long, thickened cirri in patches on o.s. excluding head; prominent patch of cirri located mid-way along

lateral line. Small cirri on lips, more commonly on bottom lip and corner of mouth, occasionally on upper lip. Teeth minute and present only on b.s. lower jaw. Large stalked eyes joined under a clear membrane without an interobital space. Anus located at base of posteriormost b.s pelvic ray; urinary papillae located slightly on o.s. and just anterior to first anal ray. Dorsal fin ray count 62-72, anal fin ray count 47-57, caudal fin ray count 13-15, pectoral fin ray count 5-6 on right side, 4-6 on left; pelvic fin ray count 4-5 on right, 3-5 on left. Dorsal, anal and caudal fins united, anterior end of dorsal fin approaching anterior edge of upper lip. Total vertebrae 40-43: 31-33 caudal and 9-10 precaudal, lateral line scales 68-86. Supracranial pterigiophores 8 of the formula 4-0-4(1) [(3-5)-0-(3-4)(1)].

Table 4. Morphometrics and meristics for *Brachirus arafurensis* holotype BMNH 1879.5.14.69, *Dexillus muelleri* holotype BMNH 1880.4.21.186, and all non-type material. Abbreviations are defined in Appendix 1; characters 2 to 12, 16-17 are expressed in hundredths of HL, characters 1, 13-15, 18 are expressed in hundredths of SL, and 19 to 28 are meristics.

		arafurensis		*muelleri*	
	Character	Günther, 1880	Holotype	Holotype	non-type
1.	HL	5 TL	4.6	4.8	4.8 (4.4-5.2)
2.	E		6.3	6.8	6.9 (5.4-9.6)
3.	S		2.7	3.1	3.1 (2.6-3.5)
4.	DNS		4.4	5.2	5.2 (3.6-7.6)
5.	Mos		3.5	3.8	3.3 (2.6-3.8)
6.	Mbs		2.9	4.0	3.4 (2.8-4.0)
7.	Pred		8.8	4.3	5.0 (2.7-6.1)
8.	Pecos	6	4.7	5.2	6.1 (4.3-9.8)
9.	Pecba		6.8	5.1	6.9 (4.1-10.5)
10.	Pelos		2.5	3.0	3.0 (2.3-3.7)
11.	Pelbs	3	3.3	3.3	3.5 (3.1-5.0)
12.	OD		3.6	3.5	3.5 (3.0-4.1)
13.	H1	2.5 TL	2.3	2.1	2.2 (2.1-2.3)
14.	H2		3.5	3.3	3.2 (2.9-3.6)
15.	HCP		10.8	12.3	13.3 (10.9-15.6)
16.	LDR		1.8	1.9	2.0 (1.6-3.2)
17.	LAR		1.5	1.7	2.0 (1.6-3.1)
18.	Hdep		3.5	4.3	3.7 (3.3-4.3)
19.	DR	65	66.0		66(62-72)
20.	AR	52	52.0		51(47-57)
21.	CR		15.0		14(13-15)
22.	PecOr	6	6.0	5.0	6(5-6)
23.	PecAR	6	6.0	6.0	6(4-6)
24.	PelOR		5.0	5.0	5(4-5)
25.	PelAR		5.0	4.0	5(3-5)
26.	CV		33.0		32(31-33)
27.	PCV		10.0		10(9-10)
28.	LL	100	69.0	78.0	77(68-86)

Colour in Alcohol

O.s. a uniform pale to dark brown, occasionally with paler spots, and dark cirri creating patches of black pigmentation on the body; head generally with dark spots; small dark

pigmented patches along the periphery of body; one large cirri patch situated centrally on lateral line; smaller patches on vertical fins; pectoral fin darker brown. On b.s.: body pale brown, with head whitish and fins uncoloured.

Geographic Distribution

Indo-West Pacific: Sri Lanka to Samoa and Tonga, north to the Philippines, south to Northern Australia.

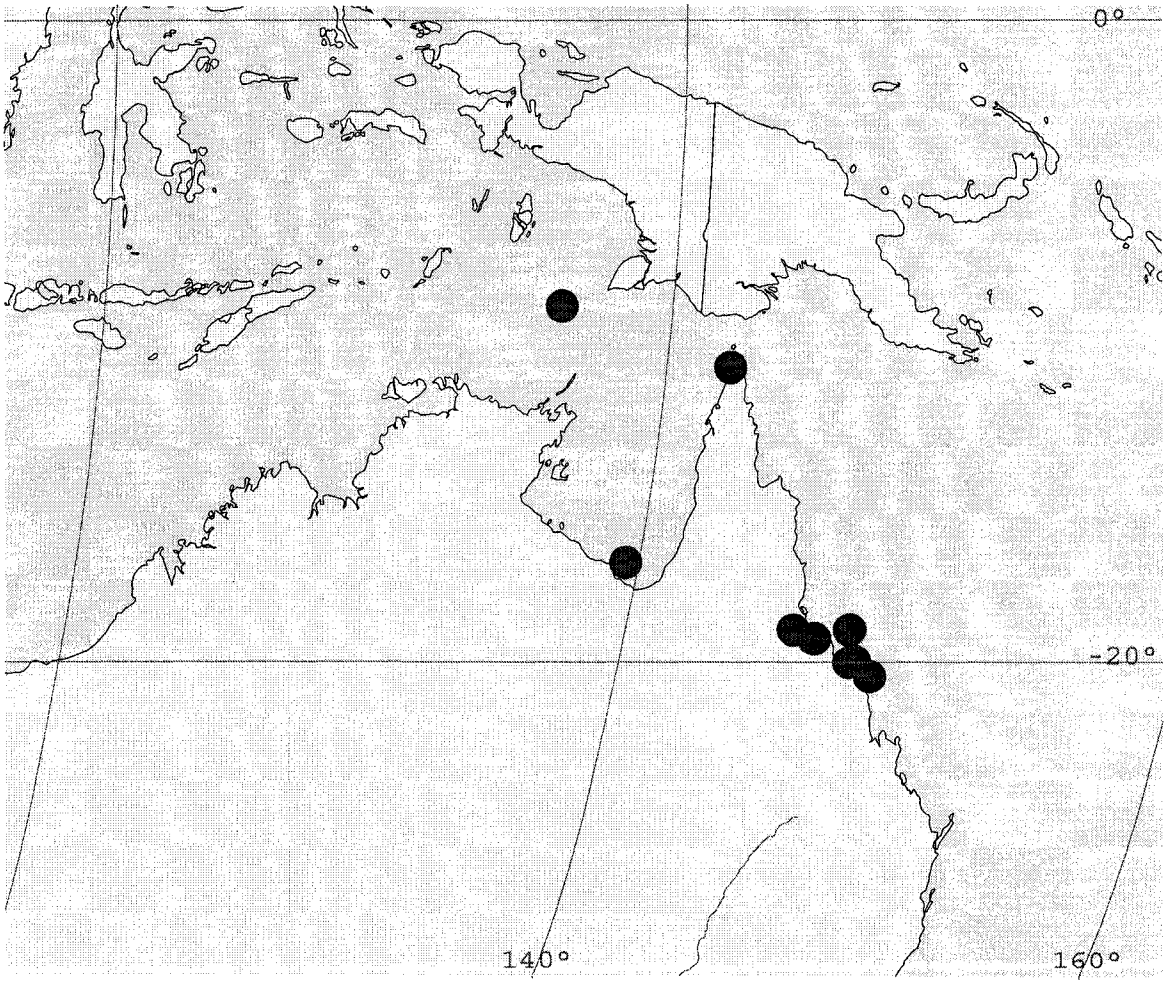

Figure 6. Geographical distribution of *Dexillus muelleri*

Remarks

This genus is unique among the *Brachirus* species complex in having contiguous eyes. Fowler (1934) draws a clear distinction between *Brachirus megalepidoura* and *B. macrolepis*. *B. megalepidoura* is described as having much smaller scales on the head, and large scales along the medial axis of the body. The scales on the proximal half of the vertical fins are small and crowded, and the small dark spots on the o.s. of the body and fins are due to darkly coloured cirri. Bleeker (1870-75) describes *B. macrolepis* as having a highly ciliated body on the o.s., having the left pectoral longer than the right, having 69 dorsal fin rays, 16 caudal fin rays, and a distinct colouration pattern.

Chabanaud (1938) indicated that *D. megalepidoura* was a subspecies of *D. muelleri* based on three specimens which were said to belong to a distinct austral form. Specimens from D. *megalepidoura* were said to differ from *muelleri* by the smaller scales on the head and larger scales along the lateral line. Other differences included height of the caudal peduncle (10.8-15.6 times in standard length for *D. muelleri* rather than 14.7-21.8 for *D. megalepidoura*) and geographical distribution.

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CHAPTER 3

Taxonomic revision and redescription of *Paradicula*

(Pleuronectiformes: Soleidae)

Abstract

Paradicula (Soleidae; Pleuronectiformes) groups *Brachirus*-like nominal species that have a fused opercular opening to the body excluding in proximity to the pectoral fins. There is currently one nominal species in the Soleidae with this unique morphology: *Paradicula setifer* Paradice & Whitley 1927. The examination of seven non-type specimens belonging to this species complex resulted in the recognition of one valid species.

Keywords

Paradicula, *Brachirus*, taxonomy, *setifer*

Résumé

Paradicula (Soleidae; Pleuronectiformes) regroupe les espèces nominales du complexe d'espèces *Brachirus* qui ont la peau de l'opercule fusionnée au corps à l'exception d'une petite ouverture operculaire près des nageoires pectorales. Il y a actuellement une espèce nominale dans les Soleidae qui présente ce caractère: *Paradicula setifer*. Une révision du genre et de la seule espèce valide est realisée en examinant sept spécimens non-types.

Mots clés

Paradicula, Brachirus, taxinomie, *setifer*

Introduction

Paradicula (Soleidae; Pleuronectidae) was first created by Whitley (1931). It included *Synaptura setifer* (Paradice & Whitley 1927) as type species, and was used as a replacement name for *Whitleyia* Chabanaud (1930) which was preoccupied by *Whitleyia* Fowler and Bean (1930) for an ambassid fish. The species within *Paradicula* have widely separated opercular opening that are restricted through fused skin to a small aperture near the pectoral fins (Chabanaud 1930). This species is found in the Western Central Pacific region, from Northern Australia to Papua New Guinea.

The purpose of this study was to provide a formal definition of the monotypic *Paradicula*.

Materials and methods

Seven specimens were examined (see list of specimens in species description). Counts and measurements are explained in Appendix 1. Measurements were done following Hubbs and Lagler (1958), with the exception of eye diameter, which was taken on the ventral eye. Dorsal, anal and caudal fin rays, precaudal and caudal vertebrae counts and the structure of the supracranial complex were taken from radiographs. The formula for the supracranial complex was first proposed in Chapleau (1989). It is based on: (the number of pterigiophores on the most anterior neural spine) – (the number of pterigiophores on the cranium) – (the number of pterigiophores on the second most anterior neural spine)(the number of pterigiophores that are between the second and third neural spine, but which are not attached to the second neural spine or touching the anterior edge of the third neural spine). The holotype for *P. setifer* was not examined.

Original type description (Paradice & Whitley, 1927) was consulted for this species. Abbreviations o.s. and b.s. are used for ocular side and blind side respectively.

Paradicula Whitley 1931

An oval soleid with a strongly rounded head, small eyes and small pectoral and pelvic fins. The main defining characteristic is the fused operculum opening to the body except for a posterodorsal aperture near the pectoral fin.

Remarks

Paradicula was created as a new genus by Whitley (1931) to accommodate the species *Synaptura setifer* (Paradice & Whitley 1927). Whitley (1931) did not describe the genus.

Relationship to *Brachirus*

Paradicula belongs to the *Brachirus* species complex due to a number of similarities it shares with *Achiroides, Brachirus* and *Dexillus:* oval body shape joined vertical fins, shape and location of the anterior blind nostril and the supracranial complex is similar. Without a proper phylogenetic study, however, it is difficult to define the interrelationships of these four genera.

Paradicula setifer (Paradice & Whitley 1927)

Synaptura setifer Paradice & Whitley 1927

Material examined

AMNH 218933, 4(85.08-91.57 mm SL), CSIRO H 4931-01, 1(127.6 mm SL), Irian Jaya, Mawati River estuary; CSIRO H 4696-01, 1(143.95 mm SL), Irian Jaya, main ajkwa river estuary.

Diagnosis

Paradicula setifer is unique among soleids in having a partial fusion of the gill covers to the body except for a short section near the pectoral fins. Otherwise, this species exhibits all the characteristics of the *Brachirus* species complex.

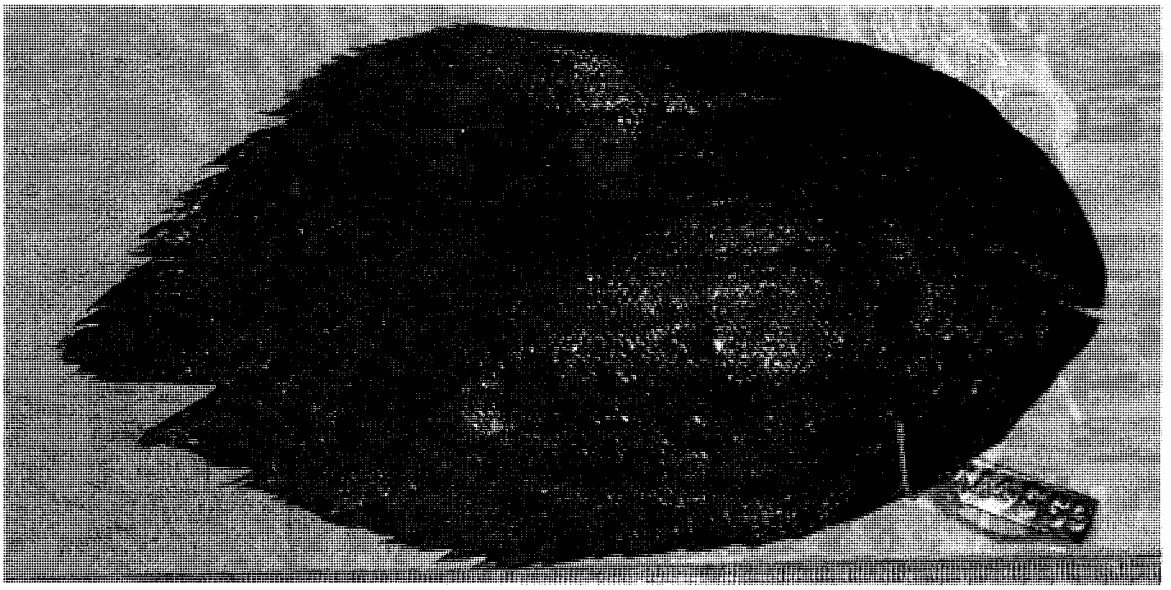

Figure 7. Photo of *Paradicula setifer* AMIA4369. 164.68 mm SL.

Description

Refer to table 5. Body oval, head short and heavily rounded. O.s. corner of anterior edge of mouth reaches 1/3 past anterior edge of ventral eye. O.s. anterior nostril is a tube of medium length, narrow and slightly curved anteriorly; posterior nostril a short, wide thin-skinned tube lying against anterior edge of ventral eye. B.s. anterior nostril a tiny hole surrounded by intricate fringe of cirri; posterior nostril a deep trench terminating in a large vertical hole slightly dorsal and in line with corner of mouth, covered by flaps of cirri. Opercular covers fused to body except for a short slit at level of pectoral fins. Operculum with flap over fused portion. Thickened cirri present on most of b.s. of head, more numerous around edges. Scales ctenoid; proximal half of vertical rays covered by small scales. Long, thin, dark cirri in patches over body. Small cirri around mouth and around nostrils on o.s. Teeth minute and found only on b.s. lower jaw. Dorsal eye in advance of lower by about half its diameter; interorbital space about equal to one and a half eye diameter. Right pectoral fin longer than left. Right pelvic fin joined to anal. Caudal fin rounded. Anus located at base of last pelvic fin ray on b.s.; urinary papillae located at base or slightly to o.s. of first anal fin ray. Dorsal fin ray count 69-77, anal fin ray count 53-61, caudal fin ray count 14-15, pectoral fin ray count 4-6; pelvic fin ray count 4. Dorsal, anal and caudal fins united, anterior end of dorsal fin approaching anterior edge of upper lip. Total vertebrae 41-42: 32-33 caudal and 8-10 precaudal; lateral line scales: 82-89. Supracranial pterigiophores 8 of the formula 3-0-4(1) [(3-4)-0-(3-4)(1)](for description of formula see Methods).

Table 5. Morphometrics and meristics for *Paradicula setifer* non-type material. Original description of Paradice & Whitey (1927) does not provide any morphological mertistic data. Abbreviations are defined in Appendix 1; characters 2 to 12, 16-17 are expressed in hundredths of HL, characters 1, 13-15, 18 are expressed in hundredths of SL, unless otherwise stated, and 19 to 28 are meristics.

	Character	non-type
1.	HL	4.6(4.4-5.1)
2.	E	9.8(8.9-11.2)
3.	S	3.0(2.8-3.1)
4.	DNS	4.3(3.6-4.9)
5.	Mos	3.1(3.0-3.4)
6.	Mbs	3.8(3.4-4.4)
7.	Pred	4.6(2.7-6.1)
8.	Pecos	5.4(4.3-5.9)
9.	Pecbs	4.9(4.1-5.8)
10.	Pelos	3.3(2.9-3.7)
11.	Pelbs	3.4(3.1-3.9)
12.	OD	3.6(3.3-4.1)
13.	H1	2.1(2.0-2.3)
14.	H2	3.0(2.8-3.2)
15.	HCP	13.6(9.2-18.2)
16.	LDR	2.4(1.7-3.2)
17.	LAR	2.5(1.9-3.1)
18.	Hdep	3.6(3.3-4.0)
19.	DR	72(69-77)
20.	AR	56(53-61)
21.	CR	15(14-15)
22.	PecOr	5(4-6)
23.	PecAR	5(4-6)
24.	PelOR	4
25.	PelAR	4
26.	CV	33(32-33)
27.	PCV	9(8-10)
28.	LL	84(82-89)

Colour in Alcohol

On o.s.: body pale mocha brown with darker patches made up of dark, thin cirri; lips and nostrils brown; thin vertical bars at right angles to the lateral line; pectoral fin dark

brown; speckled brown bars observed along the periphery of the body and continuing onto the vertical fins. On b.s.: body tan, snout region slightly darker; vertical fins edged with brown while the tips of the fins are white.

Geographic Distribution

Western Central Pacific, Northern Australia to Papua New Guinea

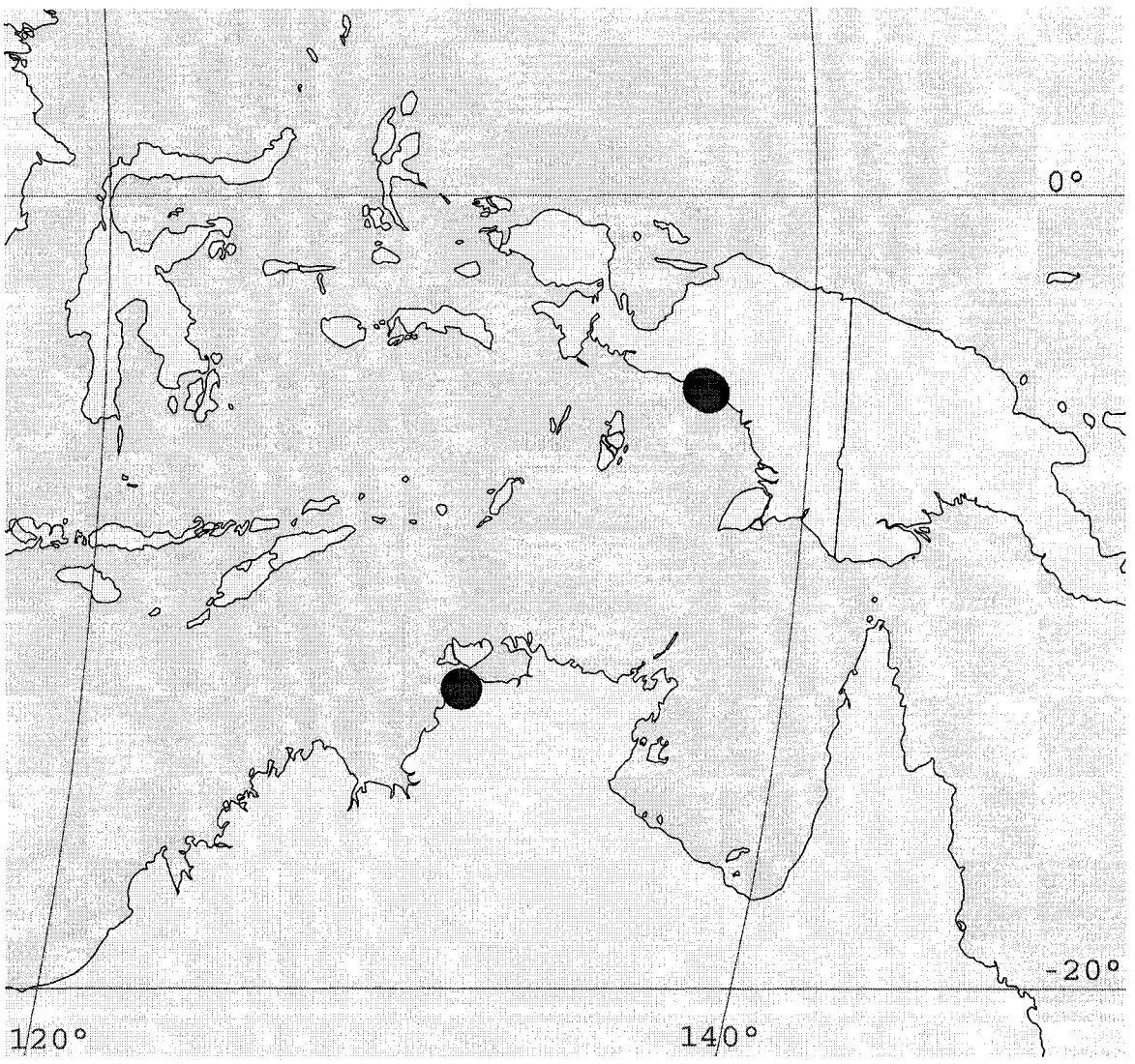

Figure 8. Geographical distribution of *Paradicula setifer*

Remarks

Paradicula setifer is unique in the *Brachirus* species complex due to the fused operculum and is thus the only species within this genus. *P. setifer* strongly resembles *B. orientalis* in shape and colour, though the caudal vertebrae (32-33 and 29-31 respectively) and caudal fin ray counts (14-15 and 17-20 respectively) are significantly different

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CHAPTER 4

Taxonomic revision and redescription of the genus *Brachirus*

(Pleuronectiformes: Soleidae)

Abstract

Brachirus (Soleidae; Pleuronectiformes) has 41 nominal species, but 17 are shown to belong to other genera. The examination of 19 type and 483 non-type specimens belonging to this species complex resulted in the recognition of 14 valid species: *B. aspilos* Bleeker 1852 (synonyms: *B. heterolepis* Bleeker 1856, *B. marmorata* Bleeker 1853, and *B. sorsongonensis* Evermann & Seale 1907), *B. sundaicus* Bleeker 1870-75 (synonyms: *B. cinerea* De Vis 1883 and *B. nigra* MacLeay,1880), *B. selheimi* MacLeay 1882 (synonymes: *B. salinarum* Ogilby 1910, and *B. villosus* Weber 1907), *B. foliacea* (Günther 1862) (synonym: *Synaptura filamentosa* Sauvage 1878), *B. siamensis* (Sauvage 1878) (synonyms: *Synaptura krempfi* Durand 1940 and *Chabanaudetta smithi* Joglekar 1971), *B. breviceps* Ogilby 1910, *B. cinerascens* (Günther 1862), *B. fitzroiensis* (De Vis 1882), *B. orientalis* (Bloch & Schneider 1801), *B. pan* (Hamilton 1822), *B. panoides* (Bleeker 1851), *B. dicholepis* Peters 1877, *B. swinhonis* Steindachner 1867 and *B. canus* Gray 1854. A formal description of *Brachirus* and of its 14 valid species is provided.

Keywords

Brachirus, taxonomy, *aspilos, sundaicus, orientalis, siamensis, selheimi*

Résumé

Le genre *Brachirus* (Soleidae; Pleuronectiformes) regroupe toutes les espèces du complexe d'espèces *Brachirus* qui n'appartiennent pas aux genres *Achiroides*, *Dexillus* et *Paradicula*. Ce groupe contient 41 espèces nominales. L'examen de 19 spécimens types et 483 spécimens non-types appartenant à ce complexe d'espèce à permis de valider 14 espèces: *B. aspilos* Bleeker 1852 (synonymes: *B. heterolepis* Bleeker 1856, *B.*

marmorata Bleeker 1853, et *B. sorsongonensis* Evermann & Seale 1907), *B. sundaicus* Bleeker 1870-75 (synonymes: *B. cinerea* DeVis 1883 et *B. nigra* MacLeay,1880), *B. selheimi* MacLeay 1882 (synonyme: *B. salinarum* Ogilby 1910, et *B. villosus* Weber 1907), *B. foliacea* Richardson 1846 (synonyme: *B. filamentosa* Sauvage 1878), *B. pan* Hamilton 1822 (synonyme: *B. canus* Gray 1854), *B. siamensis* Sauvage 1878 (synonymes: *B. krempfi* Durand 1940 et *B. smithi* Joglekar 1971), *B. breviceps* Ogilby 1910, *B. cinerascens* Gunther 1862, *B. fitzroiensis* DeVis 1882, *B. orientalis* Bloch & Schneider 1801, *B. panoides* Bleeker 1851, *B. dicholepis* Peters 1877, *B. swinhonis* Steindachner 1867 et *B. canus* Gray. Une description formelle de *Brachirus* et des 14 espèces valides est fournie.

Mots clés

Brachirus, taxinomie, *melanorhynchus*, *aspilos, sundaicus, orientalis, siamensis, selheimi*

Introduction

Brachirus was created as a subgenus of *Solea* by Swainson (1839) and included the species *orientalis* Bloch & Schneider 1801, which was designated as type species of *Brachirus* by Swain 1882, among others. *Brachirus* was defined as having two pectoral fins and the general structure of *Solea* but with the dorsal, caudal and anal fins joined. At the same time, Swainson (1839) created *Brachyrus* as a member of Scorpaenidae. Cantor (1849) unnecessarily proposed *Synaptura* as a replacement for *Brachirus* due to its apparent preoccupation as *Brachyurus* Fischer 1808 in Mammalia. Bleeker (1875) subsequently differentiated *Synaptura* from *Brachirus*. Chabanaud (1938) proposed *Euryglossa* Kaup 1858 as a replacement for *Brachirus* after incorrectly indicating that *Brachirus* was preoccupied. *Euryglossa* Kaup, however, was itself preoccupied in the Hymenoptera, and is therefore invalid. Kottelat (1998) indicated that *Brachirus* is a valid genus name due to the distinct spelling from *Brachyrus*. *Brachirus* remains a valid Soleid taxon while *Synaptura* has become an objective synonym of *Brachirus* (Desoutter et al. 2001).

The purpose of this study was to verify the validity of the nominal species within *Brachirus*. Of the original six species within *Brachirus,* two (*B. orientalis* and *B. pan*) remain valid. Since the original designation of species within *Brachirus* by Swainson (1839), many additional species have been placed within *Brachirus* resulting in 41 nominal species. Of these nominal species, eight have been excluded from this study because they belong to groups outside the scope of this study (see Appendix 2), four are placed in *Achiroides*, four in *Dexillus*, and one in *Paradicula*. This study includes a re-description of each valid species of *Brachirus*. A re-description of *B. canus, B.*

dicholepis and *B. swinhonis* could not be conducted due to types being lost or in locations from which they could not be obtained. Their inclusion in *Brachirus* was based upon the type descriptions of Gray (1854), Peters (1877) and Steindachner (1867), respectively.

This is a wide-ranging genus within the Indo-Pacific region, from Iraq to China and south to Australia.

