From "Sabang to Merauke", the presence of non-native *Oreochromis mossambicus* and *Oreochromis niloticus* (Cichliformes: Cichlidae) in Indonesia

Muhammad Iqbal*, *Tom* Amey[2], *Gusti* Ayu Widayanti[1], *Ina* Aprillia[1], *Randi* Syafutra[3], *Diah* Komala Sari[1], *Nur* Arifah[1] and *Freddy* Pattiselanno[4]

[1]Universitas Indo Global Mandiri, Department of Biology, 30129 Palembang, Indonesia
[2]Ecosystem Impact Foundation, Social and Environmental Programmes, 23897 Teupah Barat, Indonesia
[3]Universitas Muhammadiyah Bangka Belitung, Department of Natural Resources Conservation, 33134 Pangkalpinang, Indonesia
[4]Universitas Papua, Department of Animal Science, 98314 Manokwari, Indonesia

Abstract. Mozambique Tilapia *Oreochromis mossambicus* and Nile Tilapia *Oreochromis niloticus*are two non-native species of cichlids (Cichlidae: Cichliformes) that have established populations in Indonesia. There are many information about the presence of both non-native species in the country, but detailed distribution is filling a gap of information. We compile unpublished and published distribution records of *Oreochromis mossambicus* and *Oreochromis niloticus* from various sources, particularly from iNaturalist (citizen science platform) and GBIF (The Global Biodiversity Information Facility, an international network of country and organizational participants that exists to enable free and open access to biodiversity data from all sources and to support biodiversity science, environmental research and evidence based decision-making). The historical records of *O. mossambicus* and *O. niloticus* were reviewed and summarized, and put the certain known distribution records into the map. Our study suggest that *O. mossambicus* and *O. niloticus* found widely throughout Indonesia, from Sabang (northwesternost: Aceh Province, Sumatra) and Merauke (southeasternmost: South Papua Province, Papua).

1 Introduction

* Corresponding author: miqbal@uigm.ac.id

Human-facilitated carry away beyond biogeographic barriers has driven to the establishment and introduction of non-native species in new areas world wide [1]. Non-native species or alien species are organisms that do not present naturally in a biogeographic area that based eight criteria were fossil record, historical documentations, habitat, range distribution, frequency of known naturalisation, genetic diversity, reproductive pattern and possible means of introduction [2, 3]. An alien species could become an invasive alien species if this species affected native biological diversity [4].

Invasive Alien Species (IAS) are raising threat widely and affect a variety of economic, ecological and social problems [5]. The term of invasive or biological invasions as 'ecological outbreakings' meaning 'the terrificrise in number of some organism' in newly encroached areas [6]. To protect its biological diversity from IAS, the government of Indonesia has been launched its National Strategy and Management Action Plan for Invasive Alien Species (Strategi Nasional dan Arahan Rencana Aksi Pengelolaan Jenis Asing Invasif di Indonesia) [7].

The Tilapias (particularly Mozambique Tilapia *Oreochromis mossambicus* and Nile Tilapia *Oreochromis niloticus*) are the most well known and distribute in the world [8, 9]. The presence of the Tilapias have been known in Indonesia since 1936, when a native resident namely "Mr. Mujair" found this species in East Java [10, 11]. Due to the economically important, the species has been introduce everywhere in Indonesia [12]. "From Sabang to Merauke" is an Indonesian phrase which means the entire Indonesian territory encompassing some 1.9 million square kilometres along the way [13]. In this paper, we report the presence of *O. mossambicum* and *O. niloticus* from Sabang (Aceh) to Merauke (Indonesian Papua), as the most common introduce freshwater fishes in Indonesia.

2 Material and Methods

We compile and review all records of two species of Tilapias, *O. mossambicus* and *O. niloticus*, in Indonesian waters. Both species have similar morphological characters, so it is sometime very hard to determine them into species level [14, 15]. We use citizen science platform, such as iNaturalist [16] to learn the presence of *O. mossambicus* and *O. niloticus*. Another platform namely GBIF or the Global Biodiversity Information Facility has also been used to looking at distribution of both species. The GBIF is an international network of country and organizational participants that exists to enable free and open access to biodiversity data from all sources and to support biodiversity science, environmental research and evidence based decision-making [17]. Furthermore, we collate information from various published and unpublished sources, including from internet sources and social media.We also add our own observation during field visit in various fieldworks in Indonesia.

