

Distribution_and_characteristics_ of_Asian_seabass.pdf

by

FILE	DISTRIBUTION_AND_CHARACTERISTICS_OF_ASIAN_SEABASS.PDF (458.91K)		
TIME SUBMITTED	15-NOV-2020 01:32PM (UTC+0700)	WORD COUNT	3961
SUBMISSION ID	1446344380	CHARACTER COUNT	20839

PAPER • OPEN ACCESS

2
Distribution and characteristics of Asian seabass (*Lates calcarifer* Bloch, 1790) in South Sulawesi

4
To cite this article: Irmawati Irmawati *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **564** 012011

View the [article online](#) for updates and enhancements.

Distribution and characteristics of Asian seabass (*Lates calcarifer* Bloch, 1790) in South Sulawesi

Irmawati Irmawati¹, Moh. Tauhid Umar¹, Aidah Ambo Ala Husain¹, Asmi Citra Malina¹, Nadiarti Nurdin Kadir¹, and Alimuddin Alimuddin²

¹Faculty of Marine Science and Fisheries, Hasanuddin University, Makassar, 90245, Indonesia

²Faculty of Fisheries and Marine Science, IPB University (Bogor Agricultural University), Bogor 16680, Indonesia

Email: trif.ahwa@gmail.com

Abstract. The Asian seabass, *Lates calcarifer* (Perciformes, Latidae), known as barramundi in Australia, as *salamata* and *bale kanja* in South Sulawesi, was first described by Bloch in 1790 under the name *Holocentrus calcarifer*. The euryhaline *L. calcarifer* is a high-value marine and freshwater fish, on a par with salmon and tuna. This species has a widespread distribution, but there has been a lack of research on the distribution and identification of the genus *Lates* in Indonesia, including in South Sulawesi. This research aimed to track the distribution of Asia seabass in South Sulawesi (Makassar Strait, Gulf of Bone and Flores Sea) with identification based on DNA barcoding and characterization based on morphological parameters. The results show that Asian seabass can be found from Takalar to Pinrang Regency in the Makassar Strait, along the coast of Bone Bay from Bone to Luwu Regency, and from Bantaeng Regency to Selayar Island. Nucleotide sequences of COI mtDNA representing four Asian seabass populations in the Makassar Strait and Gulf of Bone had 99.12-99.41% identity with *Lates calcarifer* sequences from Singapore, Malaysia and Australia (query cover 99-100%). *L. calcarifer* captured at Cenrana in Bone District had a distinctive silvery-yellowish-white colouring, unlike the silvery-greenish-white observed at the other sites. Body depth (BD) of *L. calcarifer* was 30.10-32.20% SL and on average caudal peduncle depth was 45.65 % BD. There were several morphological differences between *L. calcarifer* in this study and *L. calcarifer* from Thailand: dorsal spine and ray counts, anal ray count, and number of vertebrae.

1. Introduction

The Asian seabass, *Lates calcarifer* Bloch (1790), also known as giant sea perch or barramundi, and in Indonesia as *ike kakap putih*, is a commercially important fish species found in the tropics and subtropics. The Asian seabass is an important species for both aquaculture and capture fisheries, not only in Southeast Asia and Australia but also in North America and Europe [1-5]. Aside from being a popular food fish, like other seabasses, the Asian seabass is also a target for recreational fisheries/sport fishing.

Asian seabass belong to the Order Perciformes, the largest of the vertebrate orders [6]. In the past, *Lates calcarifer* had several no-longer valid synonyms, through having been assigned to several genera, including *Perca*, *Pseudolates*, *Holocentrus*, *Plectropoma*, and *Plectropomus* [7]. Cuvier & Valenciennes (1828) proposed the genus *Lates* to include several other species, such as the Nile perch



Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

Published under licence by IOP Publishing Ltd

(*Lates niloticus*) [8]. In South Sulawesi, local names for the Asian seabass depend on size: *pica-pica* (fingerlings), *salamata* (juvenile fish), and *bale cannabis* (adult fish). In Japan, *L. calcarifer* is known as *akame*, which means red eyes, or *Lates japonicus*. The Asian seabass has a wide geographical distribution, from western India, around Sri Lanka to the Bay of Bengal, throughout the Southeast Asian region, to Taiwan, Papua New Guinea and Northern Australia [7-10]. Asian seabass occupy saline and freshwater habitats, including rivers, lakes, estuaries, coastal waters, and lagoons, down to depths of 10-50 meters. The Asian seabass in Southeast Asia and Taiwan form a stock which is separate from Asian seabass in Australia [5]. Asian seabass in India and Myanmar is thought to be a different species from Asian seabass in Southeast Asia and North Australia [8-12].

Asian seabass stocks in Indonesia are poorly managed and under-utilized, even though in 2017, the Indonesian Ministry of Maritime Affairs and Fisheries developed offshore aquaculture of *L. calcarifer* in Sabang, Aceh Province, the Southern Ocean waters off Java Island, and around Karimun Jawa Island in Central Java Province. In Indonesian capture fisheries, Asian seabass are considered as non-target fish (by-catch). Meanwhile, in brackish-water shrimp and milkfish ponds (*tambak*) in Indonesia, juvenile Asian seabass, which have not reached first sexual maturity, are poisoned together with other predatory fishes because they are considered pests for shrimp and milkfish culture.

Although *L. calcarifer* has a wide geographical distribution, maps showing the geographical distribution of Asian seabass stocks in Indonesia are not yet available. Asian seabass stock distribution maps could have many benefits, one of which is would be to provide vital information needed to plan management and conservation strategies, as well as to provide information on genetic diversity and suitable sources of broodstock for Asian seabass breeding activities in Indonesia. Based on these considerations, this research was conducted in South Sulawesi coastal waters, within the Wallacea region, with the following aims: (1) to map Asian seabass population spots; (2) to identify Asian seabass with barcoding methods; and (3) to characterize the morphology of Asian seabass in the study area.

2. Materials and methods

2.1. Asian seabass distribution

The methods used to track Asian seabass were based on the characteristics of the Asian seabass as a catadromous migratory predator that uses brackish-water ponds as a feeding ground at some stages in their life cycle. Therefore, the tracking and collection of Asian seabass for the distribution database used Google Map to obtain information on the coordinates of ponds (*tambak*) and estuaries. Information from Google Map was then used to sample Asian seabass from ponds, estuaries, and coastal areas by using fishing gears, including gill nets, stationary fish traps (*sero*), handlines, and set nets. Asian seabass tracking was also conducted through direct interviews with fishermen and recreational anglers who catch Asian seabass. Because the number of fish caught was not large, all fish caught were taken for analysis. The distribution of Asian seabass in the waters of the coast of South Sulawesi was presented in the form of a map.

2.2. Asian seabass identification

Asian seabass from each population were identified through a DNA barcoding method [11-14], using the primer pair FishF2 and FishR2 which targets a segment of the COX1 gene about 650 bp long [15]. Chromatograms produced from Sanger sequencing were edited using GeneStudio™ Professional (GeneStudio, Inc., USA). The Asian seabass forward and reverse nucleotide sequences for each specimen were aligned with ClustalW, combined and trimmed in MEGA X 1.1 [16]. The sequences obtained were then aligned with nucleotide sequences of *Lates calcarifer* deposited in the National Centre for Biotechnology Information (NCBI) GenBank database using the Nucleotide BLAST program. Specimen species identity was determined based on the values of the parameters % identity and % query cover.

2.3. Morphological Characterisation of Asian seabass

Asian seabass morphological characterization employed morphometric and meristic methods [14-18]. The morphometric characters measured and analyzed were body depth, pre-anal length, distance from the base of the ventral fin to the base of the anal fin, length of the base of the dorsal fin, as well as the length and width of the caudal peduncle. Meristic characters counted and analyzed included dorsal fin spines and rays, anal fin spines and rays, pectoral fin spines and rays, pelvic fin spines and rays, caudal fin rays, and a number of gill rakers. Another morphological character that was analyzed was the position of the pectoral fin relative to the ventral fin.