Materials and methods

Five hundred and two specimens were examined; 39 *Brachirus aspilos*, one *B. breviceps*, 35 *B. cinerascens*, one *B. fitzroiensis*, 48 *B. foliacea*, 53 *B. orientalis*, 19 *B. pan*, 40 *B. panoides*, 28 from *B. siamensis*, 96 *B. sundaicus*, and 142 *B. selheimi* (see list of specimens in species description). No material for *B. canus, B. dicholepis* or *B. swinhonis* was available. Counts and measurements are explained in appendix 1. Measurements were done following Hubbs and Lagler (1958), with the exception of eye diameter, which was taken on the ventral eye. Dorsal, anal and caudal fin rays, precaudal and caudal vertebrae counts and the structure of the supracranial complex were taken from radiographs. The formula for the supracranial complex was first proposed in Chapleau (1989). It is based on: [the number of pterigiophores on the most anterior neural spine] – [the number of pterigiophores on the cranium] – [the number of pterigiophores on the second most anterior neural spine][the number of pterigiophores that are between the second and third neural spine, but which are not attached to the second neural spine or that are touching the anterior edge of the third neural spine]. Types for *Synaptura aspilos*, *S. cinerascens, S. cinerea, S. filamentosa, S. fitzroiensis, S. heterolepis, S. nigra, S. panoides, S. siamensis, S. sorsogonensis, S. villosa, B. breviceps, B. salinarum,* and *Solea foliacea*, were examined. The types have been lost for *Pleuronectes canus*, *P. pan, Synaptura krempfi*, *S. selheimi, Plagusia marmorata*, and *B. sundaicus*. The syntypes of *Pleuronectes orientalis* are located in Berlin, as mounted skins, and could not be obtained; the type for *S. dicholepis* is also located in Berlin and could not be obtained. The types for *Chabanudetta smithi* are located in India and could

not be obtained; the type of *S. swinhonis* is located in Vienna and was not examined. Type descriptions were consulted for all nominal species.

Genus *Brachirus* Swainson, 1839

Synaptura Cantor 1849 (type species by original designation *Pleuronectes orientalis* Swainson 1839 (= *Pleuronectes orientalis* Bloch & Schneider 1801))

Euryglossa Kaup 1858 (type species by original designation *Pleuronectes orientalis* Bloch & Schneider 1801)

Brachirus species can range considerably in size, from 19 mm to 308mm standard length (SL). They are oval in body shape, they have a very small predorsal length, and the dorsal, caudal and anal fins are joined. Eyes and mouth are generally small (on average, eyes are nine times in head length (HL) and mouth is three times in HL). The final distinguishing characteristic is the formation of the supracranial complex which does not have any pterigiophores with their proximal ends articulating over the cranium. This feature is shared with only eight other genera in Soleidae: the three other genera within the *Brachirus* species complex, *Achiroides*, *Dexillus*, *Paradicula*, and *Zebrias*, which has a larger predorsal length and distinct stripes, *Bathysolea*, *Heteromycteris* and *Aseraggodes* which have a distinct caudal fin, and *Typhlachirus* which has rudimentary eyes.

Brachirus is very closely related to *Achiroides*, *Dexillus* and *Paradicula* as all four genera shares all the above characteristics. Theses four genera form a monophyletic

group referred to here as the *Brachirus* species complex. *Brachirus* has pectoral fins, eyes separated by a scaly interspace and an opercular membrane which is free from the body. *Brachirus*, however, cannot yet be classified as a monophyletic group.

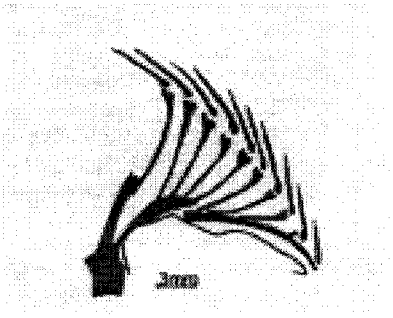

Figure 9. Formation of the supracranial complex for *Brachirus orientalis* as taken from Chapleau (1989).

Remarks

Pleuronectes orientalis is the type species of *Brachirus* and the syntypes are located in Berlin as two dried and mounted specimens. Chabanaud (1930) identified one of these types as belonging to *Pleuronectes orientalis*, but remarks, however, that the second type is a *Zebrias altipinnis*. The original description of *Brachirus orientalis* by Bloch & Schneider (1801) is vague and could describe almost any species of *Brachirus*.

Brachirus aspilos (Bleeker 1852)

Synaptura aspilos (Bleeker 1852)

Synaptura marmorata Bleeker 1853

Synaptura heterolepis Bleeker1856

Synaptura sorsogonensis Evermann & Seale 1907

Material examined

aspilos: BMNH 1862.6.3.5, Holotype(138.70 mm SL), 5° 44' 0" S, 113° 54' 0" E.

heterolepis: BMNH 1862.6.3.1, Holotype(216.60 mm SL), unknown.

sorsogonensis: USNM 55916, Holotype(195.98 mm SL), Bacon, Sorsogon, Luzon, Philippines.

BMNH 1933.3.11.792, 1(180.09 mm SL), Culion, Philippines Islands, BMNH 1933.7.31.21-2, 2(143.28-147.15 mm SL), Singapore fishmarket, CAS 120678, 1(159.07 mm SL), Lubang I., Philippines, CAS 127324, 2(222.46-177.94 mm SL), Culion I. Palawan Prov., Philippines, CAS 130706, 2(49.03-55.34 mm SL), On reefs, Singapore, CAS 132781, 1(139.83 mm SL), Singapore, CSIRO CA 205, 1(117.96 mm SL), Mallacoota Lake, Australia, MNHN A-2325, 1(139.74 mm SL), 5 00'N 22 30' E, Soulou, Philippines, NMW 35589, 1(189.4 mm SL), unknown, NMW 84334, 1(138.35 mm SL), Singapore, BMNH 81.10.12.17, 1(151.67 mm SL), unknown, SMNS 1250, 1(105.54 mm SL), Indonesia, SMNS 14652, 1(96.52 mm SL), Eagle Bluff, Australia, USNM 072194, 1(186.24 mm SL), Cuyo, Philippine Id., USNM 137679, 1(127.30 mm SL), Ulugan Bay near mouth of Baheli R., USNM 137680, 1(121.76 mm SL), Philippines: Cebu Market, USNM 137681, 1(212.70 mm SL), P.I. Cebu Market, USNM 137682, 2(147.42-170.61

mm SL), 13 45'N 120 46'E P.I.: Nasugbu Bay, S. Luzon, CA, USNM 137683, 1(154.64 mm SL), Bornea: Sandakan Market, USNM 170499, 1(259.10 mm SL), P.I.: Cebu Market, USNM 170500, 1(295.40 mm SL), P.I.: Cebu Market, USNM 210465, 1(78.61 mm SL), Just east of Rocky warf at foot of street that passes by institute of Marine Research, (Poka, Abon), USNM 291013, 1(158.73 mm SL), New Guinea, Madang, Siar Island, USNM 291016, 1(161.77 mm SL), Kranket Is., N. end in bay, Madang, USNM 340538, 1(206.30 mm SL), Manila Market, Philippines, USNM 340539, 1(307.70 mm SL), Manila Fish Market, Manila, Luzon, Philippines, WAM P12209, 1(77.58 mm SL), Shark Bay, WA, Australia, WAM P14195, 1(84.13 mm SL), Shark Bay, WA, Australia, WAM P14722, 1(78.09 mm SL), WA, Australia, WAM P14816, 1(134.26 mm SL), Shark Bay, WA, Australia, WAM P29052-017, 1(94.33 mm SL), 12 16'S 123 02' E, Timor Sea, Ashmore Reef, Middle Island, WAM P29054-021, 1(26.96 mm SL), 12 15' S 123 00' E, Timor Sea, Ashmore Reef, Hest Island.

Common Names

Dusky Sole (Kailola 1991)

Dapang bulag (Conlu 1986)

Diagnosis

Brachirus aspilos is most easily distinguished by the combination of having a long, upper lip overhanging the lower, a high number of caudal vertebrae (33-35) and a low number of caudal fin rays (12-15).

Figure 10. Photo of *Brachirus aspilos* BMNH 1862.6.3.1. 216.6 mm SL.

Description

Refer to table 6. Body large (can attain 300 mm) and slightly elongate, head short. O.s. corner of mouth extends to 1/3 of anterior edge of ventral eye; upper lip overhanging bottom lip. O.s. anterior nostril a short tube; posterior nostril a short, wide, thin-skinned tube beginning midway up anterior edge of ventral eye and touching edge of upper lip. B.s. anterior nostril a hole surrounded by intricate fringe of cirri; posterior nostril a simple hole in a horizontal line with anterior nostril, buried in a fringed flap posterior to corner of mouth. Head region on b.s. covered in a dense mat of thickened cirri from ventral edge of operculum to dorsal rays directly above. Scales ctenoid; found on proximal half of vertical rays. Large patches of thickened cirri present medially along o.s. of body excluding head. Short cirri found all around lips on o.s. Teeth minute and found only on b.s. lower jaw. Dorsal eye partially or fully in advance of lower. Anus located between posteriormost b.s. pelvic ray and first anal fin ray; urinary papillae only

slightly on o.s. just anterior of first anal ray. Dorsal fin ray count 65-75, anal fin ray count 45-60, caudal fin ray count 12-15, 4-9 pectoral rays on o.s., 4-7 on b.s., right pectoral longer than left; right pelvic fin ray count 4-5, left 3-5, right longer than left. Dorsal, anal and caudal fins united, anterior end of dorsal fin approaching anterior edge of upper lip. Upper lip greatly overhangs lower, tip rounded. Total vertebrae 42-45: 33-35 caudal and 8-10 precaudal, lateral line scales 76-117. Average supracranial pterigiophores 9 of the formula 5-0-4(1) [range of 8-11 (4-6)-0-(2-5)(0-2)] (for description of formula see Methods).

Table 6. Morphometrics and meristics for *Brachirus aspilos* holotype BMNH 1862.6.3.5, *B. heterolepis* holotype BMNH 1862.6.3.1, *B. sorsogonensis* holotype USNM 55916, and all non-type material. Abbreviations are defined in Appendix 1; characters 2 to11, 16-17 are expressed in hundredths of HL, characters 1, 12-15, 18 are expressed in hundredths of SL, and 19-28 are meristics.

		aspilos		*heterolepis*		*marmorata*	*sorsogonensis*		
	Character	Bleeker, 1852	Holotype	Bleeker, 1856	Holotype	Bleeker, 1853	Evermann & Seale, 1907	Holotype	non-type
1.	HL	5.3	4.8	5.5	4.9	5.0	5.3	5.1	4.6(3.6-5.8)
2.	E	7	7		8.6	7-8		6.1	8.6(5.5-15.3)
3.	S		2.8		2.7			2.8	2.8(2.2-3.2)
4.	DNS		4.5		4.2			4.2	4.2(3.4-5.5)
5.	Mos		2.8		3.2			3.1	3.1(2.7-3.6)
6.	Mbs		3.8		3.2			3.2	3.3(2.5-4)
7.	Pred		4.3		8.3				7(2.8-13.6)
8.	Pecos	4	3.4		2.6	4.0	3.8	3.7	3.6(2.6-6.1)
9.	Pecba		4.7		3.7	5.0	4.0	4.5	4.9(3.1-8.1)
10.	Pelos	3	2.3		2.8		2.9	2.5	2.7(2.2-3.5)
11.	Pelbs		3.1		3.2			3.2	3.5(2.8-5.4)
12.	OD		2.8		2.7			3.5	3.8(2.6-20.7)
13.	H1	2.5	2.5	2.7	2.2	2.8	2.4	2.5	2.4(2.1-3.4)
14.	H2		3.7		3.6			4.1	4(3.1-5.4)
15.	HCP		13.7		14.2			14.5	17.9(11.4-27.5)
16.	LDR		1.6		1.5			1.6	1.8(1.5-2.3)
17.	LAR		1.8		1.6			1.6	1.8(1.5-2.1)
18.	Hdep		3.5		3.3			4.0	3.7(3.1-4.7)
19.	DR	70	69	70	67	64	74	74	70(65-75)
20.	AR	55	55	52	51	50	61	60	55(45-60)
21.	CR	12	14	12	14.0	14.0	15	14	14(12-15)
22.	PecOr	6	6	6	6.0	7-8		5	6(4-9)
23.	PecAR	6	5	5	5.0	7-8		6	5(4-7)
24.	PelOR	4	5	5	5.0	5.0		5	5(4-5)
25.	PelAR	4	4	4	4.0	4.0		5	4(3-5)
26.	CV		34		34.0			34	34(33-35)
27.	PCV		10		10.0			9	10(8-10)
28.	LL	115	96	90	92.0	100.0	112	117	97(76-117)

Colour in Alcohol

On o.s.: body pale mocha brown with a marbled appearance of darker brown and small white spots that increase in size as they approach the vertical rays; cirri light brown

creating large faint patches along the lateral line; tip of pectoral fin dark brown. On b.s.: body almost white; no colouration on body or head; fins white except for the margins of the most posterior fin rays which are darkened; anterior of head region has the appearance of a very light brown as a result of the cirri.

Geographic Distribution

Western Pacific: East Indies, Philippines, Thailand, Indonesia, Singapore and Papua New Guinea.

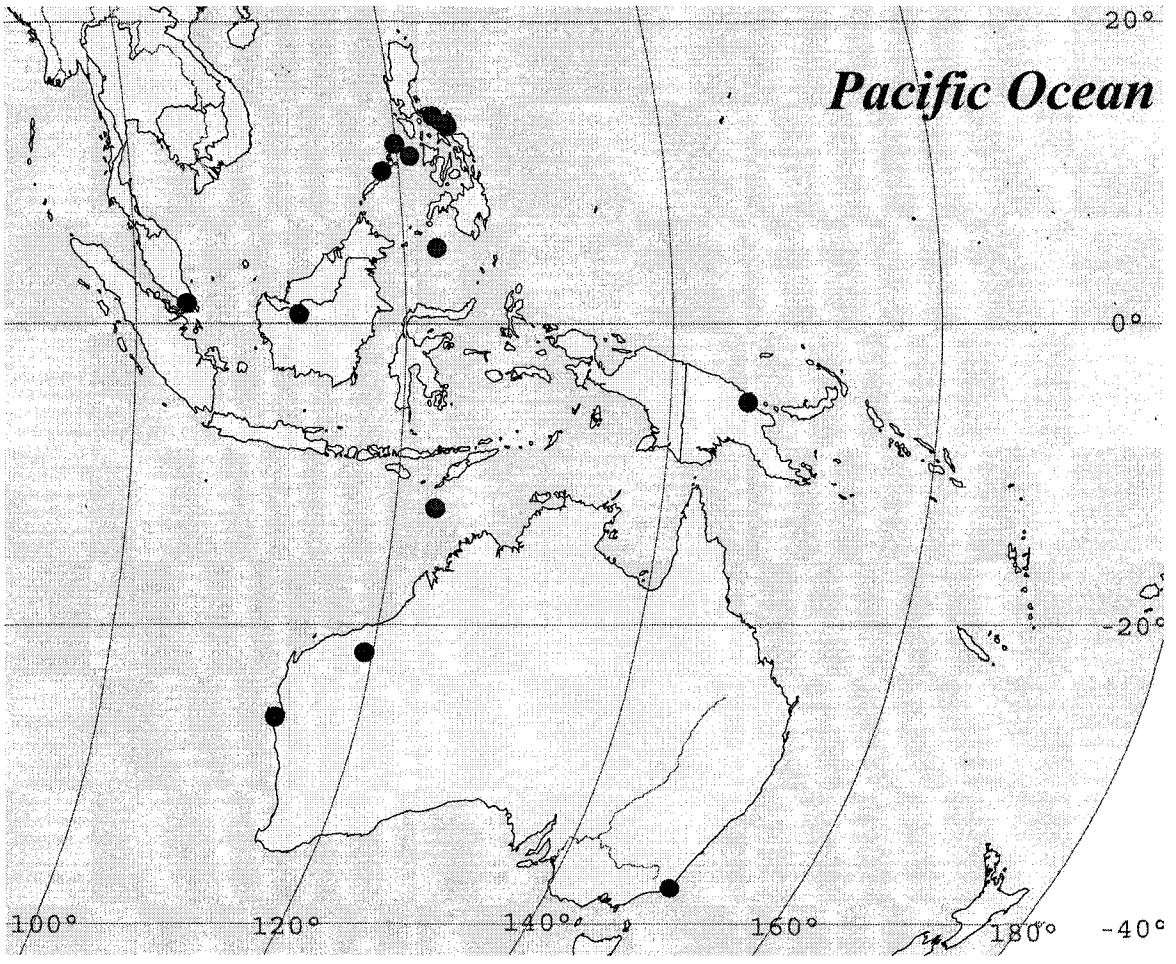

Figure 11. Geographical distribution of *Brachirus aspilos*

Remarks

Despite the large geographical range, *Brachirus aspilos* shows little morphological variation. The specimen found at the southern extent of the range may be an incorrect location based on the question mark following "Australia" on the identification tag: CSIRO CA 205.

B. aspilos Bleeker 1852, *B. marmorata* Bleeker 1851 and *B. heterolepis* Bleeker 1856 were all described as being distinct species, but Bleeker (1970-75) reconciled his original descriptions of the three nominal species into one valid species, outlining that noted differences were the result of preservation, age, and size of the specimens. *B. aspilos* appears to have been bleached, whereas *B. marmorata* maintained its colouration. Bleeker (1870-75) also noted that the original description of *B. heterolepis* was actually on a specimen of 360 mm and not 260 mm like originally stated.

All counts, measurements and descriptions of *B. sorsogonensis* are almost identical to the description of *B. aspilos*. The only difference in the type descriptions of *B. sorsogonensis* is in the dorsal and anal fin ray counts which are slightly higher (74 vs. 70 and 60 vs. 55) and can be accounted for through natural variation within the species.

Comparisons

Brachirus aspilos (76-117) has a greater number of lateral line scales than *B. breviceps* (74); fewer caudal fin rays (12-15) than *B. cinerascens* (17-19), *B. foliacea* (16-19) and *B. orientalis* (17-20); more caudal vertebrae (33-35) than *B. fitzroiensis* (31), *B. siamensis* (28-32), and *B. selheimi* (28-32); more dorsal fin rays (65-75) than *B. pan* (53-61), and *B.*

sundaicus (53-63), and fewer than *B. panoides* (76-85).

Brachirus breviceps Ogilby 1910

Material examined

QMI.865, Holotype (113.80 mm SL), 23 13'12"S 150 19'12"E, Rockhampton, Fitzroy River system,

Diagnosis

Brachirus breviceps can be distinguished from other *Brachirus* by the number of o.s. pectoral fin rays (2) and the small eyes (8.5 times in HL) which are separated by a wide interorbital space (2 times eye diameter).

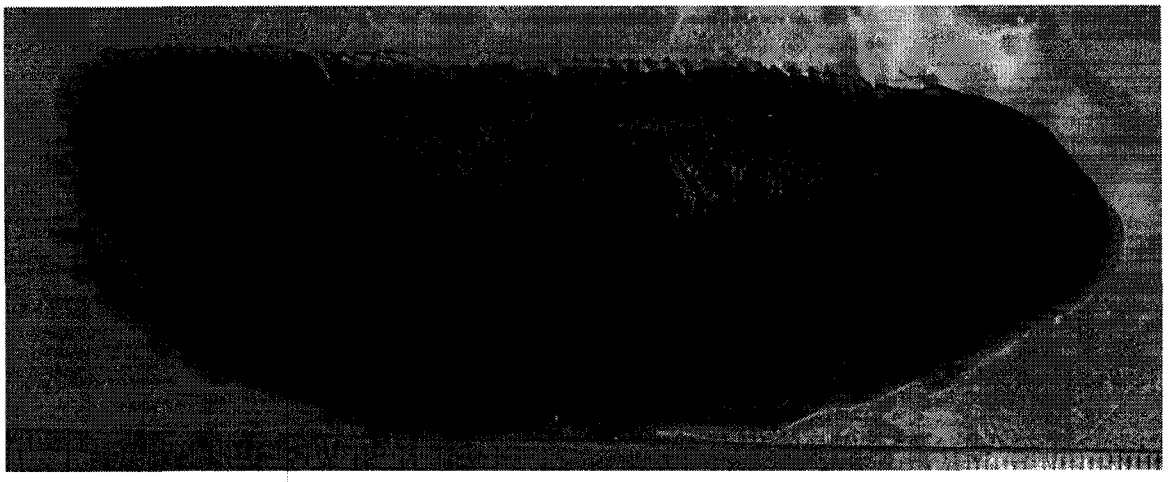

Figure 12. Photo of *Brachirus breviceps* holotype QMI.865. 113.8 mm SL.

Description

Refer to table 7. Body elongate, head short and somewhat pointed. O.s. corner of mouth reaches anterior edge of ventral eye. O.s. anterior nostril a long conical tube lying posteriorly, covering posterior nostril but not reaching eye; posterior nostril a short, flat tube, lying against anterior edge of ventral eye. B.s. anterior nostril a simple hole midway along mouth and just above lip; posterior nostril a long, wide, flat tube folded posteriorly and located more dorso-posterior to anterior. B.s. of head devoid of cirri. Scales ctenoid. No cirri present on body or lips. Teeth minute and present only on b.s lower jaw. Dorsal eye in advance of lower by about three-quarters its diameter; interorbital space about equal to one and a half eye diameter. Pectoral fin ray count 2 on o.s. Anterior end of dorsal fin approaching anterior edge of upper lip. Total vertebrae 40: 31 caudal and 9 precaudal, lateral line scales 74.

Table 7. Morphometrics and meristics for *Brachirus breviceps* holotype QMI 865. Abbreviations are defined in Appendix 1; characters 2 to11, 15-16 are expressed in hundredths of HL, characters 1, 12-14, 17 are expressed in hundredths of SL, unless otherwise stated, and 18 to 27 are meristics.

	Character	Ogilby, 1910	Holotype
1.	HL	5.5 TL	5.7
2.	E	7	8.5
3.	S	3.5	3.4
4.	DNS		5.3
5.	Mos		4.0
6.	Mbs		4.7
7.	Pred		3.2
8.	Pecos	6.0	8.0
9.	Pecba	7.5	damaged
10.	Pelos		damaged
11.	OD		9.1
12.	H1	3 TL	3.0
13.	H2		4
14.	HCP		10.3
15.	LDR	1.2 HL	3.9
16.	LAR	1.2 HL	damaged
17.	Hdep		13.5
18.	DR	72	
19.	AR	56	
20.	CR		
21.	PecOr		2
22.	PecAR		
23.	PelOR		
24.	PelAR		
25.	CV		31
26.	PCV		9
27.	LL	75	74

Colour in Alcohol

Both side uniform brown-gray with golden brown edges.

Geographic Distribution

Coast of Queensland at Rockhampton, Australia.

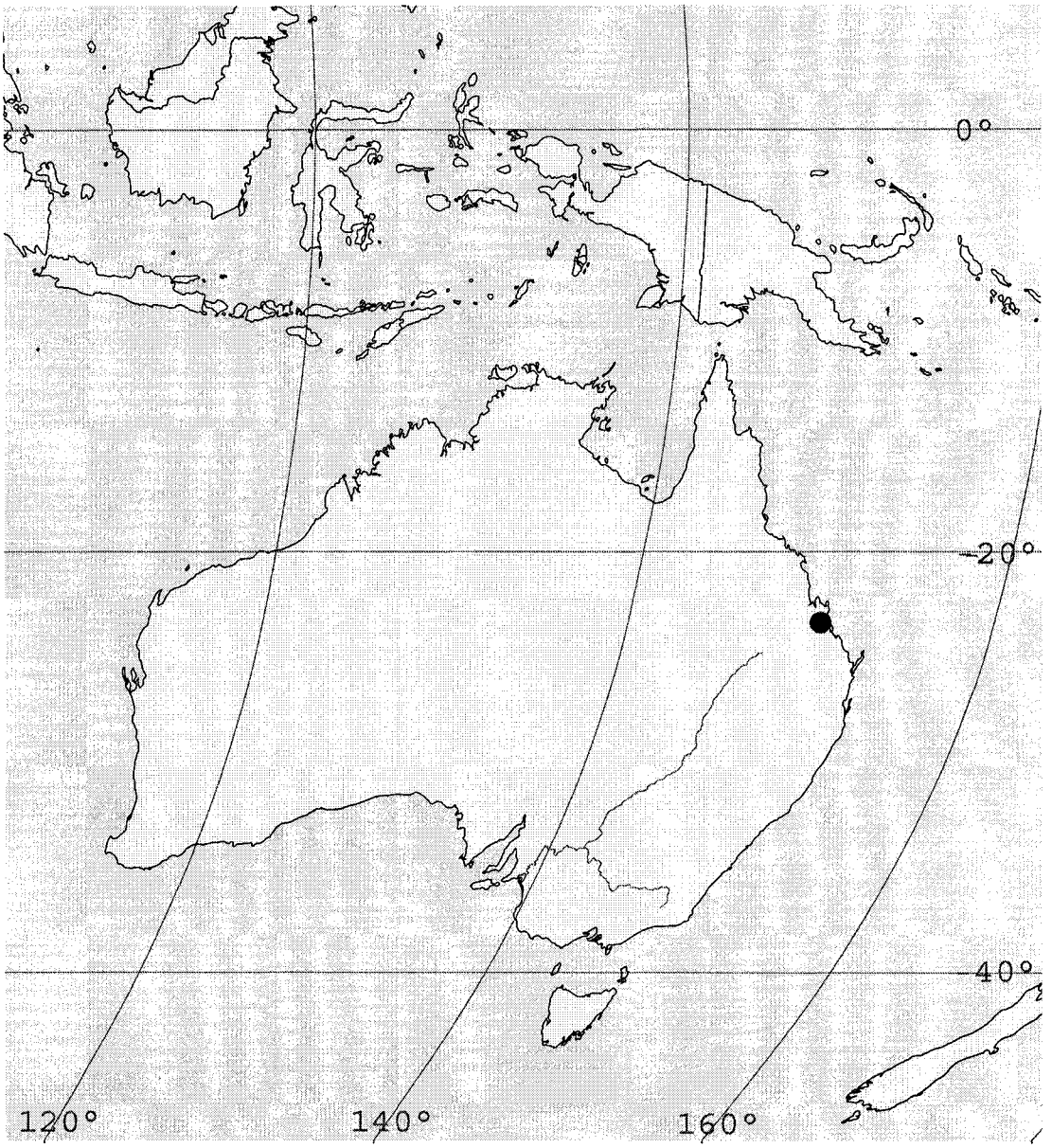

Figure 13. Geographical distribution of *Brachirus breviceps.*

Remarks

This species is known only from the type specimen, which is in very poor condition. It has only been described once in the literature. Dorsal, anal and caudal fin rays are broken completely and cannot be counted. Supracranial complex is also damaged, and only the first three pterigiophores are clearly seen from the radiograph. According to the type description by Ogilby (1910), the dorsal, anal and caudal fins are united, and the caudal fin is rounded. He also noted that the right pectoral fin is longer than the left. I could not verify these observations due to the state of the specimen. The vertical rays, left pectoral and both pelvic fins are destroyed.

Comparisons

Brachirus breviceps has only two o.s. pectoral fin rays, a characteristic that is shared only with some specimens of *B. siamensis* and *B. panoides*. *B. breviceps* can be distinguished from these species by the interorbital space which is equal to two times the diameter of the ventral eye, whereas that of *B. panoides* and *B. siamensis* is equal to the diameter of the ventral eyes. Specimen is very similar to *B. selheimi,* though the eyes are much smaller in *B. breviceps* (8.5 times in head length vs. 3.4-8.1).

Brachirus canus (Gray 1854)

Pleuronectes canus Gray 1854

Material examined

No specimens examined; type location unknown.

Description (as provided by Gray 1854)

Pleuronectes subrotundus, scaber, cinereus, unicolor; pinna pectorali exigua; cauda rotundata: oris latere albo cirroso.

Statura omino Lineati. Oculi rotundi prominentes in latere dextro. Frons obtuse rotundata. Corpus muticum, circinnatum, scabriusculum. Caput in latere albo cœco a fronte usque ad angulos oris cirris exiguis, innumerabilibus villosum, et maxillæ inferioris margo in latere oculato etiam pilis hispidus est. Pinna pectoralis in latere oculato tantum conspicua exigua, in altero vero visum fugiens. Pinnae dorsi atque ani satis altæ corpori parallelæ. Cauda rotundata. Color in latere oculato canus, unicolor: in altero vero latere albus.

Remarks

I was not able to examine any specimens of *B. canus*, but according to the literature (Bleeker 1870-75, Günther 1862, Day 1888) *Pleuronectes canus* is a synonym of *B. pan*. The type description provides no morphometric or meristic data. All three above mentioned descriptions describe the increased size of the scales on the nape of the neck as being distinguishing. Without observing the type material it is not possible to verify

synonymies and, until further examination can be done, I maintain that these are distinct species.