There are many information about the presence of *O. mossambicus* and *O. niloticus* based on the citizen science. The collection of freshwater information from social media and internet sources are followed appropriate references [18, 19]. We scrutinized carefully the citizen science reports and published papers, then only significance reports are presented. There was already available information of distribution of *O. mossambicus* and *O. niloticus* from iNaturalist 2024 and GBIF 2024.

Indonesia has divided within seven major largest islands group, including Sumatra, Kalimantan (Indonesian Borneo), Java and Bali, Sulawesi, Lesser Sundas (Nusa Tenggara), Moluccas, and Indonesian Papua or West Papua [20]. We add new information which not recorded by iNaturalist and GBIF platform, and then put information to the map (Fig. 1). There might have been more than one record in a site or island, but only significance source are used as reference. All information compiled are presented in Table 1.

3 Results and Discussion

There are 74 new recordsof *O. mossambicus* and *O. niloticus* in Indonesian waters after iNaturalistand GBIF platform (iNaturalist 2024, GBIF 2024, Table 1). Both species recorded from northwesternmost corner namely Sabang (Aceh Province, Sumatra) to southeasternmost corner namely Merauke (Indonesian Papua).

Based on the major seven Island group in Indonesia, Sumatra has the largest number records (26 records), following Kalimantan (19 records), Java (4 records), Sulawesi (14 records), Moluccas (8 records), Lesser Sunda (5 records), and Papua (4 records).

Table 1. Records of the presence of non-native *Oreochromis mossambicus* and *Oreochromis niloticus* (Cichliformes: Cichlidae) in Indonesian waters after GBIF (2024) and iNaturalist (2024). Remarks of observers: Muhammad Iqbal, TA = Tom Amey, and RS = Randi Syafutra.

Location	Province	Major Island	Number in the map (see note below for remarks)	Sources
Sabang Island	Aceh	Sumatra	1	[21]
Simeulue Island	Aceh	Sumatra	2	[22], MI & TA *Pers.obs.*
Singkil	North Sumatra	Sumatra	3	[23]
Tanjung Balai Asahan	North Sumatra	Sumatra	4	[23]
Nias Island	North Sumatra	Sumatra	5	[24]
Mandailing Natal	North Sumatra	Sumatra	6	[25]
Rokan Hilir	Riau	Sumatra	7	[26]
Rupat Island	Riau	Sumatra	8	[23]
Bengkalis Island	Riau	Sumatra	9	[27]

Location	Province	Major Island	Number in the map (see note below for remarks)	Sources
Tebingtinggi Island	Riau	Sumatra	10	[23]
Karimun Island	Riau Islands	Sumatra	11	[23]
Anambas Island	Riau Islands	Sumatra	12	[23]
Natuna Island	Riau Islands	Sumatra	13	[23]
Lingga Island	Riau Islands	Sumatra	14	[23]
Singkep Island	Riau Islands	Sumatra	15	[23]
Siberut Island	West Sumatra	Sumatra	16	[28]
Sipora Island	West Sumatra	Sumatra	17	[23]
Kerinci Lake	Jambi	Sumatra	18	[29]
Danau Dendam Tak Sudah	Bengkulu	Sumatra	19	[30]
Enggano Island	Bengkulu	Sumatra	20	[31]
Banyuasin Peninsular	South Sumatra	Sumatra	21	MI *Pers.obs.*
Sugihan Wetlands	South Sumatra	Sumatra	22	MI *Pers.obs.*
Bangka Island	Bangka Belitung Islands	Sumatra	23	[32, 33], MI & RS *Pers.obs.*
Belitung Island	Bangka Belitung Islands	Sumatra	24	[34]
Mesuji	Lampung	Sumatra	25	[35]
Lampung Timur	Lampung	Sumatra	26	[36]
Singkawang	West Kalimantan	Kalimantan	27	[23]
Sintang	West Kalimantan	Kalimantan	28	[23]
Kapuas Hulu	West Kalimantan	Kalimantan	29	[23]
Malinau	North Kalimantan	Kalimantan	30	[23]
Tarakan	North Kalimantan	Kalimantan	31	[23]