2.4. Data Analysis

Data on the morphological characteristics of *L. calcarifer* was analyzed descriptively and displayed graphically. The body depth range for *L. calcarifer* individuals within each population was presented as a boxplot produced in SPSS ver.16.

3. Results and discussion

3.1. Asian seabass distribution

The results of Asian seabass tracking in the waters of South Sulawesi show that in the Makassar Strait, the Asian seabass population was spread latitudinally between 3°38'-5°34'S longitude and longitudinally between 119°16'-119°27'E; in the Gulf of Bone the distribution was 3°14'-5°01'S and 120°18'-120°30'E; and in the Flores Sea, the distribution was 5°35'-6°05'S and 119°55'-120°27'E (Figure 1). Asian seabass specimens collected in this study came from shrimp and milkfish ponds, lakes connected to the coast, estuaries, rivers, coastal waters and seagrass meadows. Asian seabass not only has a wide geographical distribution [10], it also uses a wide variety of habitats, including seas, estuaries and coastal waters, as well as rivers, lakes and billabongs [19-20].

The Asian seabass is classified as a protandrous hermaphrodite, that is, a fish that undergoes sex change (sex reversal) where the fish first matures as a male and later transforms into the female phase [21,22,23]. The total length (TL) and weight ranges of Asian seabass caught in ponds were 171-381 mm and 0.06-0.87 kg, respectively. Asian seabass caught on the coast with a set net fishing gear (locally called *belle*) measured between 255-510 mm TL and 0.20-1.98 kg in weight. All Asian seabass caught in ponds and coastal waters were male, with gonad maturity stage (GMS) of I or II. These results are similar to those of Asian seabass studies in Western Papua where 99.92% (out of 1202 Asian seabass samples) with TL below 730 mm (about 5 years old) were male with GMS I-II, and only 0.08 % or one fish (420 mm TL) was female (about 2 years old) [24].

In this study, Asian seabass caught in seagrass beds at depths of 2-4 meters were caught with gill nets or with hook and line fishing gear. The fish were caught during the breeding season (full moon and new moon). The fish caught weighed 19-26.40 kg and were mostly females with GMS III and IV. Studies on Asian seabass migrating at our locations in the South China Sea (Thailand, Malaysia, Singapore, and Indonesia) showed that at the age of 3-4 years the female: male ratio of Asian seabass migrating at the locations was female-biased (F:J = 1.36) [7]. In contrast, research in the Fly River, Papua New Guinea, found that Asian seabass first matured as male fish occurred around the age of 3-4 years [25]. These findings indicate that Asian seabass in the South China Sea and the waters of South Sulawesi experience sex reversal earlier than Asian seabass in the Fly River in Papua New Guinea.

Asian seabasses are catadromous fish, growing in freshwater habitat and migrating to saline waters for gonad maturation, breeding and spawning. Asian seabass eggs are pelagic and hatch at around 24 hours old. Once the larvae have hatched, they inhabit mangroves and coastal areas up to 400 meters from the shore. At around one year of age, the juveniles will then migrate into brackish waters and then into rivers, to grow and develop there for 3 to 4 years [20,26].



Figure 1. Distribution of Asian seabass, *Lates calcarifer* Bloch, 1790 in South Sulawesi waters

Information on the distribution and presence of Asian seabass populations, as described above, is very important for managing and conserving Asian seabass populations in their natural environment. In addition, the distribution map will also be very useful for sourcing broodstock for Asian seabass aquaculture, which is currently starting to develop in Indonesia, including in South Sulawesi.