Brachirus cinerascens (Günther 1862)

Synaptura cinerascens Günther 1862

Material examined

cinerascens: BMNH 1854.3.29.30, holotype(108.50 mm SL), Ceylon, Sri Lanka. AMI 36, 1 of 2(90.68 mm SL), 13 05'N 80 18'E, Mandras, India, ANSP 87053, 1(151.14 mm SL), Bandia, India, BMNH 89.2.1.4031-2, 3(66.36-185.20 mm SL), Madras, India, BMNH 89.2.1.4033, 1(106.22 mm SL), Cochin, India, BMNH 89.2.1.4034-7, 2 of 4(72.15-74.00 mm SL), Calicut; India, BMNH 89.2.1.4038-9, 1 of 2(106.42 mm SL), Malabar, India, BMNH 1912.7.20.29, 1(77.84 mm SL), Travancore, India,BMNH 1969.3.27.3, 1(118.55 mm SL), Cochin, south India, BMNH 1983.10.19.47, 1(97.62 mm SL), Western Indian Ocean, Sri Lanka, Ceylon, CAS 114569, 2(142.95-144.06 mm SL), Calcutta Market, West Bengalstate, India, CAS 114570, 2(152.29-162.94 mm SL), Ennur Fisheries Station, Tamil Nadu State, India, CMK 10034, 4(104.10-118.09 mm SL), Pallomy, Kottayam Dist. Kerala, India, MNHN A-8754, 2(70.54-79.88 mm SL), 11 58'48"N 80 00'00"E, Pondichery, Coromandel, India, MNHN 0000-1249, 1(166.12 mm SL), 11 N 76 E, Malabar, India, MNHN 1981-1124, 1(141.92 mm SL), 9 56'N 76 05'E, Cochin, Kerala, India, MNHN 1998-1318, 1(51.70 mm SL), 10 N 75 E, Coast, Malabar, India, MNHN 1999-0053, 1(63.62 mm SL), 11 60' N 79 50'E, Pondichery, Coromandel, India, NMW 43047, 1(141.86 mm SL), Cochin, India, USNM 286809, 1(74.72 mm SL), Trincomalee, Ceylon Estuaries about 3 mi. N. of Mahaweli River's mouth W. side of road, USNM 286828, 2(34.73-61.84 mm SL), 7 42'36"N 81 41'42"E, Ceylon: Eastern

Province; Batticaloa Dist. Batticaloa (Tidal lagoon opposite (SW of) Government rest house), USNM 286829, 2(80.41-86.00 mm SL), Negombo, Ceylon, India,

Diagnosis

B. cinerascens can be distinguished from other *Brachirus* by the combined characteristics of having a high number of pectoral fins rays (6-10), 65-95 lateral line scales, a high number of caudal fin rays (17-19) and 8-10 pterigiophores on the supracranial complex.

Figure 14. Photo of *Brachirus cinerascens* BMNH89.2.1.4031-2-1. 185.2 mm SL.

Description

Refer to table 8. Body a slightly elongate oval, head short and rounded. O.s. corner of mouth reaches past 1/3 of anterior edge of ventral eye. O.s. anterior nostril a short, stubby, thick tube; posterior nostril also a very short, wide, thin-skinned tube lying directly against anterior edge of ventral eye. B.s. anterior nostril a hole surrounded by intricate fringe of cirri; posterior nostril a simple hole covered by a cutaneous flap, twice

the distance dorsally from mouth as anterior nostril and slightly posterior to corner of mouth. Thickened cirri restricted to snout region and occasionally lining edge of head near vertical rays. Scales ctenoid; found on proximal two-thirds of vertical rays. Occasionally a few long, thin dark cirri present on o.s. scales. Small cirri present all around mouth, some present surrounding ventral eye. Teeth minute and found only on b.s. lower jaw. Dorsal eye slightly in advance of lower by about one-quarter its diameter; interorbital space about equal to eye diameter. Pectoral fins about equal in length. Caudal fin rounded, outer rays being somewhat longer than last anal and dorsal rays. Anus located between first anal ray and posteriormost b.s. pelvic fin ray; urinary papillae located at base or slightly to o.s. of first anal fin ray. Dorsal fin ray count 61-70, anal fin ray count 45-52, caudal fin ray count 17-19, pectoral fin ray count 6-10 on right, 7-10 on left; pelvic fin ray count 4-6 on right, and 4-5 on left. Dorsal, anal and caudal fins united, anterior end of dorsal fin ray in horizontal line with base of dorsal eye. Total vertebrae 34-37: 24-26 caudal and 9-11 precaudal, lateral line scales 65-90. Average supracranial pterigiophores 9 of the formula 4-0-4(1) [Range of 8-10 (2-5)-0-(3-6)(1-2)] (for description of formula see Methods).

Table 8. Morphometrics and meristics for *Brachirus cinerascens* holotype BMNH 1854.3.29.30, and all non-type material. Abbreviations are defined in Appendix 1; characters 2 to 12, 16-17 are expressed in hundredths of HL, characters 1, 13-15, 18 are expressed in hundredths of SL, unless otherwise stated, and 19-28 are meristics.

	Character	Günther, 1962	Holotype	non-type
1.	HL	5.7 TL	4.5	4.2(3.7-4.7)
2.	E		6.7	6.2(4.9-9.4)
3.	S		3.2	3.1(2.8-3.9)
4.	DNS		5.3	4.7(3.8-5.5)
5.	Mos		3.1	3.3(2.8-4.3)
6.	Mbs		4.3	4.0(3.3-4.8)
7.	Pred		6.3	4.4(3.7-6.2)
8.	Pecos	> 2.7	2.5	2.5(2.0-3.4)
9.	Pecba	2.7	3.1	3.1(2.4-3.7)
10.	Pelos		2.8	3.0(2.3-3.8)
11.	Pelbs		3.1	3.0(2.3-3.8)
12.	OD		4.7	4.1(3.8-5.2)
13.	H1	2.3 TL	2.1	2.2(1.9-2.8)
14.	H2		3.0	3.2(2.7-4.3)
15.	HCP		9.5	13.3(8.1-33.4)
16.	LDR		2.3	2.3(2.0-2.9)
17.	LAR		2.1	2.3(1.8-2.8)
18.	Hdep		3.5	3.6(3.2-3.9)
19.	DR	68	68	65(61-70)
20.	AR	51	51	49(45-52)
21.	CR	16	18	19(17-19)
22.	PecOr	9	9	8(6-10)
23.	PecAR	9	9	8(7-10)
24.	PelOR		5	5(4-6)
25.	PelAR		5	5(4-5)
26.	CV		26	25(24-26)
27.	PCV		9	10(9-11)
28.	LL	95	90	77(65-90)

Colour in Alcohol

O.s. uniform mocha brown; right pectoral fin only slightly darker. B.s. pale brown to beige.

Geographic Distribution

Sri Lanka, India, Ceylon.

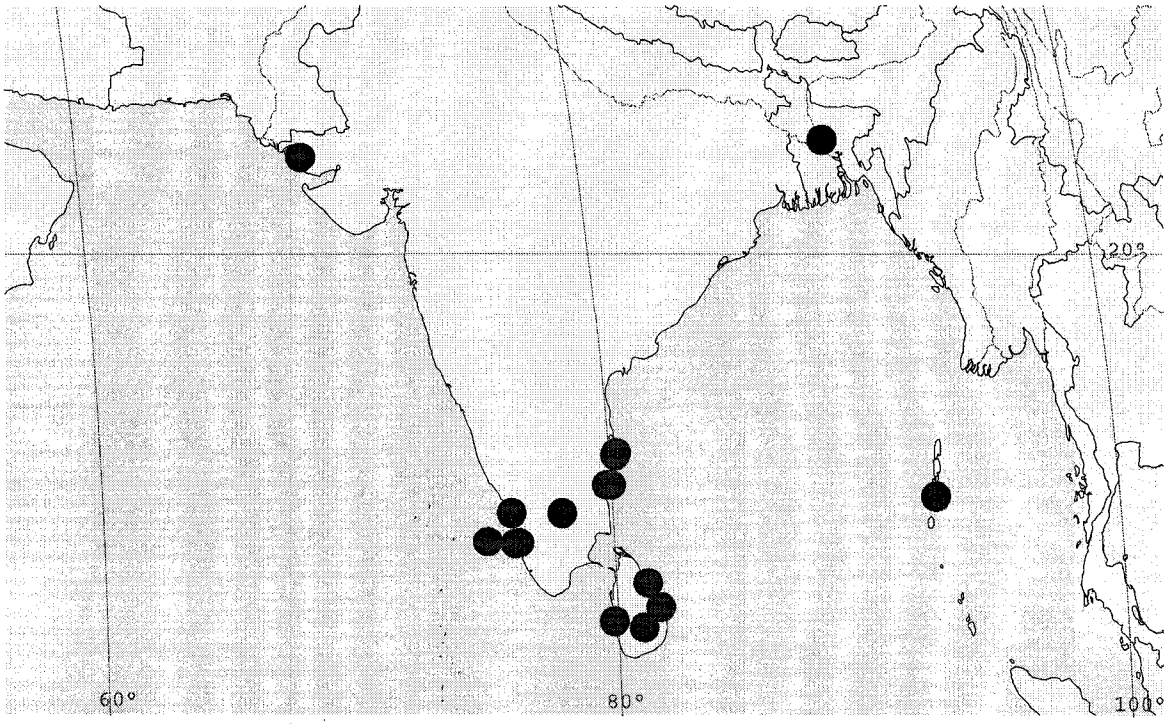

Figure 15. Geographical distribution of *Brachirus cinerascens*

Comparisons

Brachirus cinerascens is very closely related to *B. foliacea* and *B. orientalis*. *B. orientalis* has a higher anal fin ray count (51-56) than *B. cinerascens* (45-52), although there is minimal overlap (see Appendix 8), and *B. orientalis* has a higher caudal vertebrae count (29-31) than both *B. cinerascens* and *B. foliacea* (24-26 and 26-27 respectively). *B. cinerascens* also has a higher number of pterigiophores in the supracranial complex (8-10 [(3-5)-0-(3-5)(1-2)]) than both *B. orientalis* (4-6 [(1-2)-0-(2-4)(1-2)]) and *B. foliacea* (5-7 [(2-3)-0-(2-4)(1-2)]).

B. cinerascens has a higher number of pectoral fin rays (6-10) than *B. breviceps* (2), *B. panoides* (2-5) and *B. siamensis* (2-4). It has a higher number of caudal rays (17-19) than *B. aspilos* (12-15), *B. sundaicus* (12-16), *B. pan* (13-15), *B. siamensis* (13-16), *B. fitzroiensis* (15), and *B selheimi* (15-16). *B. cinerascens* has a smaller number of caudal fin rays (61-70) than *B. panoides* (76-83). Finally, *B. cinerascens* has a smaller caudal vertebrae count (24-26) than all other *Brachirus* (26-35) except for *B. pan* (23-25).

Brachirus dicholepis (Peters 1877)

Synaptura dicholepis Peters 1877

Material examined

Holotype not examined; no specimens examined.

Diagnosis

B. dicholepis can be distinguished from other *Brachirus* by the combined characteristics of the high lateral line scale count (115-120), low caudal fin ray count (14), and cycloid scales on the blind side.

Description (as provided by Peters 1877 – roughly translated from German by author. See Appendix 3 for original description)

Body height to the total length 1: 2 2/13, head length to the same 1:6. The upper eye not in advance of the lower; the interorbital area noticeably more broad than the eye diameter. Nose tube simple; neck scales not larger than body scales; o.s. scales ctenoid, b.s. scales cycloid; Lateral line scales 115 to 120. The right pectoral fin somewhat longer than the left, three times in the head length. Brownish-green, irregular black bars; B.s. yellowish with indistinct blackish bars.

Remarks

Although I was not able to examine any specimens of *B. dicholepis* (which is deposited at Museum of Berlin, Deutschland under the number ZMB 9861), it is clear from the

literature that it is a distinct species from other *Brachirus* due high lateral line scale count (115-120) which is shared only with *B. aspilos* (76-117), and *B. panoides* (82-121), and the cycloid scales on the blind side which are not present on any other *Brachirus* species. This last characteristic is odd among the *Brachirus* species complex and suspect of being inaccurate. An examination of the type specimen in Berlin would reveal whether the blind side scales are indeed cycloid or simply weakly ctenoid. If this characteristic is incorrect; *B. dicholepis* may be a synonym of *B. aspilos* due to the similarities in meristics. Peters (1877) also states that *B. dicholepis* may be a synonym of *Synaptura heterolepis*.

Brachirus fitzroiensis (De Vis 1882)

Synaptura fitzroiensis De Vis 1882

Material examined

QMI.79, Holotype (176.60 mm SL), 23 12'36"S 150 18'00"E Fitzroy River

Diagnosis

B. fitzroiensis can be distinguished from all other *Brachirus* by its very small eyes (13.1 times in HL), and interorbital space which is equal to three times the eye diameter.

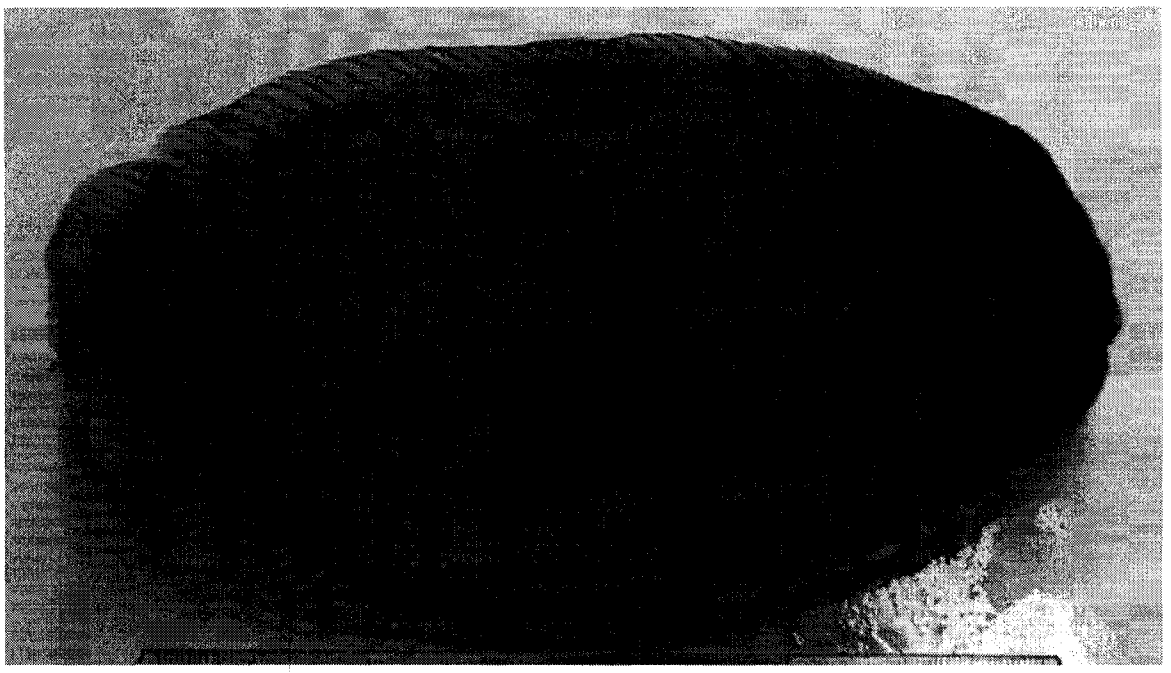

Figure 16. Photo of *Brachirus fitzroiensis* QMI.79. 176.6 mm SL.

Description

Refer to table 9. Body oval, head short and very rounded. O.s corner of mouth reaches anterior edge of ventral eye. O.s. anterior nostril a wide, thin-skinned flat tube of medium length; posterior lying next to anterior edge of ventral eye. B.s. anterior nostril a simple hole surrounded by a ring of thickened skin; posterior nostril a simple hole in vertical line with corner of mouth and two times the distance the anterior nostril is from upper lip. No thickened cirri on b.s. of head; skin intricately folded along anterior half of b.s. of head. Scales ctenoid; almost entirely covering vertical rays. No cirri present on body or lips. Teeth minute and present only on b.s. lower jaw. Dorsal eye in advance of lower by about half its diameter; interorbital space about equal to one and a half eye diameter. Right pectoral fin slightly longer than left. Caudal fin rounded. Dorsal fin ray count 67, anal fin ray count 51, caudal fin ray count 15, pectoral fin ray count 5, pelvic fin ray count 3. Dorsal, anal and caudal fins united, anterior end of dorsal fin approaching anterior edge of upper lip. Total vertebrae 40: 31 caudal and 9 precaudal, lateral line scales 84. Supracranial pterigiophores 7 of the formula 3-0-3(1) (for description of formula see Methods).

Table 9. Morphometrics and meristics for *Brachirus fitzroiensis* holotype QMI 79. Abbreviations are defined in Appendix 1; characters 2 to 12, 16-17 are expressed in hundredths of HL, characters 1, 13-15, 18 are expressed in hundredths of SL, unless otherwise stated, and 19-28 are meristics.

	Character	De Vis, 1882	Holotype
1.	HL	6 TL	4.9
2.	E		13.1
3.	S	3.8	3.1
4.	DNS		4.6
5.	Mos	3.8	3.4
6.	Mbs		4.9
7.	Pred		21.2
8.	Pecos		6.2
9.	Pecba		5.8
10.	Pelos		
11.	Pelbs		
12.	OD		3.5
13.	H1	2.3 TL	1.9
14.	H2		2.6
15.	HCP		8.9
16.	LDR		1.8
17.	LAR		1.7
18.	Hdep		3.8
19.	DR	53?	67
20.	AR	55?	51
21.	CR	13	15
22.	PecOr	7?	5
23.	PecAR	7?	5
24.	PelOR	?	3
25.	PelAR	?	3
26.	CV		31
27.	PCV		9
28.	LL	121	84

Colour in Alcohol

O.s. of body golden-brown with few faint darker spots. B.s. also golden-brown, head white. Lateral line on both sides white.

Geographic Distribution

Mouth of the Fitzroy River, Australia.

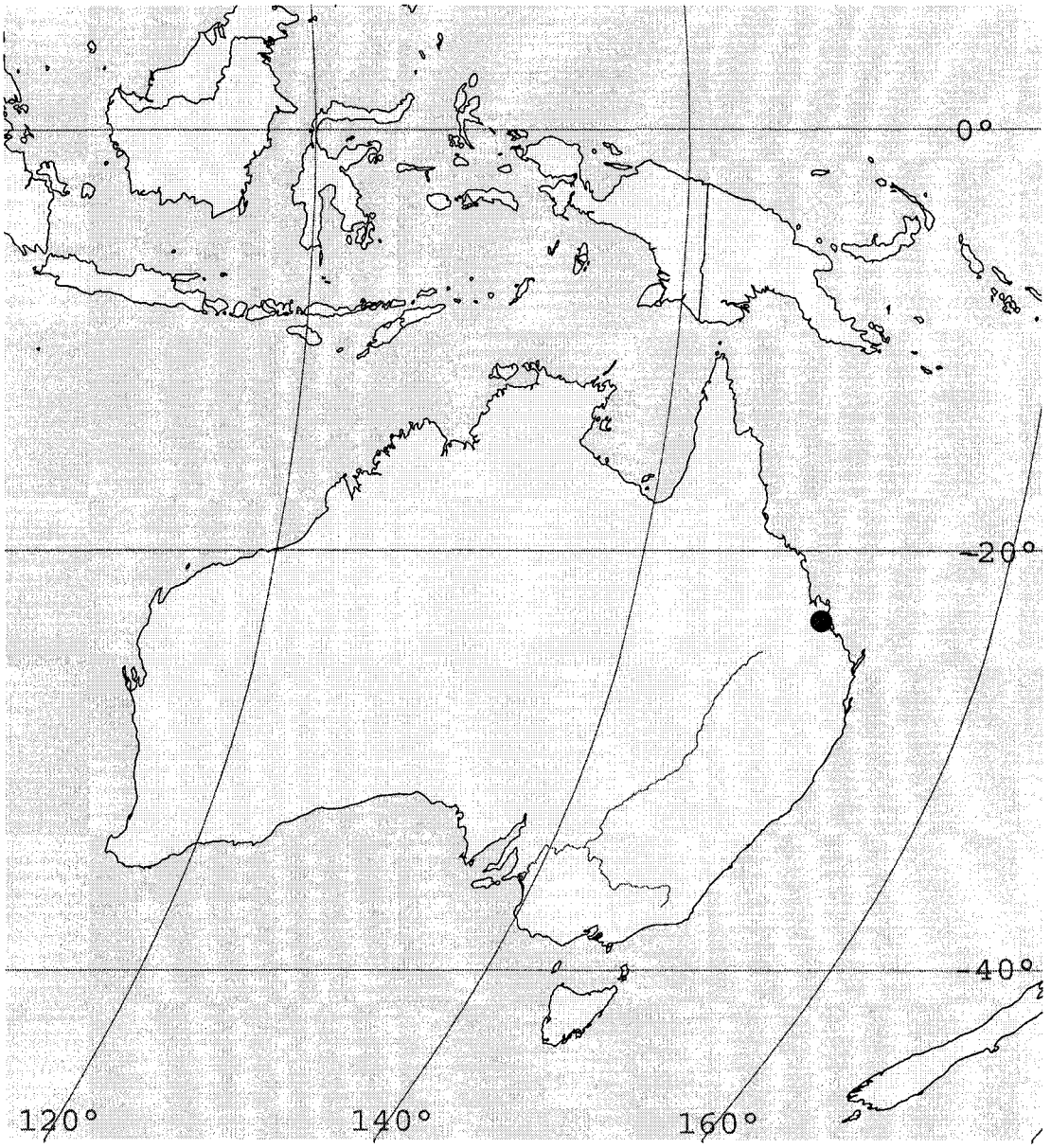

Figure 17. Geographical distribution of *Brachirus fitzroiensis*

Remarks

This species is known only from the holotype and has only been described once in the literature. Pelvic fins damaged. Some differences from the original type description by De Vis (1882): pectorals described as being rudimentary, and although they are short they do have 5 fin rays each; tentacles described as being located on the upper lip were not observed; caudal fin is not pointed but rounded; nostrils are visible and have been described above; cilia were not observed on the scales of the body. The colouration I have observed on the type specimen was also different, although this is likely due to the preservation. No dark bands were observed, though the faint spots seen may be remnant of these bands.

Comparisons

Brachirus fitzroiensis has fewer caudal vertebrae (31) than *B. aspilos* (33-35); more lateral line scales (84) than *B. breviceps* (74), *B. orientalis* (66-76), *B. pan* (56-79), and *B. selheimi*(58-76); fewer caudal fin rays (15) than *B. cinerascens* (17-19), *B. foliacea* (16-19); fewer dorsal fin rays (67) than *B. panoides* (76-85) and more than *B. sundaicus* (53-63); more right pectoral fin rays than *B. siamensis* (2-4).

Brachirus foliacea (Richardson 1846)

Solea foliacea Richardson 1846

Synaptura filamentosa Sauvage 1878

Material examined

B. foliacea: BMNH 1851.12.27.213-14, 2 Syntypes (78.02- 88.27 mm SL), China Seas.

B. filamentosa: MNHN 0000-1249, Holotype (107.63 mm SL), Laos.

AMNH 14514, 1(109.67 mm SL), unknown, ANSP 76873, 1(121.67 mm SL), Hong Kong, China, ANSP 123536, 1(91.44 mm SL), Swabue, China, Kwangtung, BMNH 62.11.1. 58, 1(208.52 mm SL), unknown, BMNH 62.12.6.38, 1(122.83 mm SL), unknown, BMNH 1925.5.26.16, 1(95.00 mm SL), Hainan, Kwangtung, China, BMNH 1933.7.31.19-20, 2(139.82-163.73 mm SL), Singapore Fish market, BMNH 1934.12.18.77, 1(122.67 mm SL), Krat, South East Siam, Thailand, BMNH 1939.3.23.98, 1(102.86 mm SL), Hong Kong, China, BMNH 1984.1.13.231, 1(139.27 mm SL), Straight of Singapore, Singapore, Angler Buoy, Indonesia, CAS 124246, 1(150.59 mm SL), Hong Kong, China, CAS 130705, 2(145.68-145.81 mm SL), Singapore, CAS 206000, 2(153.18-158.78 mm SL), Prachaup, Khiri Khan, Thailand, CAS 206001, 2(177.78-188.56 mm SL), Langsuan, gulf of Thailand, Chumphon Province, Thailand, CAS 206002, 1(166.67 mm SL), Laug suan dist. Gulf of Thailand, CAS 206004, 2(144.23-181.27 mm SL), Laug suan dist. Gulf of Thailand, CMK 14909, 5(78.91-104.58 mm SL), 21 31'36"N 107 58'07"E, Hai Ninh Dist., Quang Ninh Prov., Vietnam, MNHN A-2957, 1(151.34 mm SL), 23 23'N 116 39'E, Swatow; Kwangtung, China, MNHN 0000-3185, 1(45.51 mm SL), Begale, India, MNHN 1965-0470 1(135.42

mm SL), Snoc trou, Cambodia, MNHN 1965-0484, 2(73.23-174.36 mm SL), 10 21'N 104 18'E, Kep, Cambodia, MNHN 1969-0050, 3(106.77-174.65 mm SL), 10 31'N 103 23'E, Ream, Cambodia, MNHN 1998-1463, 3(57.00-70.50 mm SL), unknown, MNHN 1998-1689, 3(68.15-147.52 mm SL), unknown, NMW 43048, 1(85.56 mm SL), Singapore, NMW 43677, 1(112.23 mm SL), Singapore, USNM 103316, 1(155.92 mm SL), Chantabun Estuary, S.E. Siam, Thailand, USNM 291012, 1(84.76 mm SL), Tolo H., Hong Kong,

Diagnosis

Brachirus foliacea can be distinguished from other *Brachirus* by the following combination of characteristics: number of dorsal fin rays (56-66), anal fin rays (43-50) and caudal vertebrae (26-27), and by the supracranial complex of the formula 1-0-3(1).

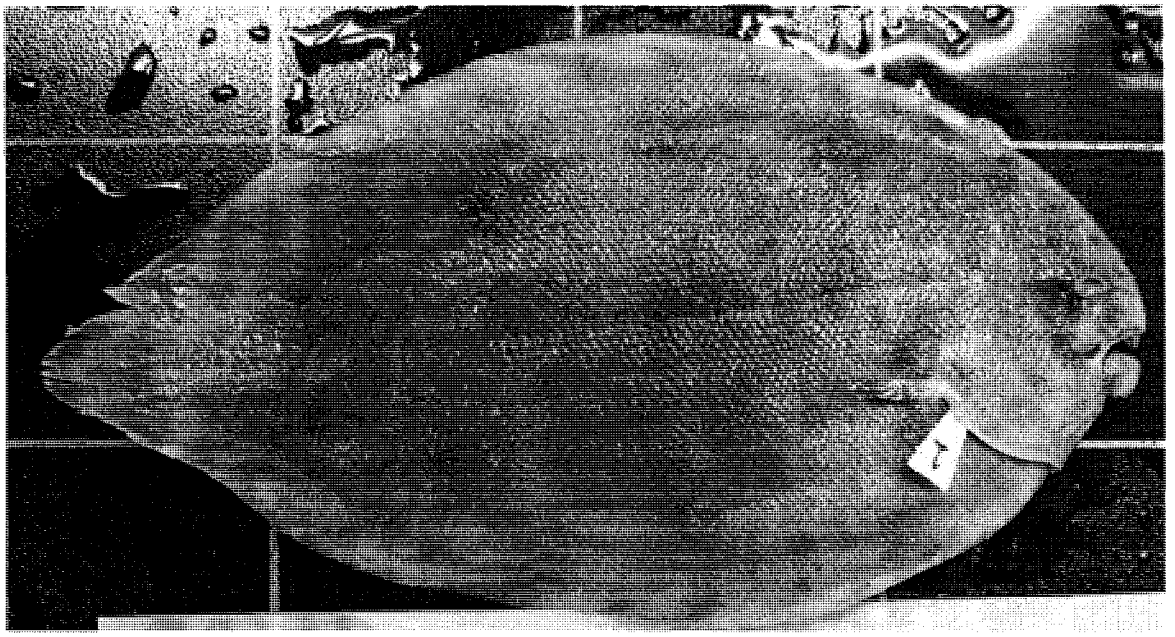

Figure 18. Photo of *Brachirus foliacea* syntype BMNH 1851.12.27.213-14. 88.27 mm SL

Description

Refer to table 10. Body oblong, head short and rounded. O.s. corner of mouth reaches anterior edge of ventral eye. O.s. anterior nostril a short and wide tube overhanging upper lip; posterior nostril a shallow tube lying against anterior edge of ventral eye. B.s. anterior blind nostril a hole surrounded by intricate fringe of cirri; posterior a simple hole in vertical line with corner of mouth and in horizontal line with anterior nostril. Thickened cirri restricted to snout and/or chin region; longer cirri present along ventral edge of head to operculum. Scales ctenoid; found on proximal half of vertical rays. Long, thin, dark cirri patchily present on body. Small cirri present on lower lip or entirely absent. Teeth minute and present only on b.s. lower jaw. Dorsal eye in advance of lower by about half its diameter; interorbital space about equal to eye diameter. Caudal fin bluntly pointed. Anus located just to b.s. of first anal fin ray; urinary papillae located at base or slightly to o.s. of first anal fin ray. Dorsal fin ray count 56-66, anal fin ray

count 43-50, caudal fin ray count 17-19, pectoral fin ray count 6-8 on right and 5-9 on left; pelvic fin ray count 5-6 on right and 4-6 on left. Dorsal, anal and caudal fins united, anterior end of dorsal fin approaching anterior edge of upper lip. Total vertebrae 36-38: 26-27caudal and 9-11 precaudal, lateral line scales 63-83. Average supracranial pterigiophores 6 of the formula 2-0-3(1) (range of 5-7 [(2-3)-0-(2-4)(1-2)] (for description of formula see Methods).