Location	Province	Major Island	Number in the map (see note below for remarks)	Sources
Berau	East Kalimantan	Kalimantan	32	[23]
Muara Komam	East Kalimantan	Kalimantan	33	[23]
Pulau Laut	South Kalimantan	Kalimantan	34	[23]
Martapura	South Kalimantan	Kalimantan	35	[37]
Puruk Cahu	Central Kalimantan	Kalimantan	36	[38]
Palangkaraya	Central Kalimantan	Kalimantan	37	[23]
Kota Warigin Timur	Central Kalimantan	Kalimantan	38	[23]
Arut Selatan	Central Kalimantan	Kalimantan	39	[23]
Sukamara	Central Kalimantan	Kalimantan	40	[23]
Pramuka Island	Jakarta	Java	41	[39]
Bawean Island	East Java	Java	42	[40]
Madura Island	East Java	Java	43	[41]
Kangean Island	East Java	Java	44	[42]
Talaud Island	North Sulawesi	Sulawesi	45	[23]
Sangihe Island	North Sulawesi	Sulawesi	46	[43]
Limboto Lake	Gorontalo	Sulawesi	47	[44]
Toli-toli	Central Sulawesi	Sulawesi	48	[45]
Donggala	Central Suawesi	Sulawesi	49	[46]
Pasangkayu	West Suawesi	Sulawesi	50	MI *Pers.obs.*
Polewali	West Sulawesi	Sulawesi	51	[23]
Tempe Lake	South Sulawesi	Sulawesi	52	MI *Pers.obs.*

Location	Province	Major Island	Number in the map (see note below for remarks)	Sources
Selayar Island	South Sulawesi	Sulawesi	53	[23]
Towuti Lake	South Sulawesi	Sulawesi	54	[47]
Bombana	Southeast Sulawesi	Sulawesi	55	[48]
Muna Island	Southeast Sulawesi	Sulawesi	56	[23]
Buton Island	Southeast Sulawesi	Sulawesi	57	[23]
Manggarai	East Nusa Tenggara	Lesser Sunda	58	[23]
Maumere	East Nusa Tenggara	Lesser Sunda	59	[23]
Sumba Island	East Nusa Tenggara	Lesser Sunda	60	[23]
Rote Island	East Nusa Tenggara	Lesser Sunda	61	[49]
Kupang	East Nusa Tenggara	Lesser Sunda	62	[50]
Morotai Island	North Maluku	Moluccas	63	[23]
Galela Lake	North Maluku	Moluccas	64	[51]
Halmahera Barat	North Maluku	Moluccas	65	[52]
Halmahera Timur	North Maluku	Moluccas	66	[53]
Bacan Island	North Maluku	Moluccas	67	[23]
Buru Island	Maluku	Moluccas	68	[23]
Seram Island	Maluku	Moluccas	69	[23]
Yamdena Island	Maluku	Moluccas	70	[54]
Sorong	West Papua	Papua	71	[55]
Biak Island	West Papua	Papua	72	[23]
Yapen Island	West Papua	Papua	73	[23]
Merauke	West Papua	Papua	74	[56]

Based on the major seven Island group in Indonesia, Sumatra has the largest number records (26 records), following Kalimantan (19 records), Sulawesi (14 records), Lesser Sunda (13 records), Moluccas (8 records), Java (4 records) and Papua (4 records).