3.2. Identification

The alignment of 683 bp COX1 gene nucleotide sequences of Asian seabass caught in the coastal waters of Takalar, Maros, Bone and Wajo Regencies shows that the Asian seabass in these waters are *Lates calcarifer*. COX1 nucleotide sequences of Asian seabass gene from coastal waters of Takalar and Maros in the Makassar Strait and coastal waters of Bone and Wajo Regencies in the Gulf of Bone had a high homology (> 99%) with COX1 L nucleotides calcarifer from Singapore, Malaysia and Australia, with query cover of 99-100% (Table 1). These results indicate that Asian seabass in the waters of the Makassar Strait and the Gulf of Bone are *L. calcarifer*. These results are consonant with the results of research [8], which found that Asian seabass in the waters of Singapore, Malaysia, Thailand, Indonesia and North Australia belong to the same Asian seabass species. In contrast, the results of another study [5] which found that Asian seabass groups from Southeast Asia and Taiwan were in a separate clade from Asian seabass living in Australian coastal waters. The identification of Asian seabass from the Flores Sea is not shown because at the time of writing, the identification process was still ongoing.

Table 1. BLAST alignment results for COX1 gene nucleotide sequences from four Asian seabass specimens, two from the Makassar Strait and two from Bone Bay, with COX1 gene *Lates calcarifer* sequences deposited in the NCBI GeneBank.

Query Cover (%)	Identity (%)	E-value	Accession Number & Country	
Makassar Straits				
Ta1-W_ Asian seabass from coastal waters of Takalar Regency	99	99.41	0.0	DQ010541.1 – <i>L. calcarifer</i> from Singapore
	99	99.27	0.0	KY213962.1 – <i>L. calcarifer</i> from Malaysia
	99	99.27	0.0	KR349919.1 – <i>L. calcarifer</i> from Australia
Ma1-W_ Asian seabass from coastal waters of Maros Regency	100	99.26	0.0	DQ010541.1 – <i>L. calcarifer</i> from Singapore
	100	99.12	0.0	KY213962.1 – <i>L. calcarifer</i> from Malaysia
	100	99.12	0.0	KR349919.1 – <i>L. calcarifer</i> from Australia
Gulf of Bone				
Bo2-W_ Asian seabass from coastal waters of Bone Regency	100	99.26	0.0	DQ010541.1 – <i>L. calcarifer</i> from Singapore
	100	99.12	0.0	KY213962.1 – <i>L. calcarifer</i> from Malaysia
	100	99.12	0.0	KR349919.1 – <i>L. calcarifer</i> from Australia
Wa2-W_ Asian seabass from coastal waters of Wajo Regency	100	99.26	0.0	DQ010541.1 – <i>L. calcarifer</i> from Singapore
	100	99.12	0.0	KY213962.1 – <i>L. calcarifer</i> from Malaysia
	100	99.12	0.0	KR349919.1 – <i>L. calcarifer</i> from Australia

17. Morphological Characteristics

Lates calcarifer caught in the coastal waters of Makassar Strait and the Gulf of Bone had an elongated body form. The Head profile was concave with protruding mouth and upper jaw extending behind the eye. The body colour was greenish silver, except for *L. calcarifer* from the coastal waters of Cenrana, Bone Regency, which had a yellowish silver body colour. The fins were brownish to black. Dorsal fin spine count varied: D.VI-VIII.I-II with 10-12 soft rays (D.VI-VIII.I-II.10-12). Six to eight dorsal fin spines were separated from the soft portion of the fin and one last spine was fused with the soft rays (Table 2). The dorsal fin character of *L. calcarifer* from South Sulawesi was more varied than in *L. calcarifer* from Phuket, Thailand (D.VII.I.11) and *L. japonicus* from Japan (D.VII-VIII.I.11) [7]. In general, in *L. calcarifer* the 3rd dorsal spine is the longest and the first dorsal spine is the shortest (Figure 2; Table 2).