Table 10. Morphometrics and meristics for *Brachirus foliacea* syntypes (2) BMNH 1851.12.27.213-14, *B. filamentosa* holotype MNHN 0000-9643, and all non-type material. Abbreviations are defined in Appendix 1; characters 2 to 12, 16-17 are expressed in hundredths of HL, characters 1, 13-15, 18 are expressed in hundredths of SL, and 19 to 28 are meristics.

		foliacea	*filamentosa*		
	Character	Syntypes	Sauvage, 1878	Holotype	non-types
1.	HL	4.1(3.9-4.4)	5 TL	4.6	4.5(4.0-5.1)
2.	E	7.7(7.6-7.8)		10	7.7(6.0-10.3)
3.	S	3.4(3.3-3.5)		3.6	3.6(3.0-4.1)
4.	DNS	5.6(5.4-5.9)		6.6	5.8(4.5-7.3)
5.	Mos	3.7(3.6-3.7)		3.8	3.4(3.0-3.9)
6.	Mbs	4.3(4.0-4.7)		4.1	3.8(3.2-5.7)
7.	Pred	3.9(3.7-4.1)		5.7	4.2(2.5-5.7)
8.	Pecos	2.4(2.4-2.5)	2	2.1	2.8(2.3-3.7)
9.	Pecba	3.7(3.6-3.7)	< pecos	3	3.5(2.8-4.5)
10.	Pelos	2.5(2.4-2.5)		2.5	2.6(2.1-3.4)
11.	Pelbs	2.7(2.6-2.7)		2.7	3.1(2.4-5.0)
12.	OD	4.6(4.4-4.8)		5.2	5.1(4.1-6.4)
13.	H1	1.9(1.8-2.0)	2 TL	2	2.1(1.8-2.5)
14.	H2	2.8(2.6-3.0)		3.1	2.9(2.6-3.4)
15.	HCP	9.7(9.3-10.1)		10.7	10.7(8.1-14.5)
16.	LDR	1.9(1.8-1.9)		1.9	1.8(1.5-2.1)
17.	LAR	1.9(1.8-2.0)		2	1.8(1.5-2.1)
18.	Hdep	3.6		3.6	4.0(2.9-5.0)
19.	DR	62(61-63)	60		61(56-66)
20.	AR	48(47-48)	45		46(43-50)
21.	CR	19			19(17-19)
22.	PecOr	8	7	8	7(6-8)
23.	PecAR	8	7	7	7(5-9)
24.	PelOR	5		5	5(5-6)
25.	PelAR	5		5	5(4-6)
26.	CV	27			27(26-27)
27.	PCV	10(9-10)			10(9-11)
28.	LL	72(69-74)	60		73(63-83)

Colour in Alcohol

O.s. pale brown with small dark patches mostly along dorsal fin and lateral line; occasionally body is marbled with darker patches of brown or black; tip of pectoral fin brown; irregular thin brown bars present at right angles and crossing the lateral line; marbling continues onto vertical fins. B.s. white; dark lines occasionally present on head and snout.

Geographic Distribution

Sri Lanka, Ceylon, China, Thailand, Vietnam.

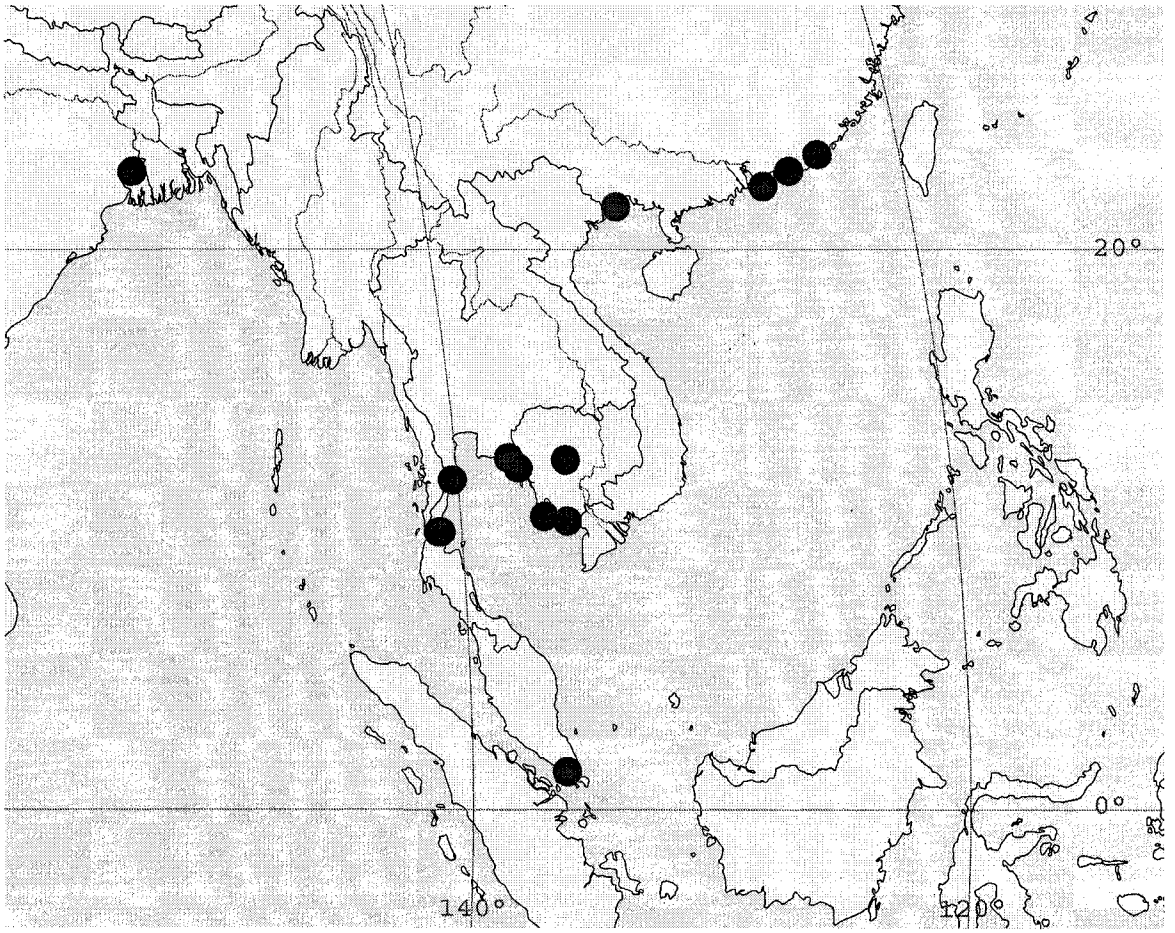

Figure 19. Geographical distribution of *Brachirus foliacea*

Remarks

Richardson's (1846) original description is of little taxonomic value due to its lack of detailed information. Günther (1862) provides a more complete description based on three non-type specimens. Günther (1862) synonimized *Solea ovalis* with *Brachirus foliacea.* This decision was based on an incomplete description by Richardson (1846) and a drawing by Reeves (1846) in Whitehead (1969) which is clearly not a *Brachirus.* Although his description of *B. foliacea* does correspond to the drawing of *S. ovalis* in Whitehead, 1969, the two cannot be considered synonyms. There are numerous characteristics that refute this synonymy, including the shape of the lateral line, which lacks the characteristic curve on the head of *Brachirus* species, the length of the mouth, which exceeds the length observed in any other *Brachirus* species, and the predorsal length which also exceeds that of any other *Brachirus.* Günther (1862) indicates that the original drawing of *S. ovalis* (for which there is no type specimen) is incorrect, but without any non-type material it is not possible to verify this statement.

Kottelat (1984) synonimized *B. orientalis* and *B. filamentosa* but based this synonymy on a specimen of *B. foliacea* which was misidentified as *B. orientalis.*

Comparisons

Brachirus foliacea is very similar in appearance to *B. orientalis* and *B cinerascens. B. foliacea* can be differentiated from *B. orientalis* by its smaller number of anal fin rays (43-50 & 51-56 respectively) and by the reduced number of caudal vertebrae (26-27 & 29-31 respectively). *B. foliacea* is different than *B. cinerascens* in the formula of the

supracranial complex and in the total number of pterigiophores (5-7 [(2-3)-0-(2-4)(1-2)] and 8-10 [(3-5)-0-(3-5)(1-2)] respectively).

B. foliacea can be distinguished from other species within *Brachirus* by the following meristics: higher number of right pectoral fins (6-8) than *B. breviceps* (2), *B. siamensis* (2-4), *B. panoides* (2-5) and *B. fitzroiensis* (5); higher caudal fin ray count (16-19) than *B. aspilos* (12-15), *B. pan* (13-15), *B. siamensis* (13-16), *B. sundaicus* (12-16) and *B. fitzroiensis* (15); fewer dorsal rays (56-66) than *B. siamensis* (67-73) and *B. panoides* (76-85); and by the number of caudal vertebrae (26-27) which is smaller than all but *B. sundaicus* and greater than all but *B. cinerascens*.

Brachirus orientalis (Bloch & Schneider 1801)

Pleuronectes orientalis Bloch & Schneider 1801

Material examined

ANSP 145353, 1(142.9 mm SL), Okha, India, BMNH 89.2.1.4028-30, 2(116.46-159.15 mm SL), Sind, Pakistan, BMNH 89.2.1.4038-9, 2(106.42-142.88 mm SL), Malabar, India, BMNH 94.11.13.41, 1(152.36 mm SL), unknown, BMNH 1920.3.3.290-296, 8(95.01-173.74 mm SL), Basra, Iraq, BMNH 1928.3.20.13, 1(129.85 mm SL), Karachi, Pakistan, BMNH 1983.5.10.18, 1(206.91 mm SL), Arabian Sea, Pakistan, FMNH 51263, 1(146.55 mm SL), Iraq, Asia, NMW 43049, 1(164.70 mm SL), Kurackee, NMW 43052:1, 1(94.40 mm SL), Bombay, India, NMW 82080, 1(162.13 mm SL), Basra, Iraq, NMW 82080:2-8, 7(139.69-176.94 mm SL), Basra, Iraq, NMW 88655:1, 1(142.71 mm SL), Basra, Iraq, NMW 88655:2-7, 6(109.30-144.43 mm SL), Basra, Iraq, NMW 88656, 1(209.90 mm SL), Basra, Iraq, NMW 88656:2-8, 7(132.73-189.57 mm SL), Basra, Iraq, NMW 88657:1, 1(180.02 mm SL), Bagdad, NMW 88657:2-6, 5(140.37-191.84 mm SL), Basra, Iraq, SMNS 14421, 1(93.74 mm SL), 29 48'N 48 25'E, Persian/Arabian Gulf, SMNS 14429, 1(66.72 mm SL), 29 54' N 48 25'E, Persian/Arabian Gulf, USNM 148018, 1(173.69 mm SL), Saudi Arabia: Persian Gulf, Tarut Bay, Ras Tanura, USNM 148093, 1(269.00 mm SL), Saudi Arabia: Persian Gulf, Tarut Bay, Zaal Id., USNM 286809, 1(74.72 mm SL), Trincomalee, Ceylon Esturies, Sri Lanka, Had Al Lowh, 2 mi. North of West Pier,

Common Names

Black sole (Kailola, 1991; Robins et al. 1991)

Blotched sole (Anon., 1972)

Oriental sole (Robins et al. 1991, Talwar & Jhingran, 1991)

Sole d'orient (Sommer, Schneider & Poutiers, 1996)

Chat yat shin (Anon, 1972)

Dali-dali (Herre & Umali, 1948)

Danchoukka serboti (Rahman, 1989)

Lenguado oriental (Menon, 1984)

Sappatee (Talwar & Kacker, 1984)

Lep (Talwar & Kacker, 1984)

Diagnosis

Brachirus orientalis can be distinguished from other *Brachirus* based on the following combination of characteristics: low number of pterigiophores in the supracranial complex, generally 5[1-0-3(1)], high number of pectoral fin rays (5-9 on the right, 5-8 on the left), high number of caudal fin rays (17-20), and a high number of vertebrae, having 29-31 in the caudal and 8-10 in the precaudal.

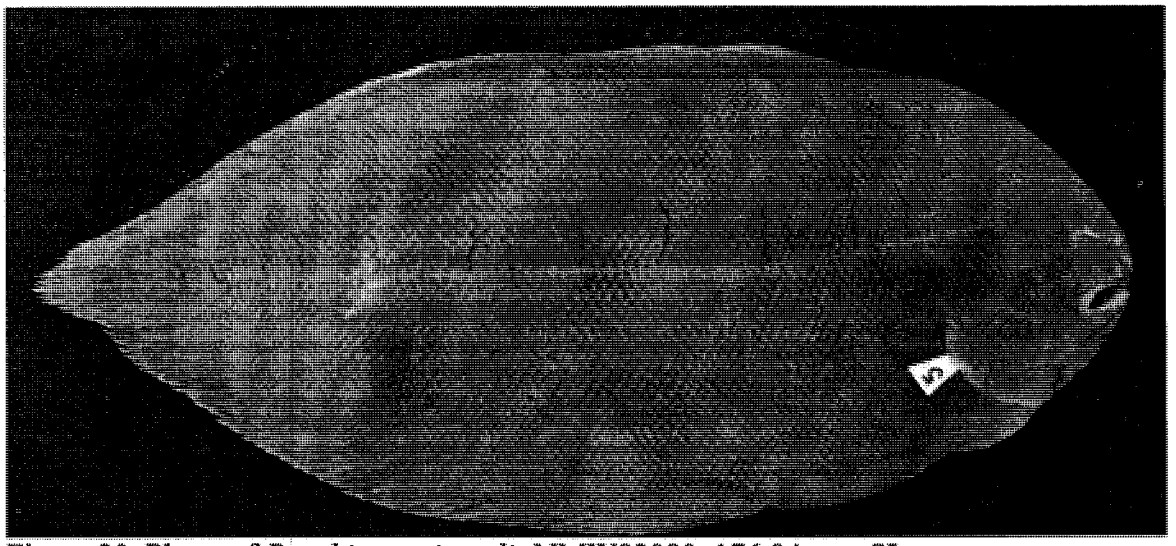
Figure 20. Photo of *Brachirus orientalis* NMW82080. 176.94 mm SL.

Description

Refer to table 11. Body elongate, head short and somewhat pointed. O.s. corner of mouth reaches past 1/3 of anterior edge of ventral eye. Snout short and narrow. O.s. anterior nostril short, thick and curved, lying anterior and mid-way between eyes; posterior nostril a short tube lying against anterior edge of ventral eye. B.s. anterior nostril a simple hole mid-way along mouth; posterior a short, flat tube extending beyond edge of mouth. B.s. of head devoid of cirri. Scales ctenoid; found on proximal half of vertical rays. Short, thick, dark cirri present as bars above and at right-angles to lateral line on right side of body. No cirri present around mouth. Teeth minute and present only on b.s. lower jaw. Dorsal eye almost directly above lower; interorbital space about equal to eye diameter. Left pectoral fin longer than right. Caudal fin rounded. Anus large, located just to b.s. of first anal fin ray; urinary papillae located at base or slightly to o.s. of first anal fin ray. Dorsal fin ray count 62-71, anal fin ray count 51-56, caudal fin ray count 17-20, pectoral fin ray count 5-9 on right side, 5-8 on left; pelvic fin ray count 4-6. Dorsal, anal and caudal fins united, anterior end of dorsal fin approaching anterior edge

of upper lip. Total vertebrae 39-41: 29-31 caudal and 8-11 precaudal, lateral line scales 66-78. Average supracranial pterigiophores 5 of the formula 1-0-3(1) (Range of 4-6 [(1-2)-0-(2-4)(1-2)] (for description of formula see Methods).

Table 11. Morphometrics and meristics for *Brachirus orientalis* and all non-type material. Abbreviations are defined in Appendix 1; characters 2 to 12, 16-17 are expressed in hundredths of HL, characters 1, 13-15, 18 are expressed in hundredths of SL, unless otherwise stated, and 19 to 28 are meristics.

	Character	Bloch & Schneider, 1801	non-type
1.	HL		4.5(3.9-5.4)
2.	E		8.3(5.0-12.9)
3.	S		3.5(2.6-4.3)
4.	DNS		5.6(4.1-7.8)
5.	Mos		3.4(2.7-4.2)
6.	Mbs		3.8(2.9-5.1)
7.	Pred		4.5(2.4-9.4)
8.	Pecos		2.8(1.7-5.2)
9.	Pecbs		3.5(2.4-5.3)
10.	Pelos		2.9(2.3-3.9)
11.	Pelbs		3.1(2.4-5.1)
12.	OD		5.0(3.2-6.9)
13.	H1		2.1(1.7-2.7)
14.	H2		3.0(2.5-4.3)
15.	HCP		11.4(3.6-17.3)
16.	LDR		2.1(1.5-3.7)
17.	LAR		2.0(1.5-4.0)
18.	Hdep		3.7(1.8-7.1)
19.	DR		67(62-71)
20.	AR		53(51-56)
21.	CR		19(17-20)
22.	PecOr	6	7(5-9)
23.	PecAR	6	7(5-8)
24.	PelOR	4	5(4-6)
25.	PelAR	4	5(4-6)
26.	CV		30(29-31)
27.	PCV		10(8-11)
28.	LL		72(66-78)

Colour in Alcohol

O.s. mocha brown, occasionally with dark reddish-brown marbling; remnants of dark, irregular dorsal bars lying at right angles across and above the lateral line; right pectoral fin darkly tipped. B.s. golden brown, lacking any pigmentation.

Geographic Distribution

Indo-West Pacific: Red Sea and Persian Gulf, then off the west coast of India and Sri Lanka.

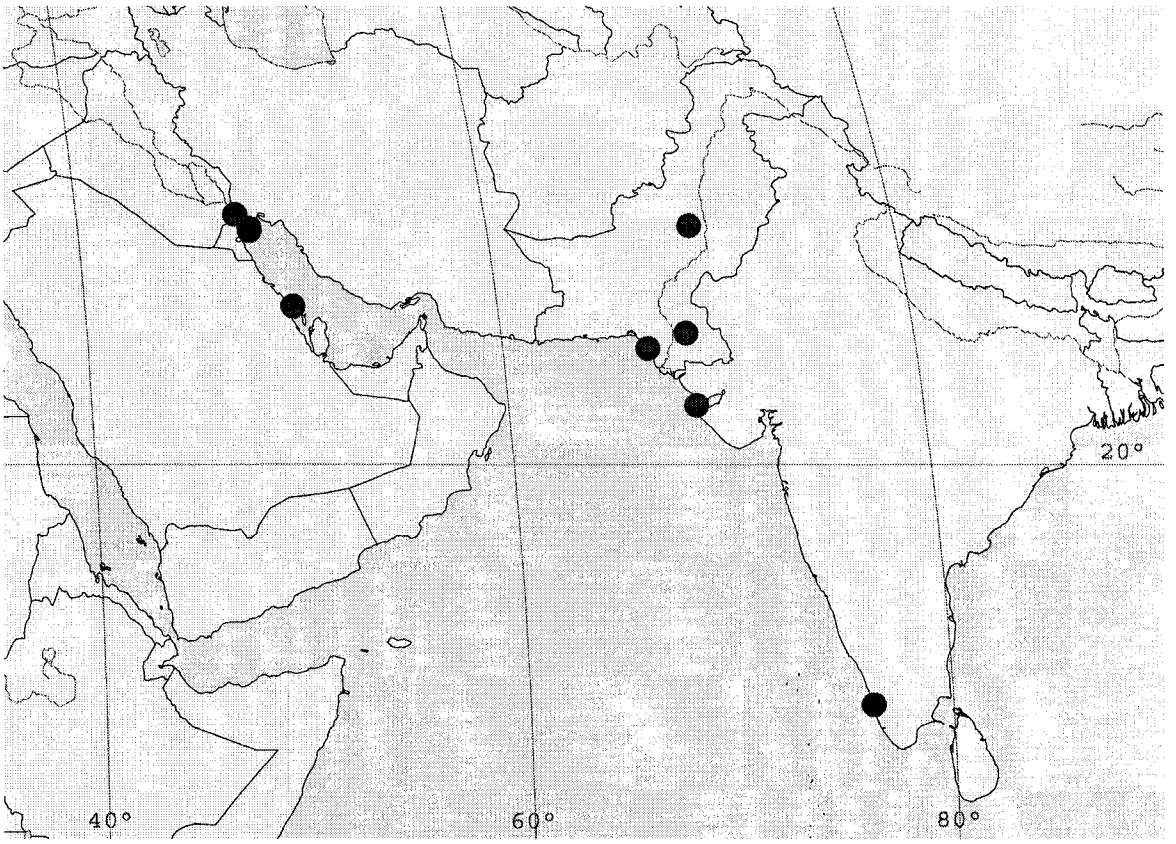

Figure 21. Geographical distribution of *Brachirus orientalis*

Remarks

Chabanaud (1930) examined the type specimens of *B. orientalis* in Berlin, and identified the original description as being without taxonomic value because the types could be assigned to different species: *B. orientalis* and *Zebrias altipinnis*. Both these species match the original description by Bloch & Schneider (1801). One type specimen matches the genus description by Swainson (1839), the other, however, has been identified by Chabanaud (1930) as being *Zebrias altipinnis*. Because the original description counts are an average between the two types, it is not possible to determine the actual counts for *B. orientalis*. And although Norman (1926) synonymizes *B. orientalis* and *B. nigra*, Chabanaud (1930) recognizes certain differences between these two species, such that the shape of the scales and urohyl.

Day (1888) distinguishes *B. orientalis* from *B. pan* by the size of the scales on the nape of the neck.

Comparisons

B. orientalis is most closely related to *B. foliacea*. These two species share almost all meristics and morphometrics except: *B. orientalis* has a higher caudal vertebrae count (29-31 vs. 26-27), anal fin ray count (51-56 vs. 43-50) and a different supracranial complex (1-0-3(1) in *B. orientalis*, 2-0-3(1) in *B. foliacea*). *B. orientalis* is also closely related to *B. cinerascens* which has more pterigiophores in the supracranial complex (4-0-4(1)).

B. orientalis can be distinguished from other *Brachirus* species by a number of characters: greater number of caudal vertebrae (29-31) than all other species except *B. panoides*, *B. cinerascens* and *B. foliacea* and it has fewer dorsal fin rays (62-71) than *B. panoides* (76-85).

Brachirus pan (Hamilton 1822)

Pleuronectes pan Hamilton 1822

Material examined

ANSP 83989, 2(42.66-54.03 mm SL), Pulta Water Works, Barrackpore District, India, BMNH (not catalogued), 1(65.56 mm SL), unknown, BMNH 89.2.1.4040, 1(132.28 mm SL), 01 22' N 103 48' E, Singapore, BMNH 1852.10.4.87, 1(97.05 mm SL), unknown, BMNH 1928.3.20.19-22, 4(43.52-54.45 mm SL), SantiapurMarshed, India, BMNH 1928.20.15-17, 3(44.40-67.50 mm SL), Sunderbunds, India, BMNH 1928.3.20.14, 1(65.37 mm SL), Calcutta, India, CAS 135708, 1(45.60 mm SL), Pulta, West Bengal, India, MNHN 1976-0378, 1 of 2(73.09 mm SL), 18 30'N 84 46'E, India, NMW 43050, 1(77.52 mm SL), Calcutta, India, NMW 43051, 1(66.56 mm SL), Meetan, NMW 43052:2, 1(83.90 mm SL), Bombay, India, USNM 044737, 1(85.00 mm SL), Lower Burma, Rangoon, British India

Common Names

Kathal pata (Rahman, 1989)

Pan sole (Talwar & Kacker, 1984)

Suistoantura (Varjo, Koli & Dahlström, 2004)

Diagnosis

B. pan can be distinguished from other *Brachirus* by the rows of enlarged scales on the nape of the neck.

Figure 22. Photo of *Brachirus pan* NMW43052. 83.9 mm SL.

Description

Refer to table 12. Body oval, head short and bluntly pointed. O.s. corner of mouth reaches past 1/3 of anterior edge of ventral eye. O.s. anterior nostril a very short, thin tube; posterior nostril a simple tube lying against anterior edge of ventral eye. B.s. anterior nostril a hole covered by a circular flap of fringed cuticle; posterior nostril a simple hole in vertical line with corner of mouth and more dorsal than anterior nostril. Thickened cirri restricted to snout region on b.s. of head. Scales ctenoid; found on proximal half of vertical rays; scales enlarged on nape of neck. Body and mouth devoid of cirri. Teeth minute and present only on b.s. lower jaw. Dorsal eye in advance of lower by about half its diameter; interorbital space about equal to eye diameter. Right pectoral fin slightly longer than left. Caudal fin rounded. Anus located just to b.s. of first anal fin ray; urinary papillae located at base or slightly to o.s. of first anal fin ray. Dorsal fin ray count 53-61, anal fin ray count 42-48, caudal fin ray count 13-15, pectoral fin ray count 4-7; pelvic fin ray count 4-5. Dorsal, anal and caudal fins united, anterior end of dorsal

fin approaching anterior edge of upper lip. Total vertebrae 32-34: 23-25 caudal and 8-10 precaudal, lateral line scales 56-79. Average supracranial pterigiophores 7 of the formula 3-0-3(1) (range of 6-8 [(3-4)-0-(2-4)(1)]) (for description of formula see Methods).

Table 12. Morphometrics and meristics for *Brachirus pan* type description and non-type material. Abbreviations are defined in Appendix 1; characters 2 to 12, 16-17 are expressed in hundredths of HL, characters 1, 13-15, 18 are expressed in hundredths of SL, and 18 to 28 are meristics.

	Character	Hamilton, 1822	non-type
1.	HL		4.2(3.8-4.6)
2.	E		7.1(6.0-10.2)
3.	S		3.2(2.6-3.9)
4.	DNS		4.7(3.9-6.0)
5.	Mos		3.5(3.0-4.0)
6.	Mbs		3.8(3.1-4.6)
7.	Pred		4.3(2.9-8.3)
8.	Pecos		2.7(2.0-3.9)
9.	Pecbs		3.3(2.4-4.2)
10.	Pelos		2.8(2.3-3.4)
11.	Pelbs		2.9(2.3-3.5)
12.	OD		4.4(3.6-5.7)
13.	H1		2.1(1.9-2.3)
14.	H2		3.1(2.5-3.6)
15.	HCP		10.9(9.3-13.1)
16.	LDR		1.8(1.4-2.2)
17.	LAR		1.8(1.5-2.3)
18.	Hdep		3.3(3.0-4.1)
19.	DR		59(53-61)
20.	AR		45(42-48)
21.	CR		14(13-15)
22.	PecOr		5(4-7)
23.	PecAR	5	5(4-7)
24.	PelOR	5	4(4-5)
25.	PelAR	4	4(4-5)
26.	CV	4	24(23-25)
27.	PCV		9(8-10)
28.	LL		68(56-79)

Colour in Alcohol

O.s golden brown with dark patches around the periphery of the body, and faint speckles in the centre of the body, right pectoral fin dark brown, some dark speckles present on the chin near the pelvic fins. B.s. pale golden brown without any distinct marking or colouration.