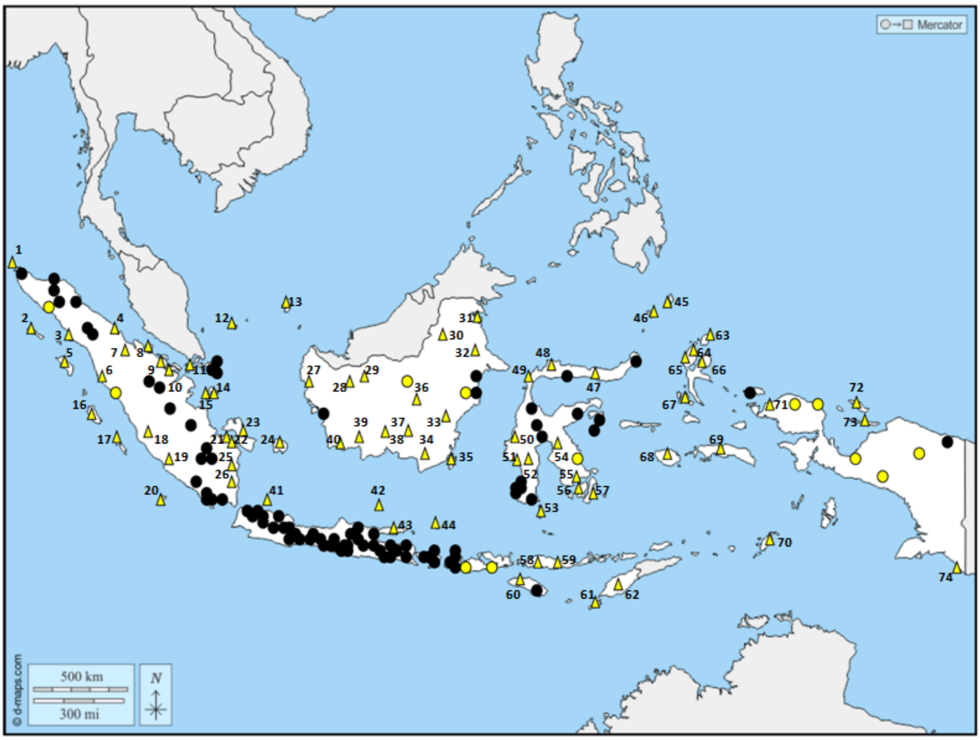

Fig. 1. Records of *Oreochromis* spp. (*Oreochromis mossambicus* and *Oreochromis niloticus*) in Indonesian waters. Black circles are record from iNaturalist (2024), yellow circles are record from GBIF (2024) and yellow triangles are records uncovered by iNaturalist (2024) and GBIF (2024). Number in the map refer to number in the Table 1.

Sumatra

In this study, Sumatra has 26 records of the presence *O. mossambicus* and *O.niloticus.* This is the largest number among other major islands group in Indonesia. The significance new records from previous documented records are documentation from sattelite islands, both from western islands group and eastern islands group. The records from western islands are from Sabang, Simeulue, Nias, Siberut, Sipora and Enggano. Few islands group from eastern Indonesia have been reported, including Rupat, Bengkalis, Tebingtinggi, Anambas, Natuna,Lingga, Singkep, Bangka and Belitung. These species have been found in various freshwater habitats, from river, swamp, lake, aquaculture pond and also in estuarine area. In Simeulue Island of Aceh Province, *Oreochromis* sp. has been recorded in Laut Tawar lake (Fig. 2).

Fig. 2. An individual of *Oreochromis niloticus* caught by local fisherman from Laut Tawar, Simeulue Island, Aceh Province, Sumatra (Photograph by Muhammad Iqbal).

Located in westernmost area in Indonesian Archipelago, Sumatra is one important site for freshwater fishes in the country [57, 5, 59]. There are more than 66 endemic freshwater species, and most of them threat by aquatic invasive species [60, 61]. As common aquaculture species, both *O. mossambicus* and *O. niloticus* are most threat for native Sumatran freshwater fishes [62].

Kalimantan

Kalimantan or Indonesian Borneo is a hotspot for freshwater fishes in Indonesia [63, 64, 65]. There are 19 records of *Oreochromis* spp. documented from Kalimantan. Most of them recorded in the main island of Borneo. There is only one recorded in smaller island, a record from Pulau Laut, South Kalimantan [23].

As other areas in Indonesia, threat to freshwater fishes in Kalimantan is aquatic invasive species [66]. *Oreochromis* spp. are bigger aquaculture cultivated commodity in Kalimantan. Thesefishes have been become common taxa found in the island waters, and also become threats for native species [67]. Further study of *Oreochromis* spp. in Kalimantan is required, because many freshwater habitats have been possibly occupied but lacking any documentations.

Java

Java is most populated island in Indonesia, and aquaculture has been knwon well by local people [68]. Few fishes in Java have been declared to be Extinct, and other numerous species have been in crtitical situation [69, 70]. In Indonesia, *Oreochromis* spp. are known as ‘ikan nila’ or ‘ikan mujair’ that the fishes have been found earlier in

Java in 1936 from Serang River, Blitar, East Java [10]. Many areas in Java have been occupied by *Oreochromis* spp. particularly in mainland Island.