The anal fin comprised three spines joined to 7-10 rays (A.III.7-10). The third anal fin spine was longer than the second and first (A.III>II>I). The anal fin spine and ray count of Asian seabass in this study were similar to those reported for *L. calcarifer* from Phuket, Thailand and *L. japonicus* from Japan (both A.III.8), however, there was a difference in the relative length of the anal fin spines between

L. calcarifer and *L. japonicus*, where the second spine of *L. japonicus* is longer than the third (A.II>III>I) [7]. The anal fin spine characteristics of *L. calcarifer* in this study were similar to those of *L. lakdiva*, a recently described *Lates* species from Western Sri Langka, but the second anal spine character differs from *L. uwisara*, a recently described *Lates* species from eastern Myanmar, in which the second anal spine is longer than the third (A.II>III>I). The caudal ray count was 16-20 and the number of vertebrae was 23 (Figure 2).



Figure 2. X-ray showing meristic characters of *Lates calcarifer* Bloch, 1790 from South Sulawesi coastal waters

Table 2. Meristic characters of Asian seabass (*Lates calcarifer* Bloch, 1790) from South Sulawesi coastal waters (Roman numerals represent spines; Arabic numerals represent rays)

Population	Dorsal fin	Anal fin	Pectoral fin	Pelvic fin	Caudal fin	Number of gill-rakers	Scales above lateral line	n
Bone	VII.I.11-12	III.8-9	15-16	1.5-6	17-19	3-4	4-6	9
Siwa-Wajo1	VII.I.12	III.9-10	15-17	1.5	17	4	4	13
Akkotengeng-Wajo2	VI-VII.I-II.10-12	III.7-9	13-18	1.4-6	16-19	4	5-6	40
Takalar	VI-VIII.I.10-12; VIII.12	III.9	15-17	1.5-8	16-18	4	4-5	8
Pinrang	VII.I.12	III.9-10	15-21	1.5-6	16-20	4	4-6	31

The average body depth of *L. calcarifer* in this study ranged from 30.10-32.20% of the standard length (SL) and the average height of the caudal peduncle was around 45.65% of body depth. *L. calcarifer* from the coastal waters of Takalar Regency had the lowest mean body depth (30.10% SL) and the body depth was greatest (32.20% SL) in *L. calcarifer* from the coastal waters of Akkotengeng Village, Wajo Regency (Wajo2). Six *L. calcarifer* specimens were outliers based on body depth, namely one specimen from Pinrang with a body depth of 25.60% SL, one specimen from the coastal waters of Siwa, Wajo Regency (Wajo1) with a body depth of 41.40% SL and four specimens from Akkotengeng (Wajo2) with a body depth ranging from 33.20-33.80% SL (Figure 3). The body depth of *L. lakdiva* is reported as 26.6-27.6% SL and the body depth of *L. uwisara* is reported as 28.4-34.5% SL [12].

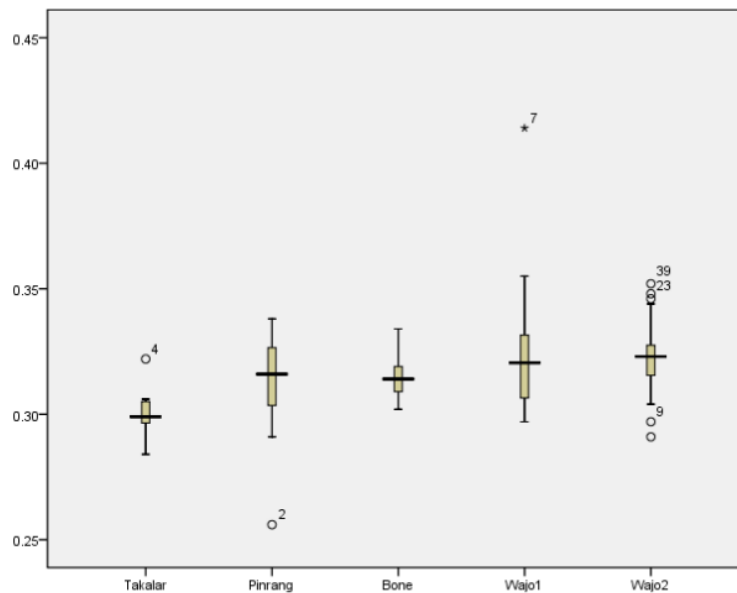


Figure 3. Boxplot of the body depth character of *L. calcarifer* Bloch, 1790 from South Sulawesi coastal waters

4. Acknowledgments

This research was carried out under programs funded by research grants from the Ministry for Research and Higher Education, Republic of Indonesia (2019), and from Hasanuddin University (2018-2019).