Geographic Distribution

Indo-West Pacific: east coast of India, to Singapore.

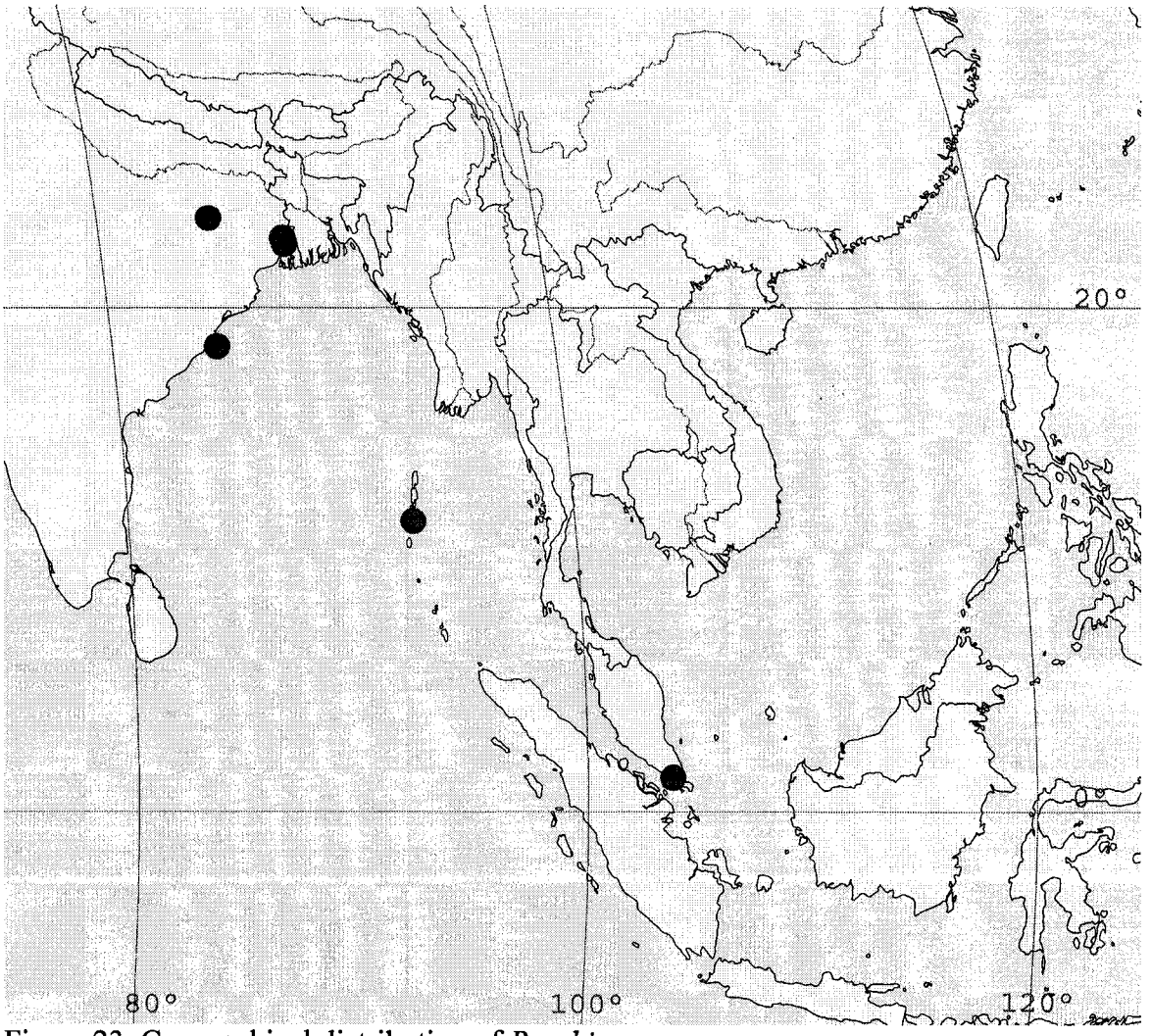

Figure 23. Geographical distribution of *Brachirus pan*

Remarks

According to various studies (Bleeker 1870-75, Günther 1862, Day 1888) *Pleuronectes canus* Gray 1854 has been considered a synonym of *Brachirus pan*, but the type description provides no morphometric or meristic data. The above-mentioned studies describe the increased size of the scales on the nape of the neck as being distinguishing. Without observing the type material it is not possible to verify this synonymy.

Comparisons

In addition to the enlarged scales on the nape of the neck, *B. pan* can be distinguished from other *Brachirus* based on the following observable differences: *B. pan* has more pectoral fin rays (4-6) than *B. breviceps* (2); fewer caudal fin rays (13-15) than *B. cinerascens* (17-19), *B. foliacea* (16-19), and *B. orientalis* (17-19); fewer lateral line scales (56-79) than *B. fitzroiensis* (84), and *B. panoides* (82-121); fewer caudal vertebrae (23-25) than *B. siamensis* (28-32), *B. sundaicus* (26-30), and *B. selheimi* (28-32).

Brachirus panoides (Bleeker 1851)

Synaptura panoides Bleeker 1851

Material examined

panoides: BMNH 1862.6.3.7, Holotype(134.67 mm SL), Singapore. AMNH 14576, 1(182.08 mm SL), unknown, ANSP 61641, 9(42.85-162.04 mm SL), Bangkok, Siam, Thailand, BMNH 47.2.9, 1(176.41 mm SL), unknown, BMNH 80.9.25.1-2, 2(132.71-155.07 mm SL), unknown, BMNH 91.1.27.11, 1(208.29 mm SL), Baram, Borneo, Malaysia, BMNH 98.4.2.135-7, 2(106.26-134.19 mm SL), Me Nam River, Thailand, CMK 7628, 7(83.58-137.06 mm SL), Mahakam River, Kalimantan Timur, Borneo, MNHN A-5004, 2(94.77-104.71 mm SL), Bangkok, Thailand, MNHN A-6423, 1(165.89 mm SL), Siam, Thailand, MNHN 0000-2002, 2(66.92-115.82 mm SL), Ajuthia, Siam, Thailand, MNHN 1976-0386, 1(124.86 mm SL), Indonesia, NMW 43053, 1(132.15 mm SL), Palembeng-Fluss, NMW 43054:1, 1(145.11 mm SL), Borneo, NMW 43054:2-3, 2(54.03-118.46 mm SL), Borneo, NMW 43055, 1(141.27 mm SL), Lahat, Sumatra, NMW 82015:1, 1(203.67 mm SL), Mooro Teweh, NMW 82015:2, 1(174.92 mm SL), Mooro Teweh, QMI.5983, 1(133.71 mm SL), 19 11' S 147 01' E, Cape Cleveland, QMI.30128, 2(175.02-185.45 mm SL), 0 02'S 115 31'E, Mahakam R, nr Tinginan R confluence, E Kalimantan 0.02 S 115.31 E, USNM 103317, 1(192.50 mm SL), Menam Chao Phya et Pakret, C. Siam, Thailand, USNM 103318, 1(211.00 mm SL), Menam Chao Phya, at Bang Torani, C. Siam, Thailand.

Common Names

Cá luoi mèo (Khoa & Huong 1993)

Ilat-ilat (Schuster & Djajadiredja 1952)

Lidah (Schuster & Djajadiredja 1952)

Pa pan gnai (Baird 1998)

Trey andat chhke veng (Rainboth 1996)

Diagnosis

Brachirus panoides differs from other *Brachirus* by the combined characteristics of the elongate body shape, high number of dorsal and anal fin rays (76-85 and 56-65 respectively) and high number of caudal vertebrae (32-35).

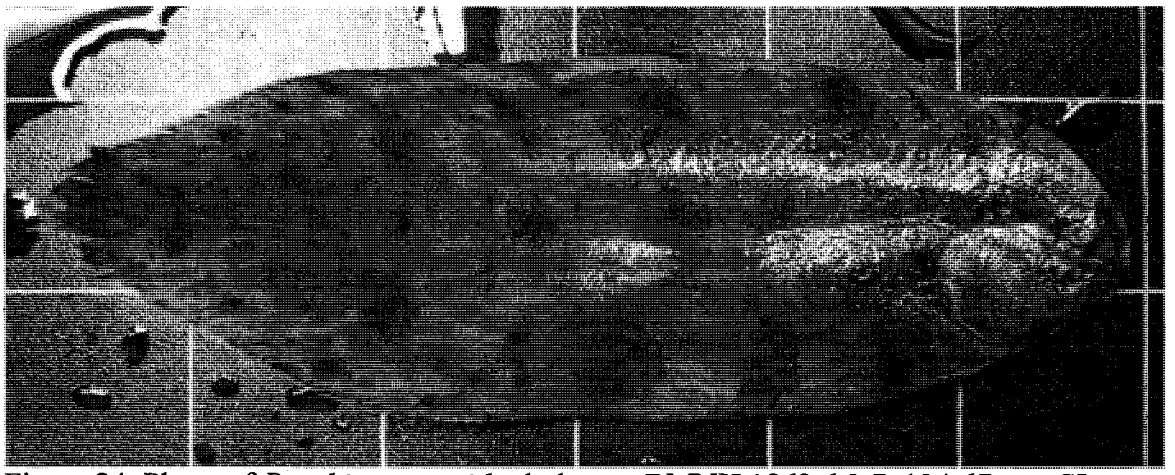

Figure 24. Photo of *Brachirus panoides* holotype BMNH 1862.6.3.7. 134.67 mm SL.

Description

Refer to table 13. Body oblong, head short and somewhat pointed. O.s. corner of mouth reaches past 1/3 of anterior edge of ventral eye. O.s. anterior nostril short and thick; posterior nostril only slightly tubular, lying against anterior edge of ventral eye. B.s. anterior nostril a hole surrounded by intricate fringe of cirri. Thickened cirri restricted to snout and chin region. Scales ctenoid. Short, thin, dark cirri patchily present on body. Small cirri on lower lip. Teeth minute and present only on b.s. lower jaw. Dorsal eye in advance of lower by about half its diameter; interorbital space about equal to eye diameter. Right pectoral fin longer than left. Caudal fin rounded. Anus located just to b.s. of first anal fin rays; urinary papillae located at base or slightly to o.s. of first anal fin ray. Dorsal fin ray count 76-85, anal fin ray count 56-65, caudal fin ray count 15-17, pectoral fin ray count 2-5 on right side, 2-5 on left; pelvic fin ray count 3-5. Dorsal, anal and caudal fins united, anterior end of dorsal fin approaching anterior edge of upper lip. Total vertebrae 42-46: 32-35 caudal and 9-11 precaudal, lateral line scales 82-121. Average supracranial pterigiophores 8 of the formula 3-0-4(1) (range of 7-9 [(2-4)-0-(3-5)(1-2)]) (for description of formula see Methods).

Table 13. Morphometrics and meristics for *Brachirus panoides* holotype BMNH 1862.6.3.7, and all non-type material. Abbreviations are defined in Appendix 1; characters 2 to 12, 16-17 are expressed in hundredths of HL, characters 1, 13-15, 18 are expressed in hundredths of SL, unless otherwise stated, and 19 to 28 are meristics.

	Character	Bleeker, 1851	Holotype	non-type
1.	HL	5.7 TL	4.9	5.2(4.1-6.0)
2.	E	8-9	7.6	9.0(6.7-11.9)
3.	S		3.4	3.4(3.0-4.3)
4.	DNS		4.8	5.0(3.9-7.7)
5.	Mos		3.2	3.5(2.9-4.3)
6.	Mbs		4.3	4.3(3.5-5.4)
7.	Pred		6.1	5.3(2.9-9.0)
8.	Pecos		7.8	7.4(2.3-15.4)
9.	Pecba		5.5	5.7(2.8-8.2)
10.	Pelos		3.4	3.3(2.7-3.4)
11.	Pelbs		3.2	3.3(2.7-4.0)
12.	OD		5.1	4.7(3.1-5.6)
13.	H1	3 TL	2.6	2.6(2.3-3.0)
14.	H2		3.5	3.7(2.6-4.5)
15.	HCP		14.3	15.3(9.1-23.6)
16.	LDR		1.7	1.9(1.5-2.6)
17.	LAR		2.0	1.9(1.5-2.3)
18.	Hdep		4.8	5.0(3.1-6.4)
19.	DR	82	79	80(76-85)
20.	AR	63	59	62(56-65)
21.	CR	16	16	16(15-17)
22.	PecOr	5	3	3(2-5)
23.	PecAR	5	5	4(2-5)
24.	PelOR	4	4	4(3-5)
25.	PelAR	4	4	4(3-5)
26.	CV		32	33(32-35)
27.	PCV		11	10(9-11)
28.	LL		101	101(82-121)

Colour in Alcohol

O.s of body golden brown with irregular dark brown patches; faint residual brown bars across body; snout region brown. Vertical fins speckled; right pectoral fin dark. B.s. golden, snout region white.

Geographic Distribution

Freshwater: Rivers and brackish waters of Thailand and Indonesia.

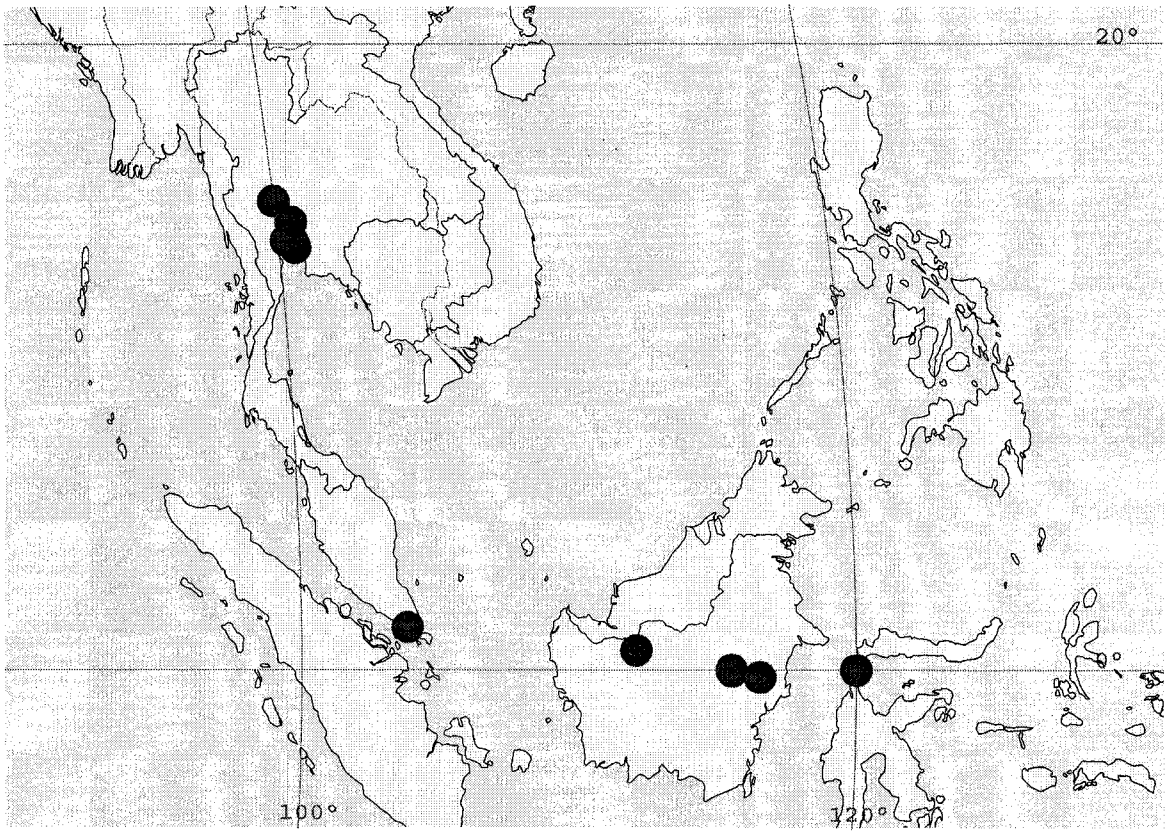

Figure 25. Geographical distribution of *Brachirus panoides*

Remarks

Whitley (1931) proposed replacing *Synaptura panoides* by *Chabanaudetta panoides* in order to replace *Anisochirus* Günther 1862 which Whitley erroneously considered to be

twice preoccupied without providing any explanation. *Anisochirus*, however, is a subgenus, thus this replacement is unnecessary and incorrect.

I agree with Kottelat (1984) that Norman (in Smith, 1945) was incorrect in considering *S. panoides* as a synonym of *S. siamensis*. There are very distinct differences between these two species including the dorsal and anal fin ray counts and the lateral line scale count (see Comparisons). Although Kottelat was not able to examine the type specimen of *B. panoides*, I confirm that these differences do exist.

Bleeker (1870-75) indicated that *Brachirus panoides* has many similarities with *B. pan* and *B. sundaicus*, though there are sufficient differences keeping them distinct, such as the elongated body of *B. panoides*, the smaller and more numerous scales, and the dorsal and anal fin rays are also more numerous. Bleeker (1851) indicated that *B. panoides* is closely related to *B. pan* and *Solea ovalis*, though it differs in the size of the scales and in the presence of cirri on the scales.

Comparisons

B. panoides (76-85) has more dorsal fin rays than *B. aspilos* (65-75), *B. cinerascens* (61-70), *B. fitzroiensis* (67), *B. foliacea* (56-66), *B. siamensis* (67-73), and *B. sundaicus* (53-63); more lateral line scales (82-121) than *B. breviceps* (74), *B. orientalis* (66-76), *B. pan* (56-79), *B. selheimi* (58-76).

Brachirus selheimi (Macleay 1882)

Synaptura selheimi Macleay 1882

Synaptura villosus Weber 1907

Brachirus salinarum Ogilby 1910

Material examined

villosus: BMNH 1913.12.15.37, Holotype(72.47 mm SL), Lorentz River, Irian Jaya, Papau New Guinea, ZMA 108.181, 1(unpublished holotype [according to Eschmeyer 2006]) (48.48 mm SL), River Wagani drainage area of the Urama, south coast, fresh water, New Guinea.

salinarum: QMI.870, Holotype(114.98 mm SL), Paratype (101.04 mm SL), Kimberley, NQ, Australia.

AMI.17972-001, 1(76.8 mm SL), 19 36'S 139 33'E, Leichardt River, by Lake Moondarra, near Mt. Isa Qld, AMI.17995-002, 1(73.48 mm SL), 25 47' S 149 34' E, Dawson River, 8 km above Orange Weir, AMI.18091-001, 1(69.11 mm SL), 12 22'S 132 58'E, E Alligator R system: Cahills Landing,AMI.38957-001, 1(47.05 mm SL), 14 56' N 133 45' E, Stangways Creek, AMIB.2218, 1(80.9 mm SL), 13 56'S 143 11'E, The Bend, Cohen River, Coen, AMIB.2219, 1(103.82 mm SL), 13 56'S 143 11'E, The Bend, Cohen River, Coen, AMIB.2356-2355, 2(84.57- 86.88 mm SL), Coen River, Coen, AMNH 57318, 64(26.86-63.02 mm SL), unknown, BMNH 1913.12.9.211, 1(63.70 mm SL), Mimika River, Dutch New Guinea, CSIRO A 3719, 1(56.31 mm SL), 17 10'S 141 45'E, Qld, Gilbert River Ford, near Sterling, CSIRO A 3720, 1(58.65 mm SL), 17 10'S 141 45'E , Qld, Gilbert River Ford, near Sterling, CSIRO A 4157, 1(54.92 mm SL), 16 14'S

141 25'E, Qld, Inkerman Station, small creek, CSIRO B 1122, 1(33.38 mm SL), 17 10'S 141 45'E, Qld, Gilbert River Ford, near Sterling, CSIRO H 4934-01, 4(33.14-53.33 mm SL), 4°24'S, 136°53'E, Ajkwa River, Irian Jaya, NTM S.1623-001, 1(66.46 mm SL), 17 47' S 132 58' E, Fish River Gorge, N.T., NTM S.10868-002, 2(48.11-51.66 mm SL), 12 24' S 132 58' E, Cannon Hill Lagoon, E. Alligator R, N.T., NTM S.11609-017, 1(69.49 mm SL), 30 07' S 131 18' E, Howley Ck floodplain, N.T., NTM S.12285-002, 1(58.66 mm SL), 13 6' S 131 23' E, NTM S.12493.001, 1(66.88 mm SL), 13 34' S 132 35' E, Fisher Ck, S. Alligator R., N.T., NTM S.12494-001, 1(41.89 mm SL), 13 35' S 132 35' E, Gimbat Causeway, S. Alligator R., N.T., NTM S.12632-005, 3(33.36-37.7 mm SL), 12 21' S 134 05' E, Liverpool R, RD Xing, Arnhem land, N.T., NTM S.13513-005, 1(80.02 mm SL), 15 36'S 136 20'E, Mouth of Bing Bong Creek, N.T., NTM S.14028-021, 1(64.14 mm SL), 14 48.46'S 135 22.69'E, E Nayarnpick Ck., Roper River, N.T., 0-1m, NTM S.14042-027, 1(66.81 mm SL), 14 54'53"S 135 25'49"E, Ck at towns river mouth, N.T., 0.5-1.5 m, QMI.7700, 1(105.86 mm SL), 21 02'N 141 48'E, Toorak Stn, Flinders R system, S of Julia Creek, QMI.9075, 1(106.38 mm SL), 20 35'S 139 32'E, Lake Moondarra, Leichhardt River system, QMI.9618, 1(44.11 mm SL), 20 39'S 142 09'E, Flinders River, at road crossing, 7 mi W of Neila, QMI.12513, 3(87.17- 110.69 mm SL), 20 44'S 139 29'E, Mt Isa, Leichhardt River system, QMI.13559, 1(54.17 mm SL), 12 57'S 132 33'E, Alligator River area, QMI.26155, 1(54.01 mm SL), 17 49' S 144 44' E, QMI.26720, 1(71.43 mm SL), 11 33'S 142 26'E, Cockatoo Ck, 70 km S of Bamaga, QMI.28165, 3(50.37-76.54 mm SL), 12 29'S 142 29'E, Wenlock R, at Batavia Downs fenceline, QMI.31547, 1(71.33 mm SL), 16 59'S 144 18'E, Walsh River, Ferguson Crossing, QMI.32807, 3(60.82-63.93 mm SL), 15 58'N 142 23'E, Hughes Crossing,

Mitchell R, Highbury Stn., QMI.32825, 2(63.59-87.49 mm SL), 16 41' S 145 14' E, QMI.32836, 4(57.17-72.88 mm SL), 16 32'N 143 47'E, Walsh River, Trimble crossing, Mitchell R system, QMI.36668, 3(57.83-74.72 mm SL), 17 53'S 140 47'E, Flinders River at Burketown Crossing,QMI 37205, 1(37.96 mm SL), 20 26'S 142 03'E, Punchbowl Waterhole, Flinders River, QMI.40100, 1(45.49 mm SL), 17 35'00"S 143 00'12"E, Bel Bel, Einasleigh R, trib. Gilbert R., QMI.40102, 1(82.91 mm SL), 17 34'45"S 140 57'59"E, Norman River, NWQ, QMI.40103, 1(73.25 mm SL), 17 39'28"S 141 05'15"E, Norman River near Normanta boat ramp, QMI.20890003, 1(99.54 mm SL), 16 38'S 130 25'E, Victoria River Dr. Little Morse Creek, USNM 217315, 1(25.03 mm SL), 6°08'30"S, 141°19'36"E, tributary of Siniam Creek, Papau New Guinea, USNM 217317, 1(49.13 mm SL), 6°24'24"S, 140°56'30"E, Lower Kanggu River, Papua New Guinea, WAM P2828-001, 1(206.5 mm SL), WA, Australia, WAM P25890-010, 1(45.65 mm SL), 12 48' S 131 38' E, Northern Territory, Viary River, Arnhem Highway Crossing, WAM P31344-006, 6(35.27-65.8 mm SL), 7°44' S, 146°30' E, Laekamu, Lyimka Camp, Sapoi R. at bulldog track crossing: cobbles, boulders, sand, Papau New Guinea, WAM P31352-007, 4(35.94-61.42 mm SL), 7°46' S, 146°28' E, Avi Avi River Tributary, Papau New Guinea.

Common Names

Velvety sole (Kailola 1991)

Australische Süßwasserseezunge (Baensch & Riehl 1985)

Marmoriantura (Varjo, Koli & Dahlström 2004)

Saltpan sole (Allen 1989)

Freshwater sole (Allen 1989)

Pähkinäantura (Varjo, Koli & Dahlström 2004)

Selheim's sole (Allen 1989)

Diagnosis

Brachirus selheimi can be distinguished from other *Brachirus* by the combined characteristics of its elongate body shape, speckled vertical fins, and the number of dorsal and anal rays (58-76 and 45-59, respectively).

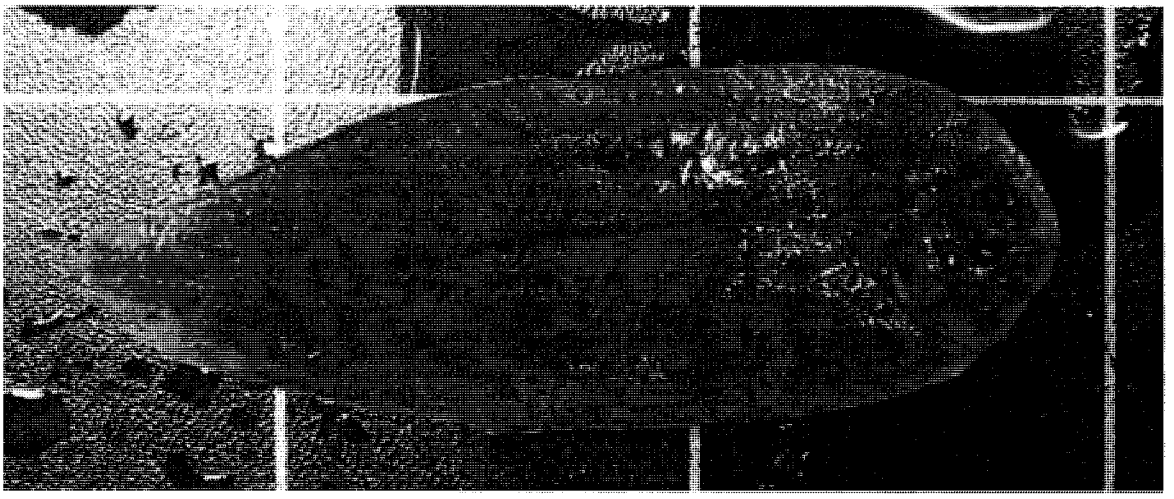

Figure 26. Photo of *Brachirus selheimi* BMNH1913.12.9.211. 63.7 mm SL.

Description

Refer to table 14. Body elongate, head bluntly pointed. O.s. corner of mouth reaches past 1/3 of anterior edge of ventral eye. O.s. anterior nostril short, wide, fleshy and slightly curved posteriorly; posterior nostril short tube lying against anterior edge of ventral eye. B.s. anterior nostril a hole surrounded by intricate fringe of cirri. Snout overhanging mouth. Thickened cirri covering anterior half of head and edge of operculum on b.s. Scales ctenoid. Few dark, long cirri evenly dispersed on body. Small cirri present on lower lip of mouth. Teeth minute and present only on b.s. lower jaw. Dorsal eye in advance of lower by half or more its diameter; interorbital space slightly smaller than eye diameter; eyes protruding more nearest to interorbital space. Right pectoral fin generally longer than left. Caudal fin bluntly pointed. Anus located just to b.s. of base of urinary papillae which is located at base of first anal ray. Dorsal fin ray count 58-83, anal fin ray count 45-61, caudal fin ray count 13-16, pectoral fin ray count 3-9 on right, 2-8 on left; pelvic fin ray count 4-6. Dorsal, anal and caudal fins united, dorsal approaching anterior edge of upper lip. Total vertebrae 38-43: 28-35 caudal and 8-10 precaudal, lateral line scales 58-97. Average supracranial pterigiophores 7 of the formula 3-0-3(1) (range of 5-9 [(2-5)-0-(2-5)(0-3)]) (for description of formula see Methods).