In this study, there are four records from Java, and most of them are from sattelite islands. The records of *Oreochromis* spp. documented from Java are from Jakarta Province (Pramuka Island) and East Java Province (Bawean, Madura and Kangean).

Sulawesi

Sulawesi Island is a mega biodiversity hotspot in Indonesia, particularly for number of endemic freshwater fishes [71]. Aquatic invasive species have been documented become threats to native species, and *Oreochromis* spp. have been recorded as aquatic invasive taxa in Sulawesi [72].

There are 14 records of *Oreochromis* spp. documented in Sulawesi in this study. The fishes have been recorded from mainland Sulawesi and its sattelite islands, including Sangihe Island in north corner and Selayar Island in south corner of the island. Most lakes in Sulawesi have been occupied by *Oreochromis* spp., including Tempe Lake in South Sulawesi (Fig. 3).

Fig. 3. A young *Oreochromis niloticus* caught by local fisherman from Tempe Lake, South Sulawesi Province, Sumatra (Photograph by Muhammad Iqbal).

Lesser Sunda

Lesser Sunda is unlike any other major regions in Indonesia, because the region has no large island such as Sulawesi and Papua [73]. There are few number of freshwater fishes in Lesser Sunda Island [74], and aquatic invasive species have been identified as threat to the native fishes in the region [66].

There are five records of *Oreochromis* spp. in Lesser Sunda from various islands, including from Flores Island (Manggarai and Maumere), Sumba Island, Rote Island, and West Timor Island (Kupang). All of these records are from East Nusa Tenggara Province. There are possibly more numerous number records of *Oreochromis* spp. presence in Lesser Sunda Islands, but the records are poorly documented.

Moluccas

The character of Moluccas is nearly similar to Lesser Sunda because the large island is absence in this region [73]. The study of freshwater fish fauna in Moluccas is poorly studied [75], but the fishes also threats by aquatic invasive species, particularly from *Oreochromis* spp. [66].

In this study, there are eight records of the presence of *Oreochromis* spp. in Moluccas. The *Oreochromis* spp. have been documented in various islands in Moluccas, including from Morotai Island, Halmahera Island, Bacan Island, Buru Island, Seram Island and Yamdena Island. Due to the lack research of freshwater fishes in Moluccas, further study of biodiversity of freshwater fishes diversity and invasive alien species are needed in this region.

Papua

Situated in easternmost side, Indonesian Papua is the largest island of Indonesia. The Island has highest number of native freshwater fishes [77, 78, 79]. Although Indonesian Papuas is a large Island, but development of aquaculture is sadly lacking [80]. Inland waters in Indonesian Papua are endowed with huge diversity, but fishery activities in the island still lack studied [80]. In this study, there are four records of *Oreochromis* spp. in Indonesian Papua. There are still many gap of information about the presence of *Oreochromis* spp. in Indonesian Papua. These taxa have been become common in the island for aquaculture purpose (Freddy Pattiselano *Pers. Obs.*). Further study is needed to fill the gap of lack information about the presence of *Oreochromis* spp. in Indonesian Papua.

4 Conclusions

Indonesia is the world's largest archipelago country, consisting from seven major islands group, including Sumatra, Kalimantan, Java, Sulawesi, Lesser Sunda, Moluccas and Papua. The Mozambique Tilapia *Oreochromis mossambicus* and Nile Tilapia *Oreochromis niloticus* are two non-native species that have been as popular aquaculture commodity in Indonesia. Recorded first time in Java in 1936 from Serang River, East Java, the *Oreochromis* spp. have been documented in entire region of Indonesia, from northwesternmost areas in Sabang (Sumatra) to southeasternmost area in Merauke (Papua).