References

- [1] Davis TLO 1985 Seasonal changes in gonadal maturity, and abundance of larvae and early juveniles of barramundi, *Lates calcarifer* (Bloch), in Van Diemen Gulf and the Gulf of Carpentaria. *Australian Journal of Marine and Freshwater Research* **36**:177-190
- [2] Chou R, Lee HB 1997 Commercial marine fish farming in Singapore. *Aquaculture Research* **28**:767-776
- [3] Frost LA, Evans BS, Jerry DR 2006 Loss of genetic diversity due to hatchery culture practices in barramundi (*Lates calcarifer*). *Aquaculture* **261**:1056-1064
- [4] Zhu ZY, Lin G, Lo LC, Xu YX, Renee C, Yue GH 2006 Genetic Analyses of Asian Seabass Stocks using Novel Polymorphic Microsatellites. *Aquaculture* **256**:167-173
- [5] Yue GH, Zhu ZY, Lo LC, Wang CM, Lin G, Feng F, Pang HY, Li J, Gong P, Liu HM, Tan J, Chou R 2009 Genetic variation and population structure of Asian seabass (*Lates calcarifer*) in the Asia-Pacific region. *Aquaculture*, **293**(1-2):22-28
- [6] Nelson JS 2006 *Fishes of the World* Hoboken, NJ: Wiley
- [7] Katayama M, Taki Y 1984 *Lates japonicus*, a new Centropomid fish from Japan. *Japanese Journal of Ichthyology* **30**(4):361-367
- [8] Eschmeyer WN 2006 Catalog of Fishes. California Academy of Sciences. Available at www.calacademy.org/research/ichthyology/catalog/(April 7, 2006)
- [9] Yue GH, Xia JH, Liu F and Lin G. 2012. Evidence for female-biased dispersal in the protandrous hermaphroditic Asian seabass, *Lates calcarifer*. *PLoS ONE* **7**:e37976
- [10] Vij S, Purushothaman K, Gopikrishna G, Lau D, Saju JM, Shamsudheen KV, Kumar KV, Basheer