Table 14. Morphometrics and meristics for *Brachirus villosus* holotype BMNH 1913.12.15.37, *B. salinarum* holotype and paratype QMI.870, *B. selheimi* and all non-type material. Abbreviations are defined in Appendix 1; characters 2 to 12, 16-17 are expressed in hundredths of HL, characters 1, 13-15, 18 are expressed in hundredths of SL, unless otherwise stated, and 189 to 28 are meristics.

		villosus		*salinarum*			*selheimi*	
	Character	Weber, 1907	Holotype	Ogilby, 1910	Holotype	Paratype	MacLeay, 1882	non-type
1.	HL	5.5 TL	5.1	5	5.0	5.1		4.5(3.9-5.3)
2.	E		5.0	8.0	6.9	6.4		5.0(3.4-8.1)
3.	S		3.6	3.0	3.1	3.6		3.2(2.4-4.5)
4.	DNS		5.6		5.0	3.5		4.4(3.0-6.1)
5.	Mos		3.1		3.1	5.4		3.3(2.3-6.6)
6.	Mbs		3.2		4.0	3.8		3.8(2.7-5.8)
7.	Pred		3.2		5.5	4.5		4.0(1.8-8.0)
8.	Pecos	6.5	3.5	2.5	2.5	2.5		3.4(2.0-8.4)
9.	Pecba		4.8	2.5	2.6	2.8		4.1(2.2-21.5)
10.	Pelos		2.5		2.1	1.9		2.5(1.9-3.7)
11.	Pelbs		2.6		2.0	2.0		2.6(2.0-3.9)
12.	OD		5.0		5.6	5.4		5.2(3.6-11.1)
13.	H1	3.5 TL	2.8	2.9	2.6	2.6	3 TL	2.9(2.3-3.6)
14.	H2		4.0		3.7	3.4		4.2(2.7-10.0)
15.	HCP		13.6		11.7	12.9		14.2(10.1-24.30
16.	LDR		2.3		3.0	3.6		2.5(1.7-4.7)
17.	LAR		2.1		2.8	3.4		2.4(1.6-3.8)
18.	Hdep	1.3	4.4		4.6	5.1		4.7(3.3-6.6)
19.	DR	65	72	66	68	70		67(58-83)
20.	AR	52	54	53	53	55		52(45-61)
21.	CR		16					15(13-16)
22.	PecOr		5		8	8	6	6(3-9)
23.	PecAR		5		8	8		6(2-8)
24.	PelOR		5		6	6		5(4-6)
25.	PelAR		5		6	6		5(4-6)
26.	CV		30		31	30		31(28-35)
27.	PCV		8		8	8		8(8-10)
28.	LL	66	71	84	89	90	81	82(58-97)

Colour in Alcohol

O.s. golden brown with faint darker brown patches giving a marbled appearance; vertical fins speckled. B.s. pale and lacking pigmentation.

Geographic Distribution

Freshwater in central-southern New Guinea; Rivers and pools of Dutch South New Guinea Oceania and Australia. Also found in the salt pans at Kimberley, North Queensland.

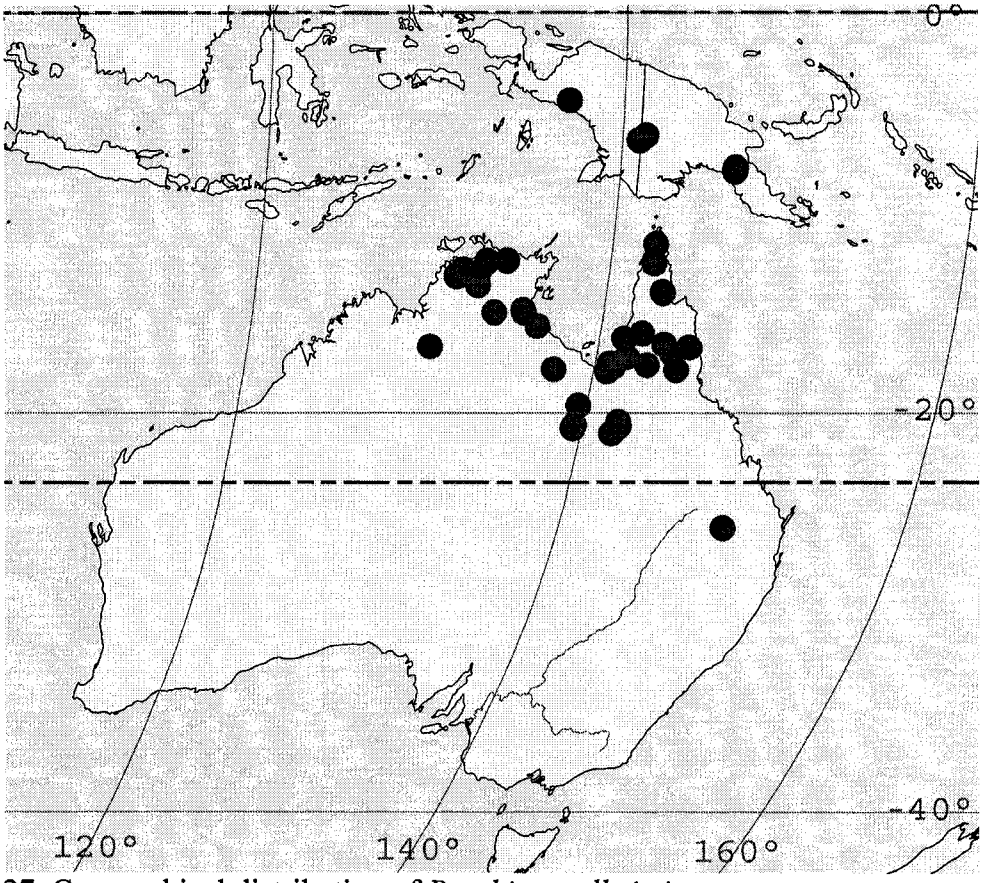

Figure 27. Geographical distribution of *Brachirus selheimi*

Remarks

According to Weber (1907), *B. villosus* is closely related to *D. macrolepis*, though it differs in the position of the eyes, and in the lengths of the pectoral fins. Type description by Ogilby (1910) is true to the type specimen.

Though the type specimens of *B. selheimi* could not be obtained, the type description is very similar to that of *B. villosus*. Geographical distributions and all counts and measurements overlap as well supporting this synonymy.

Comparisons

B. selheimi is most closely related to *B. panoides*, and is very similar in shape and meristics, though it differs in lateral line scales counts (see below) and the geographic distribution of these two species is quite unique, *S. panoides* is more northern being located around Thailand and Indonesia.

B. selheimi has fewer caudal vertebrae (28-32) than *B. aspilos* (33-35) and more than *B. foliacea* (26-27), and *B. pan* (23-25); has more o.s. pectoral fin rays (3-6) *B. breviceps* (2); fewer caudal fin rays (15-16) than *B. cinerascens* (17-19), and *B. orientalis* (15-16); fewer lateral line scales (58-76) than *B. fitzroiensis* (84), and *B. panoides* (82-121). *B. selheimi* has a much more oval body than *B. sundaicus*. *B. selheimi* differs from *B. siamensis* by the combination of having more pectoral fin rays (3-7 vs. 2-4) and fewer lateral line scales (58-85 vs. 70-96); *B. siamensis* is also geographically isolated from *B. selheimi* being located only around Thailand.

Brachirus siamensis (Sauvage 1878)

Synaptura siamensis Sauvage 1878

Synaptura krempfi Durand 1940

Chabanaudetta smithi Joglekar 1971

Material examined

AMI 43485-015, 2(91.05-102.93 mm SL), 12 15'N 104 45'E, Tonle Sap River, AMI 43485-017, 1(79.31 mm SL), 12 15'N 104 45'E, Tonle Sap River, AMI 43486-022, 2(91.73-118.81 mm SL), 12 30'N 104 00'E, Northern Lake Tonle Sap, near Siem Reap, AMI 43487-042, 2(99.18-99.44 mm SL), 12 17'N 104 41'E, Tonle Sap River, 3-5 km downstream from Kompong Chhnang, AMI 43747-016, 1(87.24 mm SL), 12 15'N 104 45'E, Tonle Sap River, ANSP 61641, 1 of 9(42.85 mm SL), Bangkok, Siam, Thailand, BMNH 98.4.2.135-7, 2(106.26-143.19 mm SL), Me Nam River, Thailand, BMNH 1928.5.22.1 , 1(127.06 mm SL), Menan Chao Phya, near Bangkok, Siam, Thailand, BMNH 1934.12.18.76, 1(162.46 mm SL), Menan Chao Phya, Ban Pahan, Siam, Thailand, CAS 67232, 1(144.31 mm SL), Bangpakong River, Prachinbury, Thailand, MNHN A-6436-7, 4(83.02-111.33 mm SL), Phnom-penh, Cambodia, MNHN 0000-9644, 1(126.30 mm SL), Stung strang, Cochincin, Vietnam, MNHN 1965-0469-76, 9(67.03-139.54 mm SL), Cambodia

Diagnosis

Brachirus siamensis can be differentiated from other *Brachirus* by the combined characteristics of the elongate body shape, thin bars along the o.s. of the body and by the number of dorsal fin rays (67-73).

Figure 28. Photo of *Brachirus siamensis* MHNA-6437. 98.2 mm SL.

Description

Refer to table 15. Body oblong, head short and somewhat pointed. O.s. corner of mouth reaches anterior edge of ventral eye. O.s. anterior nostril short and thick; posterior nostril only slightly tubular, lying against anterior edge of ventral eye. B.s. anterior nostril a hole surrounded by intricate fringe of cirri. Thickened cirri restricted to snout and chin region, and occasionally along edge of head. Scales ctenoid; found on proximal half of vertical rays. Few, long, thin, dark cirri patchily present on body. Small cirri present all around mouth. Teeth minute and present only on b.s. lower jaw. Dorsal eye in advance of lower by about half its diameter; interorbital space about equal to eye diameter. Pectoral fins about equal in length. Caudal fin bluntly pointed. Anus located at base of last pelvic fin ray on b.s.; urinary papillae located at base or slightly to o.s. of first anal

fin ray. Dorsal fin ray count 67-80, anal fin ray count 51-58, caudal fin ray count 13-16, pectoral fin ray count 2-4 on right side, 2-5 on left; pelvic fin ray count 3-5. Dorsal, anal and caudal fins united, anterior end of dorsal fin approaching anterior edge of upper lip. Total vertebrae 37-44: 28-32 caudal and 9-12 precaudal, lateral line scales 70-96. Average supracranial pterigiophores 7 of the formula 2-0-4(1) (range of 5-8 [(1-3)-0-(3-5)(1)]) (for description of formula see Methods).

Table 15. Morphometrics and meristics for *Brachirus siamensis* holotype BMNH 1862.6.3.7, *B. siamensis*, *B. krempfi* and *B. smithi*, and all non-type material. Abbreviations are defined in Appendix 1; characters 2 to 12, 16-17 are expressed in hundredths of HL, characters 1, 13-15, 18 are expressed in hundredths of SL, unless otherwise stated, and 19 to 28 are meristics.

		siamensis		*krempfi*	*smithi*	
	Character	Sauvage, 1878	holotype	Durand, 1940	Joglekar, 1971	non-type
1.	HL	5.7 TL	5.1	4.9-5.1	5.2	4.8(4.1-5.2)
2.	E		9.8	8.5		8.4(6.9-10.6)
3.	S		3.6	4.3		3.4(3.0-4.1)
4.	DNS		4.7			4.7(4.0-5.7)
5.	Mos		3.5			3.2(2.5-3.6)
6.	Mbs		4			4.1(3.4-6.1)
7.	Pred		3.9			5.4(2.9-7.8)
8.	Pecos	5	6.3	8.5		8.0(4.9-13.5)
9.	Pecbs		5.2			6.5(4.2-12.4)
10.	Pelos	6	3	4.3		3.2(2.5-4.2)
11.	Pelbs		3.4			3.1(2.6-3.7)
12.	OD		4.8			4.8(3.0-8.5)
13.	H1	2.7 TL	2.6	2.5-2.7	2.2-2.7	2.6(2.3-2.8)
14.	H2		3.8			3.7(31-4.5)
15.	HCP		17.1			15.3(9.1-21.9)
16.	LDR		1.5			1.9(1.5-2.5)
17.	LAR		1.7			1.9(1.5-2.7)
18.	Hdep		4.1			4.5(3.8-5.3)
19.	DR	68		70	65-68	71(67-80)
20.	AR	54		56	51-56	54(51-58)
21.	CR			16	17	15(13-16)
22.	PecOr	3	3	4-5		3(2-4)
23.	PecAR	4	3	4		4(2-5)
24.	PelOR		3	4		4(3-5)
25.	PelAR		4	4		4(3-5)
26.	CV					31(28-32)
27.	PCV					10(9-12)
28.	LL	88	76	90	87-90	82(70-96)

Colour in Alcohol

O.s. golden brown with large chocolate brown patches and faint marbling all over; thin dotted lines perpendicular to the lateral line and running the full depth of the body. Vertical fins speckled, pectoral dark brown. B.s. pale yellow usually devoid of pigmentation though occasionally brown spots are present near the caudal.

Geographic Distribution

Asia: Peninsular Thailand, Chao Phraya and Mekong basins.

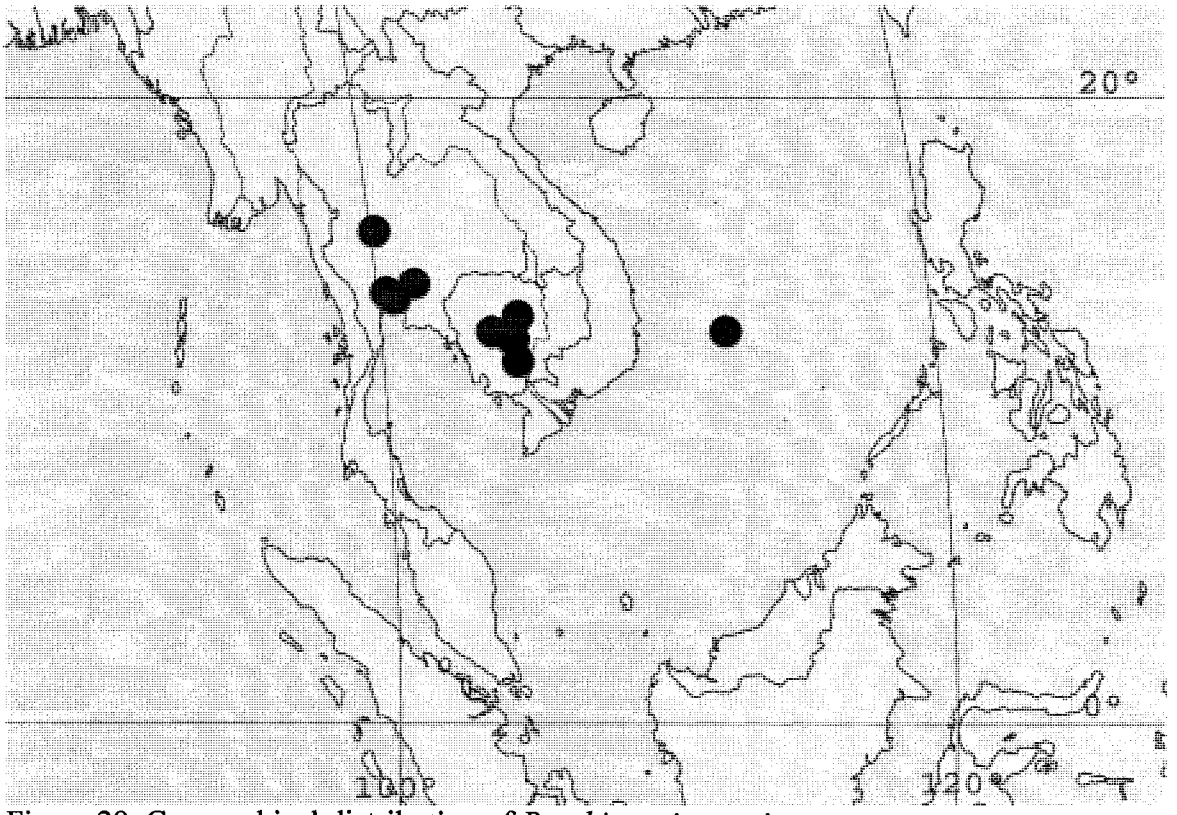

Figure 29. Geographical distribution of *Brachirus siamensis*

Remarks

Despite not having been able to examine any of the specimens of *B. krempfi* or *B. smithi*, I have determined that they are synonyms of *B. siamensis* based on the type descriptions

and associated literature. Kottelat (1984) examined these species and was unable to see distinguishing features. He also commented on Norman's (in Smith, 1945) synonymy of *B. siamensis* with *B. panoides* which he deems to be inappropriate. I agree with Kottelat in this respect based on the differences in dorsal fin rays counts (see Comparisons).

Comparisons

B. siamensis has fewer caudal vertebrae (28-32) than *B. aspilos* (33-35), and *B. pan* (23-25); has more caudal fin rays (17-19) than *B. cinerascens* (13-16), *B. orientalis* (17-20); fewer right pectoral fin rays (2-4) than *B. fitzroiensis* (5); fewer dorsal fin rays (56-66) than *B. foliacea* (67-73), *B. panoides* (76-85), and more dorsal fin rays than *B. sundaicus* (53-63). *B. siamensis* can be distinguished from *B. breviceps* by the mouth which does not surpass the anterior edge of the anterior eye in *B. breviceps* but does in *B. siamensis*. *B. siamensis* differs from *B. selheimi* by the combination of having fewer pectoral fin rays (2-4 vs. 3-7) and more lateral line scales (70-96 vs. 58-85); *B. selheimi* is also geographically isolated from *B. siamensis* being located only around northern Australia and New Guinea.

Brachirus sundaicus Bleeker 1865

Synaptura cinerea De Vis 1883

Synaptura nigra McLeay 1880

Material examined

cinerea: QMI.118, Holotype (145.5 mm SL), 27 15'S 153 15'E, Moreton Bay.

nigra: AMI.16280-001, 3 Syntypes(186.00-221.99 mm SL), 33 50' S 151 15' E, Port Jackson.

AMI.3993, 3(96.54-232.45 mm SL), 32 54' S 151 54' E, Newcastle Bight, AMI.3994, 1(142.1 mm SL), 34 50' S 150 48' E, In Shoalhaven Bight, AMI.4526, 1(202.19 mm SL), Sydney Fish Markets, Australia, AMI.4780, 1(202.53 mm SL), Unknown, AMI.7878, 1(304.02 mm SL), 34 44' S 151 39' E, Wattamolla Bay, AMI.8004, 1(252.79 mm SL), 33 51' S 151 16' E, Sydney Harbour, AMI.9623, 1(236.28 mm SL), 33 51' S 151 14' E, Port Jackson, NSW, Australia, AMI.9624, 1(162.76 mm SL), 33 51' S 151 16' E, Port Jackson, NSW, Australia, AMI.10888, 2(198.53-215.59 mm SL), Unknown, AMI.10889, 2(202.67-225.37 mm SL), Unknown, AMI.16847-011, 1(40.72 mm SL), 35 08' S 150 44' E, Jervis Bay: Greenpatch Beach, AMI.19895-001, 1(136.06 mm SL), 37 38' S 149 96' E, Nadgee Nature Researve: Little River Estuary, AMI.20035-005, 1(99.35 mm SL), 36 05' S 150 06' E, Tuross River: Entrance and Channel, AMI.20047-005, 1(24.79 mm SL), 36 08' S 150 06' E, Brou Lake or Mummuga? Far end of lake, AMI.23319-047, 1(22.59 mm SL), 19 16' S 147 03' E, E of Townsville, at AIMS, AMI.25431-001, 1(152.51 mm SL), 28 24'S 153 24' E, Stoker - nr Shoalhaven R., AMI.25923-002, 1(190.16 mm SL), 32 41'S 152 16' E, off Port Stephens, AMI.27322-

012, 1(190.21 mm SL), 32 08' S 152 31' E, AMI.29775-001, 1(48.06 mm SL), 32 44' S 151 41' E, Hunter River, between Newcastle Harbour and Raymond Terrace, AMI.30349-002, 1(155.56 mm SL), 33 39' S 151 09' E, Bobbin Head, Ku-Ring-Gai Chase Nat. Pk., AMI.32396-001, 1(253.41 mm SL), 34 03' S 151 09' E, Cronulla Beach, AMI.36106-001, 1(139.79 mm SL), 33 60' S 151 09' E, Botany Bay, Australia, AMI.36217-013, 1(128.2 mm SL), 33 58' S 151 11' E, Botany Bay, Australia, AMI.36217-014, 1(110.6 mm SL), 33 58' S 151 11' E, Botany Bay, AMI.37631-008, 1(84.73 mm SL), 22 31' S 150 32' E, Triangular Islands, Shoalwater Bay, AMI.38258-006, 1(18.98 mm SL), 32 50' S 151 48' E, Fullerton Cove, East Near Above (ENA) - Hunter River, AMI.41263-021, 1(78.49 mm SL), 28 51' S 153 34' E, North Creek, Prospect bridge, N side, AMI.41263-022, 2(44.66 -106.87 mm SL), 28 51' S 153 34' E, North Creek, Prospect bridge, N side, AMI.41287-022, 4(25.22-123.49 mm SL), 29 26' S 153 19' E, Yamba, NE side of road bridge, AMI.41518-027, 1(82.53 mm SL), 29 23' S 153 20' E, Clarence River,Thorny Creek. On Thorny Island,5km north-west of Yamba, AMI.41755-034, 1(226.28 mm SL), 37 15' S 149 56' S, Wonboyn River Estuary, AMI.41874-006, 1(114.58 mm SL), 28 22' S 153 35' E, Hastings Point, just inside mouth of Cudgera Creek, AMIA.58, 1(217.2 mm SL), Unknown, AMIA.3963, 1(217.56 mm SL), 33 51' S 151 16' E, Port Jackson, NSW, Australia, AMIB.1702, 1(31.68 mm SL), 26 48' S 153 08' E, Caloundra, AMIB.3827, 1(218.39 mm SL), 33 26' S 151 20' E, Gosford: Saratoga Sand Flat, AMIB.4091, 1(182.53 mm SL), 33 14' S 151 34' E, Tuggerah: Budhewoi Lake, AMIB.4251, 1(211.12 mm SL), 34 00'S 151 09' E, Sydney: Botany, Australia, AMIB.5082, 1(184.00 mm SL), Unknown, AMIB.6269, 1(146.46 mm SL), 28 00' S 153 00' E, Off Ballina, AMNH 96140, 1(156.15 mm SL), unknown,

AMNH 96141, 1(127.7 mm SL), unknown, AMNH 96142, 1(161.5 mm SL), unknown, AMNH 96143, 1(143.83 mm SL), unknown, AMNH 96145, 1(140.22 mm SL), unknown, AMNH 96147, 1(145.32 mm SL), unknown, AMNH 217916, 1(166.88 mm SL), unknown, BMNH 73.4.3.117, 1(153.36 mm SL), Coral Sea, Bowen, Australia, BMNH 76.5.1.18, 1(195.14 mm SL), Sydney, Australia, BMNH 83.11.29.77, 1(231.51 mm SL), Tasmanian Sea, NSW, Australia, BMNH 1890.9.23.226-8, 4(112.17-181.31 mm SL), Sydney, Australia, BMNH 1914.8.20.271, 1(156.07 mm SL), NSW, Australia, BMNH 1925.3.20.7, 1(149.88 mm SL), Port Jackson, New South Wales, Australia, CAS 109136, 1(161.52 mm SL), Port Jackson, NSW, Australia, CSIRO C 2111, 2(28.81-84.25 mm SL), 26 35'S 153 01' E, Qld. Maroochy Bay, 2 miles above entrance, GLD, Australia, CSIRO C 300, 1(114.72 mm SL), 10 37'S 150 40'E, PNG, Bakau Bay, Samarai, CSIRO C 4425, 1(128.83 mm SL), NSW, Botany Bay, between Kernell and Sans, NSW, Australia, CMV 43009, 1(126.60 mm SL), unknown, MNHN 1999-1928, 1(147.55 mm SL), 33 35' S 151 20' E, Port Jackson, NSW, Australia, NMW 43044, 1(179.03 mm SL), New Caledonien, NMW 43045:1, 1(147.95 mm SL), Melbourne?, Australia, NMW 43045:2, 1(140.89 mm SL), Melbourne?, Australia, QMI. 5933, 1(133.71 mm SL), 19 11'S 147 01'E, Cape Cleveland, QMI.6966, 1(191.55 mm SL), 19 11' S 146 49' E, QMI.7064, 1(194.03 mm SL), 27 17' S 153 00' E, QMI.7330, 1(193.51 mm SL), 26 48' S 153 09' E, QMI.12426, 1(140.29 mm SL), 20 29' S 148 45' E, Conway Beach, SE of Proserpine, QMI.21974, 2(58.03-106.53 mm SL), 28 07' S 153 27' E, Tallebudgera Creek, QMI.22377, 1(174.31 mm SL), 27 15' S 153 15' E, Moreton Bay, Australia, QMI.23808, 1(29.2 mm SL), 19 50' S 147 42' E, Molongle Creek, E of Gumlu, QMI.26528, 1(186.45 mm SL), 27 15' S 153 15' E, Moreton Bay, Australia,

QMI.26665, 1(72.49 mm SL), 27 22' S 153 10' E, QMI.26671, 1(51.81 mm SL), 27 10' S 153 05' E, QMI.28394, 1(156.89 mm SL), 22 24' S 150 18' E, QMI.34034, 1(225.79 mm SL), 27 10' S 151 49' E

Common Names

Black sole (Robins et al. 1991)

Diagnosis

B. sundaicus can be distinguished from other *Brachirus* by the combined characteristics of its oval body shape, dorsal and anal fin ray counts (53-63 and 41-55 respectively), and the lack of enlarged scales on the nape of the neck.

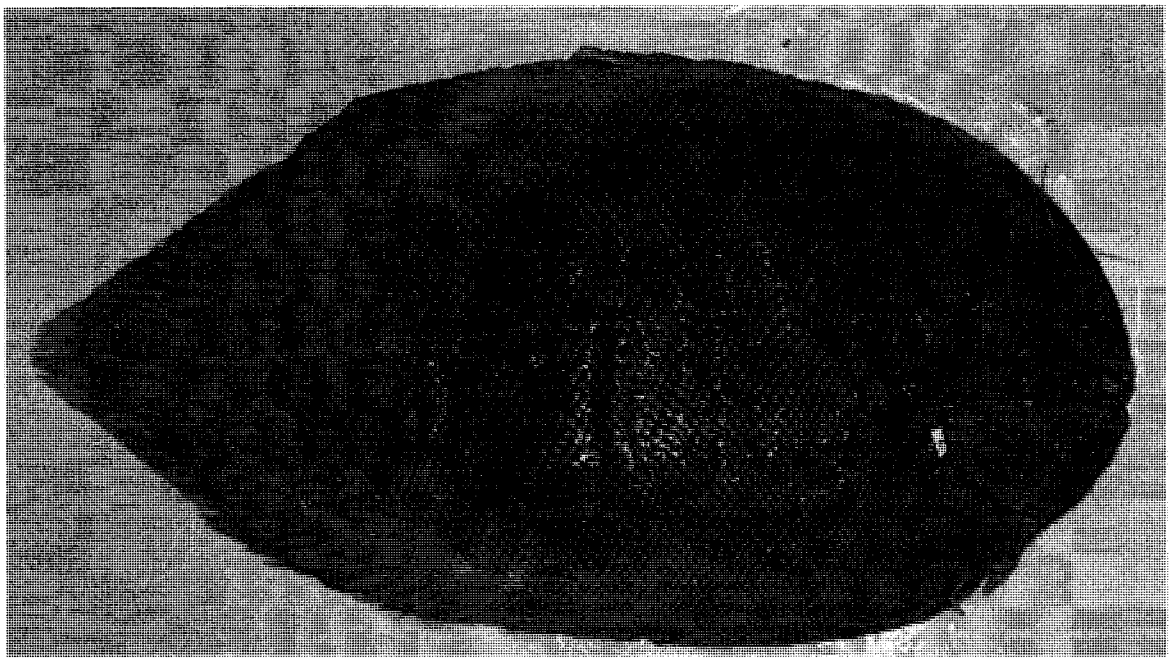

Figure 30. Photo of *Brachirus sundaicus* AMI.16280-001. 186.00 mm SL.

Description

Refer to table 16. Body oval, head short and heavily rounded. O.s. corner of mouth reaches past 1/3 of anterior edge of ventral eye. O.s. Anterior nostril a short and thick fleshy tube. B.s. anterior nostril a hole surrounded by multiple cutaneous flaps. Thickened cirri restricted to snout and chin region and along edges of head to operculum. Scales ctenoid; found on proximal half of vertical rays. Rarely any cirri present on body; small cirri present all around mouth on o.s.. Teeth minute and present only on b.s. lower jaw. Dorsal eye in advance of lower by about half to two-thirds its diameter; interorbital space about equal to eye diameter. Caudal fin rounded. Anus located at base of last pelvic fin ray on b.s.; urinary papillae located at base or slightly to o.s. of first anal fin ray. Dorsal fin ray count 53-63, anal fin ray count 41-55, caudal fin

ray count 12-18, pectoral fin ray count 4-9; pelvic fin ray count 3-5. Dorsal, anal and caudal fins united, anterior end of dorsal fin approaching anterior edge of upper lip. Total vertebrae 35-40: 26-30 caudal and 8-11 precaudal, lateral line scales 59-86. Average supracranial pterigiophores 6 of the formula 2-0-3(1) (range of 5-7 [(1-4)-0-(1-4)(0-2)]) (for description of formula see Methods).

Table 16. Morphometrics and meristics for *Brachirus cinerea* Holotype QMI.118, *B. nigra, B. sundaicus* and all non-type material. Abbreviations are defined in Appendix 1; characters 2 to 12, 16-17 are expressed in hundredths of HL, characters 1, 13-15, 18 are expressed in hundredths of SL, unless otherwise stated, and 19 to 28 are meristics. *has been shown to be incorrect.

		cinerea		*nigra*		*sundaicus*	
	Character	De Vis, 1883	Holotype	MacLeay, 1880	Syntypes	Bleeker, 1870-75	non-type
1.	HL	16 TL*	4.8		4.3(4.1-4.4)		4.2(3.8-4.6)
2.	E		8.7		9.0(8.1-9.6)		7.1(6.0-10.2)
3.	S	3	3		3.4(3.2-3.6)		3.2(2.6-3.9)
4.	DNS		4.7		5.2(4.5-5.9)		4.7(3.9-6.0)
5.	Mos		3.1		3.3(3.2-3.4)		3.5(3.0-4.0)
6.	Mbs		4		3.8(3.5-4.2)		3.8(3.1-4.6)
7.	Pred		5.8		6.8(6.4-7.8)		4.3(2.9-8.3)
8.	Pecos	2	1.8	> 3 HL	3.0(2.8-3.1)		2.7(2.0-3.9)
9.	Pecbs	< pecos	2.4	< pecos	3.0(2.8-3.4)		3.3(2.4-4.2)
10.	Pelos		2.3		3.2(3.1-3.3)		2.8(2.3-3.4)
11.	Pelbs		2.5		3.4(3.2-3.7)		2.9(2.3-3.5)
12.	OD		3.5		4.1(3.8-4.4)		4.4(3.6-5.7)
13.	H1	2 TL	1.8		1.8(1.7-1.9)	2.25-2.5	2.1(1.9-2.3)
14.	H2		2.8		2.9(2.5-3.1)		3.1(2.5-3.6)
15.	HCP		11.2		11.6(10.5-12.3)		10.9(9.3-13.1)
16.	LDR		1.7		1.7(1.7-1.8)		1.8(1.4-2.2)
17.	LAR		1.7		1.6(1.4-1.7)		1.8(1.5-2.3)
18.	Hdep		3.4		2.9(2.8-2.9)		3.3(3.0-4.1)
19.	DR	57	60	57	57(54-57)	61-63	58(53-63)
20.	AR	39	45	47	45(43-47)	46-48	45(41-55)
21.	CR	14	14	14	14(13-14)	14-15	14(12-18)
22.	PecOr	4	5		6(5-7)	5	6(4-9)
23.	PecAR	4	5		6(5-6)	4	6(4-9)
24.	PelOR	4	4		4(4-5)	5	4(3-5)
25.	PelAR	4	4		4	4	4(3-5)
26.	CV		27		28(28-29)		28(26-30)
27.	PCV				10		10(8-11)
28.	LL		67	77	75(71-81)		73(59-86)

Colour in Alcohol

O.s. black or dark brown with faint brown to black patches; right pectoral fin darker in lighter-coloured specimens. B.s. pale, almost white; snout region grey.

Geographic Distribution

Southwest Pacific: eastern Australia.

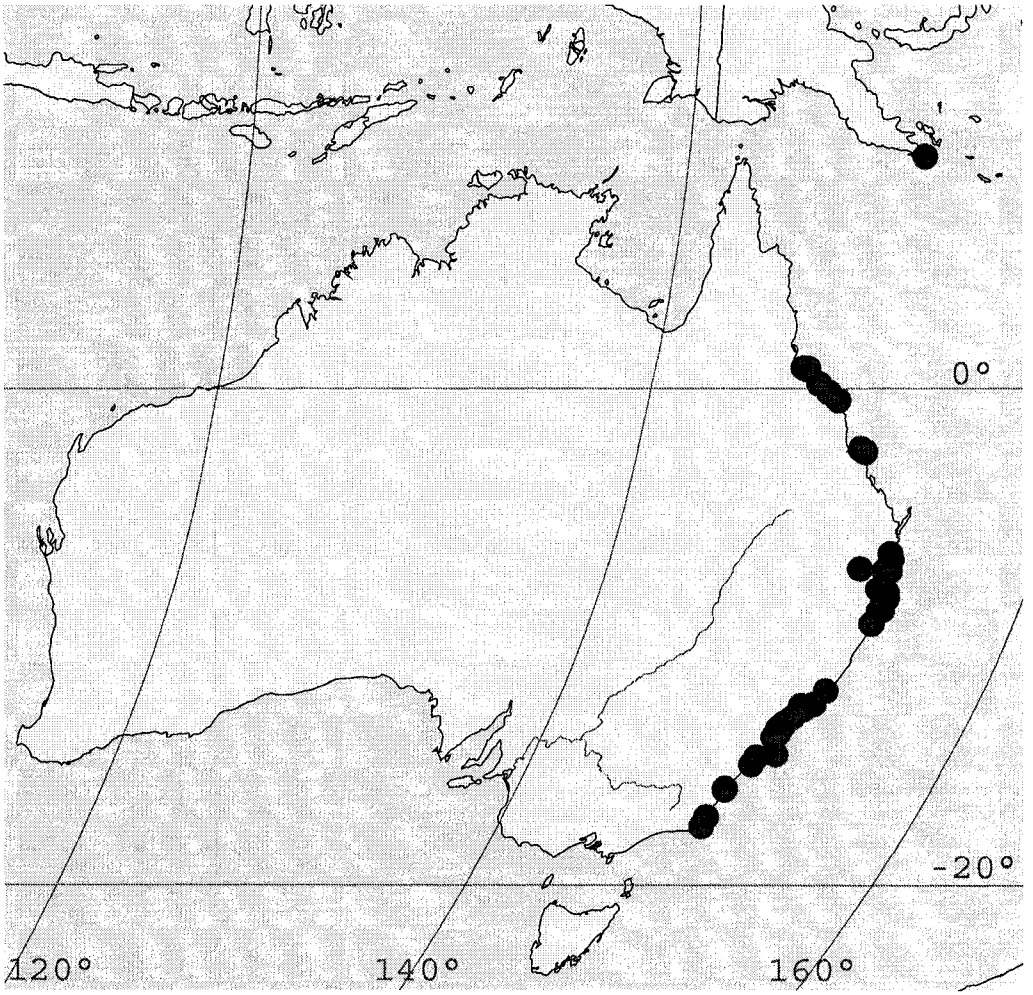

Figure 30. Geographical distribution of *Brachirus sundaicus*

Remarks

Despite not being able to obtain the holotype of *B. sundaicus*, I was able to determine by the type description that *B. nigra* and *B. cinerea* are indeed synonyms of *B. sundaicus*. Ogilby (1910) was first to suggest that *B. cinerea* and *B. nigra* were synonyms. Bleeker (1870-75) provided an illustration of *B. sundaicus*. Based on my counts and measurements, all three nominal species overlap in all respects.

There is a specimen of *B. sundaicus* with a caudal fin ray count of 18. This is higher than expected for a specimen of this species, however all other meristics and measurements as well as geographical distribution support correct placement of this specimen, therefore this outlying value can be considered an anomaly.

Comparisons

B. sundaicus is extremely close in measurements and counts to *B. pan*, though *B. sundaicus* can be distinguished by the lack of enlarged scales on the nape of the neck and by the colouration which is much darker, almost black in B. *sundaicus* and more golden brown in *B. pan*. *B. sundaicus* has fewer dorsal fin rays (53-61) than *B. aspilos* (65-75), *B. fitzroiensis* (67), *B. panoides* (76-85), and *B. siamensis* (67-73); more right pectoral fin rays (4-9) than *B. breviceps* (2); fewer caudal fin rays (12-16) than *B. cinerascens* (17-19), *B. foliacea* (17-19), and *B. orientalis* (17-20); more caudal vertebrae (26-30) than *B. pan* (23-25). *B. sundaicus* has a much more oval body than that of the elongate *B. selheimi.*

Brachirus swinhonis (Steindachner 1867)

Synaptura swinhonis Steindachner 1867

Material examined

Holotype not examined; No specimens examined.

Diagnosis

B. swinhonis can be distinguished from other *Brachirus* by the combined characteristics of having a low number of caudal fin rays (13), a high number of lateral line scales (95), small eyes (10 HL) and small pelvic fin rays (5 HL).

Description (extracted from Steindacher 1867 – see Appendix 3 for full description)

P. 6; D. 72; C. 13; A. 57; V. 5 (o.s.) – 4 (b.s.); LL 120 (95 on caudal).

Upper eye in advance of the lower; b.s. lower jaw with numerous, extremely pointed teeth. Height of body 16 mm and 3 times in SL; head length 10 mm; eye diameter almost 1mm; interorbital space 1 1/3 mm; length of o.s. pelvic fin 4 mm, b.s. 3 mm; length of pectoral fin 2 mm.

Remarks

Although I was not able to examine any specimens of *B. swinhonis* it is clear from the literature that it is a distinct species from other *Brachirus* due to a number of characteristics. *B. swinhonis* has a lower caudal fin ray count (13) which is only shared with *B. selheimi* (13-16), *B. pan* (13-15), *B. sundaicus* (12-16) and *B. aspilos* (12-15),

and a high lateral line scale count (95) which is only shared with *B. panoides* (82-121), *B. selheimi* (58-97), *B. siamensis* (70-96), *B. aspilos* (76-117). *B. swinhonis* has smaller eyes (10 HL) than *B. selheimi* (3-8 HL), and smaller pelvic fins (5 HL) than *B. aspilos* (2-3 HL).

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General Conclusion

As a result of this taxonomic revision of the *Brachirus* complex, it has been discovered that of the 41 nominal species, 19 are valid. The *Brachirus* complex was subsequently divided into four genera: *Achiroides*, *Dexillus*, *Paradicula* and *Brachirus*. These four genera form a monophyletic group characterized by the structure of the supracranial complex, by the united dorsal, anal and caudal fins, and by the anterior edge of the dorsal fin approaching the upper lip. *Achiroides* and *Paradicula* are each comprised of a single valid species, while *Dexillus* is comprised of three valid species. The remaining 14 valid species were placed within *Brachirus,* although without a phylogenetic study it is not possible to ascertain that these species form a monophyletic group. A new species key has been provided for all the valid species within the *Brachirus* species complex.

In chapter 1, the taxonomic revision of *Achiroides* resulted in the synonymization of three nominal species (*Achiroides aenea*, *A. harmandi* and *A. leucorhynchos*) under the senior synonym *A. melanorhynchus*. *Achiroides* was redescribed to encompass flatfish resembling *Brachirus,* but lacking true pectoral fins.

In chapter 2, the taxonomic revision of *Dexillus* resulted in the synonymization of *D. arafurensis* with the senior synonym *D. muelleri*. *D. muelleri* and *D. megalepidoura* were redescribed while *D. macrolepis* was described using the original description due to lack of material. The genus *Dexillus* was redescribed to encompass flatfish resembling *Brachirus,* but with contiguous eyes covered by a common translucent membrane.

In chapter 3, the taxonomic revision of *Paradicula* confirmed the placement of *Paradicula setifer* as the sole species within this genus. The genus *Paradicula* was

redescribed to encompass flatfish resembling *Brachirus,* but having an operculum cover fused with the body except at the extremities.

In chapter 4, the taxonomic revision of *Brachirus* resulted in the synonymization of numerous groups of species. *Brachirus heterolepis*, *B. marmorata* and *B. sorsogonensis* have been synonymized with the senior synonym *B. aspilos*; *B. cinerea* and *B. nigra* are junior synonyms of *B. sundaicus*; *B. filamentosa* is a junior synonym of *B. orientalis*; *B. salinarum* and *B. villosus* are junior synonyms of *B. selheimi*; and *B. krempfi* and *B. smithi* are junior synonyms of *B. siamensis*. *B. breviceps*, *B. fitzroiensis*, *B. foliacea*, *B. pan*, *B. panoides* have been redescribed while *B. canus*, *B. dicholepis* and *B. swinhonis* have had their original type descriptions reiterated due to a lack of material.

This revision allows for a much clearer understanding of this important taxonomic group of Soleids, and is an important step towards understanding the interrelations between all Soleids. A phylogenetic study is still required to determine the phylogenetic status of the species within *Brachirus*, as previously mentioned, and the overall standing of the *Brachirus* complex among other Soleids.

Phylogenetic Conclusion

Although a formal phylogenetic analysis was not done, certain relationships were revealed during this study. The four genera covered in this study form a monophyletic group but the interrelationships of these genera remains unknown. The species within *Brachirus* form distinct clusters when *Achiroides* is used as the sister group. *Brachirus pan* and *B. canus* share many similarities including the enlarged scales on the nape of the neck, and they share very similar meristics with *Achiroides*. *Brachirus aspilos*, *B.*

dicholepis and *B. panoides* are grouped together by the exceptionally high number of lateral line scales (>115). *B. orientalis*, *B. foliacea*, and *B. cinerascens* are extremely close in appearance and all share a high number of caudal fin rays (17-20). *B. cinerascens*, *B. foliacea*, and *B. pan* also share a low caudal vertebrae count (22-27) with *Achiroides melanorhynchus*.

Another characteristic that may be worth considering is the freshwater habitat of *B. panoides*, *B. selheimi* and *B. siamensis* which is shared with *Achiroides*. It is interesting to note that the body shape of these three freshwater *Brachirus* species are very similar as well, in that they are much more elongate than other *Brachirus* species. *Achiroides* has an oval body shape.

Placing *Dexillus* and *Paradicula* within this phylogeny is more difficult. *Paradicula setifer* shares a wide interorbital space with *Brachirus breviceps* and *B. fitzroiensis*. *B. foliacea*, *B. pan* and *B. sundaicus* also share a low dorsal fin ray count with *Achiroides melanorhynchus* and species of the *Dexillus* genus have an intermediate number of dorsal fin rays between this group and the remaining *Brachirus* and *Paradicula* species.

A phylogenetic analysis of these genera and species would be most useful and might even force a re-examination of the generic denomination used within this research project.

Identification key for all valid species within the *Brachirus* species complex.

- Lack of pterigiophores with their proximal ends over the cranium
- Dorsal, anal and caudal fins united
  - rudimentary pectoral fins — *Achiroides melanorhynchus*
  - fully developed pectoral fins
    - eyes contiguous
      - eyes > 10 HL — *Dexillus macrolepis*
      - eyes < 8 HL
        - scales enlarged on flank — *D. megalepidoura*
        - scales uniform — *D. muelleri*
    - eyes separated by a scaly interorbital space
      - opercular covers fused to body excluding next to pectoral fins — *Paradicula setifer*
      - opercular covers free
        - Long, over-hanging upper lip — *Brachirus aspilos*
        - Anterior edge of upper lip flush with lower
          - Interorbital space ≥ 2 eye diameter
            - Eyes 8.5 times in HL — *B. breviceps*
            - Eyes 13.1 times in HL — *B. fitzroiensis*
          - Interorbital spaces < ½ eye diameter — *B. canus*
          - Interorbital space < 2 eye diameter
            - 17-20 caudal fin rays
              - 29-35 caudal vertebrae
                - 82-121 lateral line scales — *B. panoides*
                - 66-78 lateral line scales — *B. orientalis*
              - 24-27 caudal vertebrae
                - 8-10 pterigiophores in the SC; 24-26 caudal vertabrae — *B. cinerascens*
                - 5-7 pterigiophores in the SC; 26-27 caudal vertabrae — *B. foliacea*
            - 12-16 caudal fin rays
              - Scales enlarged on nape of neck — *B. pan*
              - Scales uniform
                - 115-120 lateral line scales
                  - scales cycloid on b.s. — *B. dicholepis*
                  - scales ctenoid on b.s. — *B. swinhonis*
                - 58-97 lateral lines scales
                  - Thickened cirri covering anterior half of head on b.s. — *B. selheimi*
                  - Thickened cirri restricted to snout and chin on b.s.
                    - 53-63 dorsal fin rays — *B. sundaicus*
                    - 67-80 dorsal fin rays — *B. siamensis*

Appendix 1. List of characters used in the taxonomic revision of the *Brachirus* species complex.

Acronym	Measurements/Counts/Descriptions
TL	Total Length - Length from snout tip to end of longest caudal fin ray
SL	Standard Length - Length of axial skeleton
HL	Head Length - Length from snout tip to just behind operculum
E	Eye Width - Horizontal width of ventral eye
S	Snout Length - Length from snout tip to most anterior edge of ventral eye
NSD	Nostril to snout distance - Distance from most anterior ocular nostril to snout tip
Mos	Mouth Length on Ocular Side - Distance from snout tip to the corner of the mouth on ocular side
Mbs	Mouth Length on Blind Side - Distance from snout tip to the corner of the mouth on blind side
Pred	Predorsal Distance - Distance between the edge of upper lip and first dorsal fin ray
Pecos	Pectoral Length on Ocular Side - Length of the pectoral fin from the base of the central fin ray to the tip of the longest ray on the ocular side
Pecbs	Pectoral Length on Blind Side - Length of the pectoral fin from the base of the central fin ray to the tip of the longest ray on the blind side
Pelos	Pelvic Length on Ocular Side - Length of the pelvic fin from the base of the central fin ray to the tip of the longest ray on the ocular side
Pelbs	Pelvic Length on Blind Side - Length of the pelvic fin from the base of the central fin ray to the tip of the longest ray on the blind side
OD	Ocular Distance - Shortest distance between the edge of the dorsal eye and base of the dorsal fin rays
H1	Height 1 - Largest distance between base of dorsal and anal rays
H2	Height 2 – Height of body excluding vertical fin rays and their associated pterigiophores
HCP	Height of Caudal Peduncle - narrowest distance of the caudal peduncle
Th	Thickness - Thickness of the body behind the operculum
LDR	Longest Dorsal Ray - Length of the longest dorsal ray
LAR	Longest Anal Ray - Length of the longest anal ray
Hdep	Head depth - Depth of the head at the posterior edge of the ventral eye
Dorsal R	Dorsal Ray Count
Anal R	Anal Ray Count
PecOR	Pectoral Ray Count on Ocular Side
PecBR	Pectoral Ray Count on Blind Side
PelOR	Pelvic Ray Count on Ocular Side
PelBR	Pelvic Ray Count on Blind Side
Caudal R	Caudal Ray Count
ACD	Sum of the Anal Caudal and Dorsal rays
Cdl Vert	Caudal Vertebrae Count
Precdl Vert	Precaudal vertebrae Count
LL	Lateral Line Count - Scale count along straight length of the lateral line
ODS	Ocular Distance Scale Count - Number of scales between the two eyes
SC	Supracranial complex - arrangement of the pterigiophores along the cranium
Tail	Tail Complex - arrangement of the tail bones
Scale Point	Number of ctenii on the scale taken from the posterior end of the ocular side, ventral of the lateral line
Scale Base	Number of scale radii taken from the posterior end of the ocular side, ventral of the lateral line
E.Nostrils	Length and shape of the Ocular Nostrils

Acronym	Measurements/Counts/Descriptions
B.Nostrils	Length and shape of the Blind Nostrils
'Hairs'	Pattern of cirri on blind face
CS	Presence, length and colour of Cirri on scales
Pigment	description of the pigmentation on both the ocular and blind sides
CL	Presence, length and abundance of Cirri on Lips
Teeth	Presence, and location of teeth
Eyes	Amount of overlap between eyes represented as a fraction
Anus	Position of Anus in proximity to pelvic fins, anal fin and papillae
Papillae	Position of Papillae in proximity to pelvic fins, anal fin and anus
Tail Shape	Description of the shape of the tail
LL Shape	Description of the shape of the lateral line on the head on the ocular side

Appendix 2: List of specimens examined but which do not belong to *the Brachirus* species complex and their hypothesized designations.

USNM 93095 – *Brachirus annularis* (holotype) – *Zebrias annularis*

USNM 93206 – *Brachirus annularis* (paratype) - *Zebrias annularis*

AMI.22828-015 – *Synaptura annularis* - *Zebrias annularis*

WAM P5534 – *Synaptura hediste* (paratype) – *Zebrias hediste*

WAM P5533 – *Synaptura hediste* (paratype) – *Zebrias hediste*

AMI.34756-085 – *Brachirus sp.* - unknown

ANSP 91018 – *Synaptura orientalis* – *Solea sp.*

WAM P 28152-016 – *Brachirus sp.*

WAM P 28154-015 – *Brachirus sp.* (2 specimens)

WAM P 28155-015 – *Brachirus sp.* (5 specimens)

} unknown, same species

Appendix 3. Original non-translated type descriptions.

Synaptura heterolepis Bleeker 1856

Synapt. Corpore oblongo, altitudine 2 2/3 circiter in ejus longitudine; capite obtuse rotundato, 5 ½ cir`iter in longitudine corpis, Paulo altiore quam longo; oculis dextris diametro 1 circiter distantibus, superiore ante os prominente; ore subantico rictu curvato sub oculo inferiore desinentel labiis mentoque fimbriatis maxillis latere sinistro tantum, pluriseriatis, setaceis; linea laterali antiee verticem adscendente et curvature amplectente; squamis dextro latere ciliates, 90 p.m. sinistro latere cycloideis apice emarginatis plus quam 120 in serie longitudinali usque supra aperturam branchialem; squamis anterioribus squamis posterioribus minoribus; pinnis dorsali, anali caudalique totis unitis radiis fissis; dorsalio rostro infra oculum superiorem incipiente, anali non altiore, corpore plus quadruple circiter, pectorali sinistra majore, obtuse; colore latere dextro corpore violascente-olivaceo, pinnis imparibus alivascente-violaceo; corpore latere oculari nebulis diffuses fuscis et maculis sparsis margaritaceis vel luteis; pinnis imparibus pulchre luteo marginatis; pectorali-dextra violaceo-nigra luteo marginata, sinistra albida; corpoe sinistro latere albo; pinnis imparibus sinistro latere basi albis, marginem versus violaceis luteo marginatis.

B.6.D.70.C.12.A.52.P.d.6.sin.5.V.d.5.sin.4

Habit. Amboina, in mari.

Longitudo speciminis unici 260"'

Brachirus dicolepis (Peters 1877)

D. 66; A. 55; C. 14; P. 5; V. 5; Lin. lat. 115 ad 120.

Körperhöhe zur Totallänge wie 1: 2 2/13, Kopflänge zu dersalben wie 1:6. Das obere Auge überragt nicht das untere nach vorn; der Interorbitalraum merklich breiter als ein Augendurchmesser. Oberlippe hakenförmig vorspringend; Nasentube eing=fach Nackenschuppen nicht grösser als die Körperschuppen; die Schuppen der rechten Site ctenoid, die der linken Seite cycloid und am hintern Rande tief eingebuchet; an beiden Seiten warden die Schuppen nach dem Schwanze hin grösser; Seitenlinie ganz grade, 115 bis 120 Schuppen enthaltend. Die rechte Brustflosse etwas länger als die linke, drei Mal in der Kopflänge enthalten.

Schmutzig grün, unregelmässig Schwarz geflackt, links gelblich, oben und unten mit undeutlichen schwärzlichen Querbinden.

Ein Exemplar 31 ½ Centimeter lang; am 18. Juli bei Neu-Hannover gefangen. Diese art steht der Synaptura heterolepis Bleeker aus Amboina am nächsten, welche aber nur 98 Schuppen in der Seitenlinie hat und sich daher ebenso von der vorstehenden Art wie S. zebra Bloch von S. zebrine Schlegel unterscheidet.

Brachirus swinhonis (Steindachner 1867)

P. 6; D. 72; C. 13; A. 57; V. 5 (v.) – 4 (l.); L. lat. 120 (95 davon auf dem Rumpfe.)

Beide Pectoralen gleich schwach entwickelt; rechte Ventrale etas kürzer als die linke, Auge klein, länglich rund, mit längerem Längerdurchmesser, oberas Auge etwas weiter nach vorne gerückt als das untere. Linke Hälfte des Unterkiefers mit zahlreichen, äußerst spitzen Zächnchen besetzt; rechte Hälfte desselben Knochens zahnlos. Mundspalte klein, stark gekrümmt; Oberkieferspitze hackenförmig verlängert und das

vordere Ende des Unterkiefers umfassend. Oberes Kopfprofil stark bogenförmig gekr:ummt. An der unteren oder blinden Seite des Kopfes liegen zahlreiche Hautläppchen. Das auf der rechtenKopfseite vordere Nasenloch mündet in ein ziemlich langes Röhrchen, welches am Ende nicht gespalten ist; die Narine der linken Kopfseite ist nicht erweitert.

Die größte Höhe des Körpers fällt um eine Caudallänge vor die Mitte der Körperlänge ohne Caudale und erreicht nahezu 1/3 der Totallänge.

Die einfache Seitenlinie beider Körperseiten läuft vom hinteren Kopfende angefangen in fast horizontaler Richtung zur Caudale; sie liegt in der vorderen Körperhälfte etwas über der Höhenmitte des Rumpfes, in der hinteren etwas kleineren Körperhälfte nimmt sie genau die Mitte der Rumpfhöhe ein und endigt am hinteren Ende des mittleren, längsten Caudalstrahles.

Die Schuppen sind klein, an der linken Körperseite glatt und noch kleiner als die der rechten Körperseite, welche am hinteren Rand emit 3-5 verhältnißmäßig langen Zähnchen besetzt sind.

Die rechte Körperseite ist chocoladebraun, die Spitzen sämmtlichner Flossenstrahlen sind weiß, vor dem freien Ende der Dorsal- Anal- und Caudalstrahlen liegt eine blauschwarze Binde, welche gegen die Basis der Flossen zu allm;alig in die Grundfarbe des Körpers übergeht. Die eugenlose Körperseite ist gelblichweiß. Ein schwarzer, länlicher, quergestallter Flack in der Mitte der Totallänge des beschriebenen exemplars 46'''.

Größte Körperhöhe 16'''; Kopflänge 10'''; Augendiameter nahezu 1'''; Entfernung der Augen 1 1/3'''; Höhe des Körpers in der Mitte der Totalläne 15'''; Körperhöhe zu

Anfang des letzten Viertels der Körperlänge (ohne Caudale) 9 4/5‴; Länge der rechten Ventrale 4‴ der linken 3‴; Länge der Pectorale 2‴; Länge der Schwanzflosse 6 4/5‴.

Fundort. Hongkong.