- VS, Gopalakrishnan A, Hossain MS, Sivasubbu S, Scaria V, Jena JK, Ponniah AG and Orbán L 2014 Barcoding of Asian seabass across its geographic range provides evidence for its bifurcation into two distinct species. *Front. Mar. Sci.* **1**:30
- [11] Ward RD, Holmes BH and Yearsley GK. 2008. DNA barcoding reveals a likely second species of Asian sea bass (barramundi) (*Lates calcarifer*). *J. Fish Biol* **72**, 458–463
- [12] Pethiyagoda R and Gill AC. 2012. Description of two new species of sea bass (Teleostei: Latidae: *Lates*) from Myanmar and Sri Lanka. *Zootaxa* 3314, 1–16. Available online at: <http://www.mapress.com/zootaxa/2012/f/zt03314p016.pdf>
- [13] Hebert PDN, Cywinska A, Ball SL, de Waard JR 2003 Biological identifications through DNA barcodes. In: Barrett S (ed.). *Proceedings of The Royal Society B. Royal Society of London* **270**(1512): 313-321
- [14] Lakra WS, Verma MS, Goswami M, Lal KK, Mohindra V, Punia P, Gopalakrishnan A, Singh KV, Ward RD, Hebert P 2011 DNA barcoding Indian marine fishes. *Mol Ecol Res* **11** (1): 60-71
- [15] Ward RD, Zemlak TS, Innes BH, Last PR, Hebert PDN 2005 Barcoding Australia's fish species. *Philosophical Transactions of the Royal Society B: Biological Sciences* **360**:1847-1857
- [16] Kumar S, Stecher G, Li M, Knyaz C, Tamura K 2018 MEGA X: Molecular Evolutionary Genetics Analysis Across Computing Platforms. *Mol Biol Evol.* **35**(6):1547-1549. doi: 10.1093/molbev/msy096
- [17] Turan C 2004 Stock Identification of Mediterranean Horse Mackerel (*Trachurus mediterraneus*) Using Morphometric and Meristic Characters. *ICES Journal of Marine Science* **61**:774-781
- [18] Irmawati 2016 Genetika Populasi Ikan Penerbit Andi, Yogyakarta 244 hal
- [19] Otero O 2004 Anatomy, systematics and phylogeny of both Recent and fossil latid fishes (Teleostei, Perciformes, Latidae). *Zoological Journal of the Linnean Society* **141**(1):81-133
- [20] Mathew G 2019 Taxonomy, identification and biology of Seabass (*Lates calcarifer*). Central Marine Fisheries Research Institute, India 43p
- [21] Moore R 1979 Natural sex inversion in the giant perch (*Lates calcarifer*). *Marine and Freshwater Research* **30**:803-813
- [22] Davis T 1982 Maturity and sexuality in barramundi, *Lates calcarifer* (Bloch), in the Northern Territory and south-eastern Gulf of Carpentaria. *Marine and Freshwater Research*, **33**:529-545
- [23] Blaber S, Milton D, Salini J 2008 The biology of barramundi (*Lates calcarifer*) in the Fly River system. *Developments in Earth and Environmental Sciences*, **9**:411-426
- [24] Moore R, Reynold L 1982 Migration patterns of barramundi, *Lates calcarifer* (Bloch), in Papua New Guinea. *Marine and Freshwater Research* **33**: 671–682
- [25] Stephan JM Blaber, David AM, John PS 2008 Chapter 11: The Biology of Barramundi (*Lates calcarifer*) in the Fly River System. *Developments in Earth and Environmental Sciences* **9**:411-426
- [26] Moore R 1982 Spawning and early life history of barramundi, *Lates calcarifer* (Bloch). *Australian Journal of Marine and Freshwater Research* **33**:647-661

ORIGINALITY REPORT

% **18**
SIMILARITY INDEX

% **14**
INTERNET SOURCES

% **14**
PUBLICATIONS

% **7**
STUDENT PAPERS

PRIMARY SOURCES

1 elib.dlr.de Internet Source % **3**

2 onlinelibrary.wiley.com Internet Source % **2**

3 Submitted to Universitas Jenderal Soedirman Student Paper % **1**

4 mafiadoc.com Internet Source % **1**

5 DJ Hume. "Interspecific hybridization between carp (*Cyprinus carpio* L.) and golfish (*Carassius auratus* L.) from Victorian Waters", Marine and Freshwater Research, 1983 Publication % **1**

6 researchonline.jcu.edu.au Internet Source % **1**

7 pertambangan.fst.uinjkt.ac.id Internet Source % **1**

8 Submitted to University of Lancaster Student Paper % **1**

9	Wang, Le, Zi Yi Wan, Huan Sein Lim, and Gen Hua Yue. "Genetic variability, local selection and demographic history: genomic evidence of evolving towards allopatric speciation in Asian seabass", <i>Molecular Ecology</i> , 2016.	% 1
Publication		
10	Stephen J. M. Blaber. "Tropical Estuarine Fishes", Wiley, 2000	% 1
Publication		
11	journals.plos.org	% 1
Internet Source		
12	spccfpstore1.blob.core.windows.net	<% 1
Internet Source		
13	Submitted to Universitas Hasanuddin	<% 1
Student Paper		
14	Yongxia Chen, Yifeng Chen. "Bibarba bibarba: A new genus and species of Cobitinae (Pisces: Cypriniformes: Cobitidae) from Guangxi Province (China)", <i>Zoologischer Anzeiger - A Journal of Comparative Zoology</i> , 2007	<% 1
Publication		
15	Wang, Le, Zi Yi Wan, Huan Sein Lim, and Gen Hua Yue. "Genetic heterogeneity and local adaptation of Asian seabass across Indonesian Archipelago revealed with gene-associated SNP markers", <i>Fisheries Research</i> , 2015.	<% 1