Appendix 4. Status of the nominal species of *Achiroides*. The principal reference is Eschmeyer, W., 1998 with online updates in 2006. Catalog of Fishes. California Academy of Sciences, San Franciso. 2905 pages. www.calacademy.org

Species / Author / Year	Status	Status Designated By:	Reference	Type Specimens
Plagusia melanorhynchus Bleeker 1851	Valid as *Achiroides melanorhynchus* Bleeker 1851	Roberts 1989	-Bleeker, P. 1851. Bijdrage tot de kennis der ichthyologische fauna van Borneo, met beschrijving van 16 nieuwe soorten van zoetwatervisschen. Natuurkd. Tijdschr. Neder. Indië v. 1: 1-16.	Holotypes BMNH 1880.4.21.186, examined
Synaptura aenea Smith 1931	Synonym of *Achiroides melanorhynchus* Bleeker 1851	Author	-Smith, H. M. 1931 (26 Mar.). Descriptions of new genera and species of Siamese fishes. Proc. U. S. Natl. Mus. v. 79 (no. 2873): 1-48, Pl. 1.	Holotype USNM 90311 lost
Synaptura (Anisochirus) harmandi Sauvage 1878	Synonym of *Achiroides melanorhynchus* Bleeker 1851	Author	-Sauvage, H. E. 1878. Sur quelques pleuronectes appartenant aux genres Synaptura et Cynoglossus et provenant de la Cochin-chine et du Laos. Bull. Soc. Philomath. Paris (Ser. 7) v. 2: 92-96.	Holotype MNHN 0000-9517 examined
Achiroides leucorhynchos Bleeker 1851	Synonym of *Achiroides melanorhynchus* Bleeker 1851	Roberts 1989	-Bleeker, P. 1851. Bijdrage tot de kennis der ichthyologische fauna van Borneo, met beschrijving van 16 nieuwe soorten van zoetwatervisschen. Natuurkd. Tijdschr. Neder. Indië v. 1: 1-16.	Holotype RMNH 6771 not examined

Appendix 5. Status of the nominal species of *Dexillus*. The principal reference is Eschmeyer, W., 1998with online updates in 2006. Catalog of Fishes. California Academy of Sciences, San Franciso. 2905 pages. www.calacademy.org

Species / Author / Year	Status	Status Designated By:	Reference	Type Specimens
Synaptura arafurensis Günther 1880	Synonym of *Dexillus muelleri* (Steindachner 1879)	Hoese & Bray 2006	-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. Rept. Challenger Shore Fishes v. 1 (pt 6): 1-82, Pls. 1-32.	Holotype BMNH 1879.5.14.69 examined
Synaptura muelleri Steindachner 1879	Valid as *Dexillus muelleri* (Steindachner 1879)	Randall et al. 2004	-Steindachner, F. 1879. Über einige neue und seltene Fischarten aus den zoologischen Museen zu Wien, Stuttgart und Warschau. Anz. Akad. Wiss. Wien v. 16 (no. 4): 29-34.	Holotype SMNS 2278 examined
Brachirus megalepidoura Fowler 1934	Synonym of *Dexillus megalepidoura* (Fowler 1934)	Author	-Fowler, H. W. 1934 (20 Jan.). Descriptions of new fishes obtained 1907 to 1910, chiefly in the Philippine Islands and adjacent seas. Proc. Acad. Nat. Sci. Phila. v. 85 (for 1933): 233-367.	Holotype USNM 93081, Paratypes USNM 93552, USNM 93553, USNM 93554 examined
Synaptura macrolepis Bleeker 1858	Valid as *Dexillus macrolepis* (Bleeker 1858)	Author	-Bleeker, P. 1858. Twaalfde bijdrage tot de kennis der vischfauna van Borneo. Visschen van Sinkawang. Acta Soc. Sci. Indo-Neerl. v. 5 (art. 7): 1-10.	Holotype lost

Appendix 5. Status of the nominal species of *Paradicula*. The principal reference is Eschmeyer, W., 1998with online updates in 2006. Catalog of Fishes. California Academy of Sciences, San Franciso. 2905 pages. www.calacademy.org

Species / Author / Year	Status	Status Designated By:	Reference	Type Specimens
Paradicula setifer Paradice & Whitley 1927	Valid as *Paradiula setifer* Paradice & Whitley 1927	Paradice & Whitley 1927	-Paradice, W. E. J. and G. P. Whitley 1927 (28 Apr.). Northern Territory fishes. Mem. Queensl. Mus. v. 9 (pt 1): 76-106, Pls. 11-15.	Holotype AMS IA.1535 not examined

Appendix 7. Status of the nominal species of *Brachirus*. The principal reference is Eschmeyer, W., 1998with online updates in 2006. Catalog of Fishes. California Academy of Sciences, San Franciso. 2905 pages. www.calacademy.org

Species / Author / Year	Status	Status Designated By:	Reference	Type Specimens	Comments
Brachirus annularis Fowler 1934	Not a *Brachirus*, likely a *Zebrias*	Author	-Fowler, H. W. 1934 (20 Jan.). Descriptions of new fishes obtained 1907 to 1910, chiefly in the Philippine Islands and adjacent seas. Proc. Acad. Nat. Sci. Phila. v. 85 (for 1933): 233-367.	Holotype USNM 93095, Paratype USNM 93206 examined	- Supracranial complex and thickened neural spines correspond to those of *Zebrias*
Synaptura aspilos Bleeker 1852	Valid as *Brachirus aspilos* (Bleeker 1852)	Munroe in Randall & Lim 2000	-Bleeker, P. 1852. Bijdrage tot de kennis der ichthyologische fauna van Singapore. Natuurkd. Tijdschr. Neder. Indië v. 3: 51-86.	Holotypes BMNH 1862.6.3.5 examined	
Brachirus breviceps Ogilby 1910	Valid as *Brachirus breviceps* Ogilby 1910	Ogilby 1910	-Ogilby, J. D. 1910 (7 Nov.). On new or insufficiently described fishes. Proc. R. Soc. Queensl. v. 23: 1-55.	Holotype QMI.865 examined	
Synaptura callizona Regan 1903	Not a *Brachirus*, likely a *Zebrias*	Author	-Regan, C. T. 1903 (1 Jan.). Notes on the genus Synaptura Cantor, with descriptions of two new species. Ann. Mag. Nat. Hist. (Ser. 7) v. 11 (no. 61): 56-58, Pl. 6.	Holotype BMNH 1879.5.14.68 not examined	-Type description alludes to this species belonging to *Zebrias*
Synaptura cancellata McCulloch, 1916	Not a *Brachirus*, likely a *Zebrias*	Gomon et al. 1994	-McCulloch, A. R. 1916 (10 July). Ichthyological items. Mem. Queensl. Mus. v. 5: 58-69, Pls. 7-9.	Holotype AMS I.13199, Paratype AMS E.2486-87,	-Type description alludes to this species belonging to *Zebrias*
Pleuronectes canus Gray 1854	Valid as *Brachirus canus* (Gray 1854)	Author	-Gray, J. E. 1854. Catalogue of fish collected and described by Laurence Theodore Gronow, now in the British Museum. London. Cat. Fish Gronow: i-vii + 1-196.	Holotype location unknown	

Synaptura cinerascens Günther 1862	Valid as *Brachirus cinerascens* Günther 1862	Author	-Günther, A. 1862 (8 Nov.). Catalogue of the fishes in the British Museum. Catalogue of the Acanthopterygii, Pharyngognathi and Anacanthini in the collection of the British Muesum. Cat. Fishes v. 4: i-xxi + 1-534.	Holotype BMNH 1854.3.29.30 examined
Synaptura cinerea De Vis 1883	Synonym of *Brachirus sundaicus* Bleeker 1870-75	Author	-De Vis, C. W. 1883 (17 July). Description of new genera and species of Australian fishes. Proc. Linn. Soc. N. S. W. v. 8 (pt 2): 283-289.	Holotype QMI.118 examined
Synaptura dicholepis Peters 1877	Valid as *Brachirus dicholepis* (Peters 1877)	Munroe 2001	-Peters, W. (C. H.) 1877. Übersicht der während der von 1874 bis 1876 unter der Commando des Hrn. Capitän z. S. Freiherrn von Schleinitz ausgeführten Reise S. M. S. Gazelle gesammelten und von der Kaiserlichen Admiralität der Königlichen Akademie der Wissenschaften übersandten Fische. Monatsb. Akad. Wiss. Berlin 1876: 831-854.	Holotype ZMB 9861 not examined
Synaptura filamentosa Sauvage 1878	Synonym of *Brachirus foliacea* (Richardson, 1846)	Author	-Sauvage, H. E. 1878. Sur quelques pleuronectes appartenant aux genres Synaptura et Cynoglossus et provenant de la Cochin-chine et du Laos. Bull. Soc. Philomath. Paris (Ser. 7) v. 2: 92-96.	Holotype MHN 0000-9643 examined
Synaptura fitzroiensis De Vis 1882	Valid as *Brachirus fitzroiensis* (De Vis 1882)	Hoese & Bray 2006	-De Vis, C. W. 1882 (28 Oct.). Description of three new fishes of Queensland. Proc. Linn. Soc. N. S. W. v. 7 (pt 3): 318-320.	Holotype QMI.79 examined

Solea foliacea Richardson 1846	Valid as *Brachirus foliacea* (Richardson 1846)	Li & Wang 1995	Richardson, J. 1846 (June/July). Report on the ichthyology of the seas of China and Japan. Rep. Brit. Assoc. Adv. Sci. 15th meeting [1845]: 187-320.	Syntypes BMNH 1851.12.27.213-14, BMNH 1851.12.27.213-15 examined	
Synaptura hediste Mees 1964	Not a *Brachirus*, likely a *Zebrias*	Author	-Mees, G. F. 1964 (28 Feb.). Additions to the fish fauna of Western Australia--4. Fish. Bull. W. Austr. No. 9 (pt 4): 31-55, Pls. 2-5.	Paratypes WAM P5533, WAM P5534 examined	- Supracranial complex and thickened neural spines correspond to those of *Zebrias*
Synaptura heterolepis Bleeker 1856	Synonym of *Brachirus aspilos* (Bleeker 1852)	Bleeker 1870-75 (species) Munroe 2001 (genus)	-Bleeker, P. 1856. Beschrijvingen van nieuwe en weinig bekende vischsoorten van Amboina, verzameld op eene reis door den Molukschen Archipel gedaan in het gevolg van den Gouverneur Generaal Duymaer van Twist, in September en Oktober 1855. Acta Soc. Sci	Holotype BMNH 1862.6.3.1 examined	
Synaptura krempfi Durand 1940	Synonym of *Brachirus siamensis* (Sauvage 1878)	Kottelat 1984 (species) Kottelat 2001 (genus)	-Durand, J. 1940. Notes sur quelques poissons d'espèces nouvelles ou peu connues des eaux douces cambodgiennes. Inst. Océanogr. L'Indochine Note 34 [or 36]: 1-40, table, Pls. 1-8.	Holotype location unknown	
Synaptura lipophthalma Károli 1882	Not a *Brachirus*, likely a *Typhlachirus*	Author	-Károli, J. 1882. Prodromus piscium Asiae orientalis a domine Joanne Xantus annis 1868-70 collectorum. Természet. Füzetek, Budapest v. 5: 147-187.	Holotype Mus1115 not examined	-eyes missing, may be *Typhlachirus*
Synaptura marmorata Bleeker 1853	Synonym of *Brachirus aspilos* Bleeker 1852	Bleeker 1870-75	-Bleeker, P. 1853. Bijdrage tot de kennis der ichthyologische fauna van Solor. Natuurkd. Tijdschr. Neder. Indië v. 5: 67-96.	No type known	

Synaptura nebulosa Chen & Weng 1965	Not a *Brachirus*, likely *Zebrias annularis*	Li & Wang 1995 (species) Author (genus)	-Chen, J. T. F. and H. T. C. Weng 1965 (Dec.). A review of the flatfishes of Taiwan. Biol. Bull. Tunghai Univ. Ichthyol. Ser. No. 5 Nos. 25, 27: 1-103.	Holotype THUP 02768 not examined	-Likely a synonym of *Brachirus annularis*
Synaptura nigra MacLeay 1880	Synonym of *Brachirus sundaicus* Bleeker 1870-75	Author	-Macleay, W. 1880 (Aug.). On two hitherto undescribed fishes well-known in the Sydney market. Proc. Linn. Soc. N. S. W. v. 5 (pt 1): 48-49.	Syntypes AMI.16280-001, AMI.16280-002, AMI.16280-003 examined	
Pleuronectes orientalis Bloch & Schneider 1801	Valid as *Brachirus orientalis* (Bloch & Schneider 1801)	Lu & Wu in Kuang et al. 1986	Bloch, M. E. and 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. Systema Ichthyol.: i-lx + 1-584, Pls. 1-110.	Syntypes ZMB 7404 (1, right skin), 7405 (1, dry, lost), 7407 (1, right skin) not examined	- Syntypes belonging to both *Brachirus orientalis* and *Zebrias altipinnis*
Solea ovalis Richardson 1846	Not a *Brachirus*	Author	-Richardson, J. 1846 (June/July). Report on the ichthyology of the seas of China and Japan. Rep. Brit. Assoc. Adv. Sci. 15th meeting [1845]: 187-320.	No types known	-Based solely on illustration by Reeves (see Whitehead, 1970) -predorsal length, lateral line shape and mouth differ from *Brachirus*
Pleuronectes pan Hamilton 1822	Valid as *Brachirus pan* (Hamilton 1822)	Li & Wang 1995	-Hamilton, F. [Buchanan] 1822. An account of the fishes found in the river Ganges and its branches. Edinburgh & London. Fishes Ganges: i-vii + 1-405, Pls. 1-39.	Holotype location unknown	

Synaptura panoides Bleeker 1851	Valid as *Brachirus panoides* (Bleeker 1851)	Munroe in Randall & Lim 2000	-Bleeker, P. 1851. Vijfde bijdrage tot de kennis der ichthyologische fauna van Borneo, met beschrijving van eenige nieuwe soorten van zoetwatervisschen. Natuurkd. Tijdschr. Neder. Indië v. 2: 415-442.	Holotype BMNH 1862.6.3.7 examined	
Brachirus salinarum Ogilby 1910	Valid as *Brachirus villosa* (Weber 1907)	Author	-Ogilby, J. D. 1910 (7 Nov.). On new or insufficiently described fishes. Proc. R. Soc. Queensl. v. 23: 1-55.	Holotype and Paratype QMI.870 examined	
Synaptura selheimi MacLeay 1882	Valid as *Brachirus villosa* (Weber 1907)	Author	-Macleay, W. 1882 (23 May). The fishes of the Palmer River. Proc. Linn. Soc. N. S. W. v. 7 (pt 1): 69-71.	Syntypes lost	
Synaptura siamensis Sauvage 1878	Valid as *Brachirus siamensis* (Sauvage 1878)	Munroe in Randall & Lim 2000	-Sauvage, H. E. 1878. Sur quelques pleuronectes appartenant aux genres Synaptura et Cynoglossus et provenant de la Cochin-chine et du Laos. Bull. Soc. Philomath. Paris (Ser. 7) v. 2: 92-96.	Holotype MNHN 0000-9644 examined	
Chabanaudetta smithi Joglekar, 1971	Synonym of *Brachirus siamensis* (Sauvage 1878)	Kottelat 2001	-Joglekar, A. 1971. On a new sole of the genus Chabanaudetta Whitley (Pisces, Soleidae) from Nontabury, Siam. Zool. Anz. v. 187 (nos. 5/6): 369-371.	Holotype ZSI F6284/2; Paratypes ZSI F6285/2 not examined	
Synaptura smithi Regan 1903	Not a *Brachirus,* possibly a *Zebrias*	Author	-Regan, C. T. 1903 (1 Jan.). Notes on the genus Synaptura Cantor, with descriptions of two new species. Ann. Mag. Nat. Hist. (Ser. 7) v. 11 (no. 61): 56-58, Pl. 6.	Holotype BMNH 1902.10.31.152 not examined	-Type description alludes to this species belonging to Zebrias

Synaptura sorsogonensis Evermann & Seale 1907	Synonym of *Brachirus aspilos* (Bleeker 1852)	Author	-Evermann, B. W. and A. Seale 1907 (11 Jan.). Fishes of the Philippine Islands. Bull. Bur. Fish. v. 26 (for 1906): 49-110	Holotype USNM 55916 examined
Brachirus sundaicus Bleeker 1870-75	Valid as *Brachirus sundaicus* Bleeker 1870-75	Bleeker 1870-75	-Bleeker, P. 1870-75. Atlas ichthyologique des Indes Orientales Néêrlandaises, publiés sous les auspices du Gouvernement colonial néêrlandais. Tome VI. Pleuronectes, Scombrésoces, Clupées, Clupésoces, Chauliodontes, Saurides. Atlas Ichthyol. v. 6: 1-170, Pls. 232-278.	Syntypes location unknown
Synaptura swinhonis Steindachner 1867	Valid as *Brachirus swinhonis* (Steindachner 1867)	Li & Wang 1995	-Steindachner, F. 1867. Über einige neue und seltene Meeresfische aus China. Sitzungsber. Math.-Naturwiss. Classe K. Akad. Wiss. Wien v. 55 (pts 4-5): 585-592.	Holotype NMW 43070 not examined
*Synaptura villosa W*eber 1907	Valid as *Brachirus villosus* (Weber 1907)	Roberts 1978	-Weber, M. 1907. Süsswasserfische von Neu-Guinea ein Beitrag zur Frage nach dem früheren Zusammenhang von Neu-Guinea und Australien. In: Nova Guinea. Résultats de l'expédition scientifique Néerlandaise à la Nouvelle-Guinée.	Holotype BMNH 1913.12.15.37 examined

Appendix 8: Meristics for all species within the *Brachirus* species complex.

Number of right pectoral fin rays												
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**n**	**x**	**S**
B. breviceps	1									1	2.0	
B. siamensis	2	12	14							28	3.4	0.6
B. panoides	4	18	15	1						38	3.3	0.7
B. selheimi		7	3	19	18	82	10	1		140	6.4	1.2
P. setifer			1	5	1					7	5.0	0.6
B. pan			1	13	4	1				19	5.3	0.7
B. sundaicus			2	15	58	8	7	1		91	6.1	0.9
B. aspilos			1	13	16	6	2	1		39	5.9	1.0
D. megalepidoura				8						8	5.0	0.0
B. fitzroiensis				1						1	5.0	
D. muelleri				5	9					14	5.6	0.5
B. orientalis				1	4	23	21	2		51	7.4	0.8
B. foliacea					19	18	10			47	6.8	0.8
B. cinerascens					3	4	19	6	1	33	7.9	0.9
Number of left pectoral fin rays												
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**n**	**x**	**S**
B. siamensis	1	9	17	1						28	3.6	0.6
B. panoides	2	10	24	4						40	3.8	0.7
B. selheimi	1	8	8	24	20	70	9			140	6.1	1.3
D. megalepidoura		2	5	1						8	3.9	0.6
D. muelleri			2	2	10					14	5.6	0.8
P. setifer			1	3	3					7	5.3	0.8
B. aspilos			8	17	12	1				38	5.2	0.8
B. pan			4	12	2	1				19	5.0	0.7
B. sundaicus			1	27	54	5	2	1		90	5.8	0.7
B. fitzroiensis				1						1	5.0	
B. orientalis				3	10	27	11			51	6.9	0.8
B. foliacea				5	15	21	4	1		46	6.6	0.9
B. cinerascens						7	18	7	1	33	8.1	0.7

Number of right pelvic fin rays							
	3	**4**	**5**	**6**	**n**	**x**	**S**
B. fitzroiensis	1				1	3.0	
B. siamensis	2	24	2		28	4.0	0.4
A. melanorhynchus	2	154	44		200	4.2	0.4
B. panoides	1	23	16		40	4.4	0.5
B. sundaicus	2	75	16		93	4.2	0.4
P. setifer		6	1		7	4.1	0.4
B. aspilos		3	35		38	4.9	0.3
D. muelleri		1	14		15	4.9	0.3
B. pan		16	3		19	4.2	0.4
B. cinerascens		2	30	1	33	5.0	0.3
B. orientalis		1	39	9	49	5.2	0.4
B. selheimi		1	117	23	141	5.2	0.4
D. megalepidoura			8		8	5.0	0.0
B. foliacea			44	2	46	5.0	0.2
Number of left pelvic fin rays							
	3	**4**	**5**	**6**	**n**	**x**	**S**
D. muelleri	1	2	12		15	4.7	0.6
B. aspilos	1	24	13		38	4.3	0.5
A. melanorhynchus	2	165	33		200	4.2	0.4
B. panoides	2	25	13		40	4.3	0.6
B. sundaicus	3	79	11		93	4.1	0.4
B. siamensis	1	25	2		28	4.0	0.3
D. megalepidoura	2	2	4		8	4.3	0.9
P. setifer		6	1		7	4.1	0.4
B. pan		17	2		19	4.1	0.3
B. cinerascens		3	30		33	4.9	0.3
B. foliacea		8	38	1	47	4.9	0.4
B. orientalis		9	38	2	49	4.9	0.5
B. selheimi		4	116	21	141	5.1	0.4

Number of lateral line scales																										
	40	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**n**	**x**	**S**
A. melanorhynchus	1	2	1	6	3	1	2	7	11	8	10	15	17	15	14	16	12	10	12	6	3	12	5			
B. pan																1					2	2				
B. selheimi																		1	1	1	1	2	2			
B. sundaicus																			1			2				
B. foliacea																							1			
D. megalepidoura																										
B. cinerascens																										
B. orientalis																										
D. muelleri																										
B. siamensis																										
B. breviceps																										
B. aspilos																										
P. setifer																										
B. panoides																										
B. fitzroiensis																										
	64	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**			
A. melanorhynchus	3	1	2	3		1	2																			
B. pan		1	1	1	1	1	3	2			1	1				2										
B. selheimi	3	1	2	1		1	1	2	2	1	2	1	4	3	2		8	7	6	8	14	6	9			
B. sundaicus	2	2		4	1	8	4	6	6	9	8	7	5	2	4	3	3	2	3		3		1			
B. foliacea		2		2	2	4	1	3	7	2	3	5	4	3	2	2	1	1	1	1						
D. megalepidoura		1							1		2	1	1		1		1									
B. cinerascens		2			2	1	1	1	1	1	2	4	1		3	2	1	1	1	2	2	1	2			
B. orientalis			2	4	3	3	6	3	6	4	3	6	4	5	2											
D. muelleri					1	1	1		3			1	1	1	1		2			1		1	1			
B. siamensis							1					1	2	2	2	2	2	1	2	1	2	1	2			
B. breviceps											1															
B. aspilos													1									1	1			
P. setifer																			3		2					
B. panoides																			1			1	1			
B. fitzroiensis																					1					

	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109			
A. melanorhynchus																										
B. pan																										
B. selheimi	12	8	5	5	4	1	2	4	3	3	1															
B. sundaicus																										
B. foliacea																										
D. megalepidoura																										
B. cinerascens		1		1																						
B. orientalis																										
D. muelleri																										
B. siamensis	3	1	1			1				1																
B. breviceps																										
B. aspilos	3			1		4	3	3	3	2	1	1	1	1	1	2		1	2	1	1					
P. setifer	1		1																							
B. panoides			1		1	3		1		1	1	2	4	4	3		2			1	3	2	2			
B. fitzroiensis																										

	111	112	113	114	117	118	120	121	n	x	S
A. melanorhynchus									201	54.8	5.7
B. pan									19	68.2	6.2
B. selheimi									140	82.2	8.8
B. sundaicus									86	73.4	5.4
B. foliacea									47	73.3	4.6
D. megalepidoura									8	74.3	4.5
B. cinerascens									33	77.2	6.7
B. orientalis									51	72.3	3.5
D. muelleri									15	76.2	5.8
B. siamensis									28	82.3	5.7
B. breviceps									1	74.0	
B. aspilos	2		1	1	1				39	97.3	8.9
P. setifer									7	84.3	2.8
B. panoides		2		1		1	1	1	40	101.4	9.2
B. fitzroiensis									1	84.0	

Number of caudal fin rays

	12	13	14	15	16	17	18	19	20	n	x	S
B. aspilos	1	1	24	3						29	14.0	0.5
B. sundaicus	2	17	58	7	1		1			86	13.9	0.8
D. muelleri		3	3	7						13	14.3	0.9
B. pan		1	14	1						16	14.0	0.4
B. siamensis		1	1	4	8					14	15.4	0.9
A. melanorhynchus		3	25	38	17	2				85	14.9	0.9
D. megalepidoura			6							6	14.0	0.0
P. setifer			1	5						6	14.8	0.4
B. selheimi		2	31	86	2					121	14.7	0.5
B. fitzroiensis				1						1	15.0	
B. panoides				9	11	2				22	15.7	0.6
B. foliacea						2	7	18		27	18.6	0.6
B. cinerascens						1	6	15		22	18.6	0.6
B. orientalis						2	4	13	1	20	18.7	0.7

Number of dorsal fin rays

	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	n	x	S
A. melanorhynchus	1	3	7	16	12	11	12	7	8	5	2															
B. pan			1			1		2	6	4	2															
B. sundaicus			3	5	8	10	16	10	11	11	6	3	1													
B. foliacea						1	1	4	5	2	3	4	4	1		1										
B. selheimi								1	1	5	6	8	10	11	7	16	8	12	8	4	7	4	6			
D. megalepidoura											2	1		1	1											
B. cinerascens											1		3	4	5	3	1	4		1						
B. orientalis												1			1	3	6	6	1		2					
D. muelleri												1	3	1		3	2	1				2				
B. aspilos															1	1	5	2	2	5	4	3	2			
B. fitzroiensis																	1									
B. siamensis																	2	1	3	2	1		4			
P. setifer																		1	2	1		2				
B. breviceps																						1				
B. panoides																										

	74	75	76	77	78	79	80	81	82	83	85													n	x	S
A. melanorhynchus																								84	56.0	2.3
B. pan																								16	58.8	2.0
B. sundaicus																								84	57.7	2.3
B. foliacea																								26	60.5	2.4
B. selheimi	2	1	1						1	1														120	66.6	4.4
D. megalepidoura																								5	62.6	1.8
B. cinerascens																								22	65.4	2.2
B. orientalis																								20	67.3	1.9
D. muelleri																								13	66.1	3.2
B. aspilos	2	1																						28	70.0	2.6
B. fitzroiensis																								1	67.0	
B. siamensis							1																	14	70.9	3.4
P. setifer				1																				7	71.0	3.1
B. breviceps																								1	72.0	
B. panoides			1	2	3	5	2	4	3	2	1													23	80.0	2.2

Number of anal fun rays

	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	n	x	S
A. melanorhynchus	2	4	12	23	21	15	8	2																		
B. sundaicus			3	5	12	12	11	16	12	6	2	2	2				1									
B. pan				1	2	5	3	4		1																
B. foliacea					1	5	6	5	6	2	1	1														
D. megalepidoura							1	2	1			2														
B. cinerascens							1		2	6	4	5	3	1												
B. aspilos							1			1		1	1	2	3	4	5	5	2	3		2				
B. selheimi							1	1	5	5	7	16	17	13	17	16	8	9	4	1	1	1	2			
D. muelleri									1	2	1	1	1	3	2	1			1							
B. fitzroiensis													1													
B. orientalis													1	5	4	6	3	1								
B. siamensis													2	2	2	3	3	1		1						
P. setifer															2	1	1	1					1			
B. breviceps																		1								
B. panoides																		1	1		2	3	2			

	62	63	64	65											n	x	S
A. melanorhynchus															87	42.7	1.5
B. sundaicus															84	45.4	2.5
B. pan															16	44.7	1.5
B. foliacea															27	45.9	1.7
D. megalepidoura															6	47.3	2.2
B. cinerascens															22	49.0	1.6
B. aspilos															30	54.5	3.3
B. selheimi															124	52.3	3.0
D. muelleri															13	51.2	2.8
B. fitzroiensis															1	51.0	
B. orientalis															20	53.4	1.3
B. siamensis															14	53.8	2.0
P. setifer															6	55.3	3.0
B. breviceps															1	56.0	
B. panoides	6	3	2	3											23	61.6	2.4

Number of caudal vertebrae

	22	23	24	25	26	27	28	29	30	31	32	33	34	35	n	x	S
A. melanorhynchus	4	10	63	9											86	23.9	0.6
B. pan		5	10	1											16	23.8	0.6
B. cinerascens			2	13	8										23	25.3	0.6
B. foliacea					13	13									26	26.5	0.5
B. sundaicus					1	8	51	20	5						85	28.2	0.8
B. siamensis							1		4	8	1				14	30.6	0.9
B. selheimi							1	19	50	23	10	18	1	1	123	30.7	1.4
B. orientalis								3	14	3					20	30.0	0.6
B. breviceps										1					1	31.0	
B. fitzroiensis										1					1	31.0	
D. megalepidoura										3	3				6	31.5	0.5
D. muelleri										3	3	7			13	32.3	0.9
P. setifer											3	4			7	32.6	0.5
B. panoides											1	15	6	1	23	33.3	0.6
B. aspilos												5	20	4	29	34.0	0.6

Number of precaudal vertebrae									
	7	8	9	10	11	12	n	x	s
A. melanorhynchus	2	47	38				87	8.4	0.5
B. selheimi		79	38	7			124	8.4	0.6
B. aspilos		1	8	19			28	9.6	0.6
P. setifer		1	3	3			7	9.3	0.8
B. pan		5	9	2			16	8.8	0.7
B. sundaicus		5	16	55	4		80	9.7	0.7
B. orientalis		1	2	14	3		20	10.0	0.7
D. megalepidoura			6				6	9.0	0.0
B. breviceps			1				1	9.0	
B. fitzroiensis			1				1	9.0	
D. muelleri			1	12			13	9.9	0.3
B. cinerascens			8	13	2		23	9.7	0.6
B. foliacea			3	20	3		26	10.0	0.5
B. panoides			5	4	14		23	10.4	0.8
B. siamensis			3	3	7	1	14	10.4	0.9