16

www.its.ac.id

Internet Source

<% 1

17

www.ansaqlid.com.au

Internet Source

<% 1

18

David A. Spratt. "Significance of bacterial identification by molecular biology methods", *Endodontic Topics*, 11/2004

Publication

<% 1

19

Han Ming Gan, Hiroshi Takahashi, Michael P. Hammer, Mun Hua Tan, Yin Peng Lee, Jasmyn M. Voss, Christopher M. Austin. " Mitochondrial genomes and phylogenetic relationships of , , and (Perciformes: Latidae) ", *Mitochondrial DNA Part B*, 2017

Publication

<% 1

20

www.mapress.com

Internet Source

<% 1

21

M. Kovacik. "The biology of Roule's goby in the Kvarner area, northern Adriatic Sea", *Journal of Fish Biology*, 10/2001

Publication

<% 1

22

Loughnan, Shannon R, Carolyn Smith-Keune, Dean R Jerry, Luciano B Beheregaray, and Nicholas A Robinson. "Genetic diversity and relatedness estimates for captive barramundi

<% 1

(Lates calcarifer , Bloch) broodstock informs efforts to form a base population for selective breeding", Aquaculture Research, 2015.

Publication

23

www.jmbfs.org

Internet Source

<% 1

24

repository.dl.itc.u-tokyo.ac.jp

Internet Source

<% 1

25

www.ijbs.com

Internet Source

<% 1

26

"Smiths' Sea Fishes", Springer Nature, 1986

Publication

<% 1

27

scholarbank.nus.edu.sg

Internet Source

<% 1

28

Muhammad Altin Massinai, Lantu, Hidayat Latuconsina, Muhammad Fawzy Ismullah M. "Distribution Analysis of Sulphide Mineral (Pyrite) Using Induced Polarization Method in Libureng, Bone, South Sulawesi", IOP Conference Series: Earth and Environmental Science, 2018

Publication

<% 1

29

link.springer.com

Internet Source

<% 1

30

Thevasagayam, Natascha, Prakki Sridatta,

<% 1

Junhui Jiang, Amy Tong, Jolly Saju, Purushothaman Kathiresan, Hsiao Kwan, Si Ngoh, Woei Liew, Inna Kuznetsova, Xueyan Shen, Si Lok, Shubha Vij, and László Orbán. "Transcriptome Survey of a Marine Food Fish: Asian Seabass (*Lates calcarifer*)", *Journal of Marine Science and Engineering*, 2015.

Publication

31

Yue, Gen Hua, Jun Hong Xia, Feng Liu, and Grace Lin. "Evidence for Female-Biased Dispersal in the Protandrous Hermaphroditic Asian Seabass, *Lates calcarifer*", *PLoS ONE*, 2012.

Publication

32

Simon, Thomas. "Reproductive Biology and Life History Accounts for Percids in the Ohio River Drainage", *Reproductive Biology and Early Life History of Fishes in the Ohio River Drainage Percidae - Perch Pikeperch and Darters Volume 4*, 2005.

Publication

33

Yue, G.H.. "Genetic variation and population structure of Asian seabass (*Lates calcarifer*) in the Asia-Pacific region", *Aquaculture*, 20090801

Publication

<% 1

<% 1

<% 1

EXCLUDE QUOTES ON
EXCLUDE ON
BIBLIOGRAPHY

EXCLUDE MATCHES < 5
WORDS