References

1. W. Dawson, D. Moser, D, M. van Kleunen, Global hotspots and correlates of alien species richness across taxonomic groups. Nature Ecology & Evolution. **1,** 0186 (2017). https://doi.org/10.1038/s41559-017-0186

2. D.A. Webb, What are the criteria for presuming native status?. Watsonia. **15**, 231-236 (1985)

3. M.B. Usher, The nativeness and non-nativeness of species. Watsonia. **23**, 323-326 (2000)

4. CBD-UNEP, Pathways of introduction of invasive species, their prioritization and management (CBD-UNEP, Montreal, 2014). Available: https://www.cbd.int/doc/meetings/sbstta/sbstta-18/official/sbstta-18-09-add1-en.pdf

5. N. Jubase, R.T. Shackleton, J. Measey, Public awareness and perceptions of invasive alien species in small towns. Biology. **10**, 1322 (2021). https://doi.org/10.3390/biology10121322

6. R. Gentili, U. Schaffner, A. Martinoli, S. Citterio, Invasive alien species and biodiversity: impacts and management. Biodiversity. **22**, 1-3 (2021). https://doi.org/10.1080/14888386.2021.1929484

7. A. Yuwono, S.A. Awang, B. Harpini, N. Prasmadji., Strategi nasional dan arahan rencana aksi pengelolaan jenis asing invasif di Indonesia (Ministry of Environment and Forestry, Jakarta, 2015)

8. E. Prabu, C.B.T, Rajagopalsamy, B, Ahilan, I.J.M.A. Jeevagan, M. Renuhadevi, Tilapia – An Excellent Candidate Species for World Aquaculture: A Review. Annual Research & Review in Biology. **31**, 1-14 (2019). https://doi.org/10.9734/arrb/2019/v31i330052.

9. A.F.M. El-Sayed, K. Fitzsimmons, From Africa to the world-The journey of Nile tilapia. Reviews in Aquaculture. **15**, 6-21 (2023). https://doi.org/10.1111/raq.12738

10. S. Naim, 74 Years of Tilapia culture and development in Indonesia (1936-2010) (University of Arizona, Arizona, 2010). Available: https://repository.ipmi.ac.id/1857/1/Arizona-MS-Enviro-2010.pdf

11. M.S. Dadiono, A review of the *Tilapia mossambica* (*Oreochromis mossambicus* Peters) invasion on the island of Java (Jenderal Soedirman University, Semarang, 2021). Available: https://sinelitabmas.unsoed.ac.id/google-doc/5054319.pdf

12. Minapoli, The fish site (https://thefishsite.com/articles/the-opportunities-and-challenges-of-indonesian-tilapia-strains, 2024)

13. E. Dimitria, Briefing on Indonesian arts and culture. Indonesiana. **1**, (2014). Available: https://repositori.kemdikbud.go.id/14750/1/Indonesiana%201.pdf

14. M. Kottelat, A.J. Whitten, S.R. Kartikasari, and S. Wirjoatmodjo., Freshwater fishes of western Indonesia and Sulawesi (Periplus Editions,Hongkong, 1993)

15. M. Iqbal, I. Yustian, A. Setiawan, and D. Setiawan., Ikan-Ikan di Sungai Musi dan Pesisir timur Sumatera Selatan (KPB-SOS, Palembang, 2018)

16. iNaturalist. Observations (https://www.inaturalist.org/observations?place_id=6966&taxon_id=90511, 2024)

17. GBIF. Occurences (https://www.gbif.org/occurrence/map?country=ID&taxon_key=2372271&occurrence_status=present, 2024)

18. M. Iqbal, A. Setiawan, D. Setiawan, I. Yustian., Second record of goblin shark *Mitsukurina owstoni* (Lamniformes: Mitsukurinidae) in Indonesian waters. Ecologica Montenegrina. **30**, 119-123 (2020). https://doi.org/10.37828/em.2020.30.11

19. M. Iqbal, E. Nurnawati, A. Setiawan, Z. Dahlan, I. Yustian, First photographic inland record of blacktip reef sharks *Carcharhinus melanopterus* (Carcharhiniformes: Carcharhinidae) in Indonesian waters. Ecologica Montenegrina. **24**, 6-10 (2019). https://doi.org/10.37828/em.2019.24.2

20. Pormansyah, M. Iqbal, A. Setiawan, I. Yustian, H. Zulkifli, A review of recent status on mudskippers (Oxudercine Gobies) in Indonesian waters. Oceanography and Fishireies Open Access Journal. **9**, 555769 (2019). https://doi.org/10.19080/OFOAJ.2019.09.555769

21. E. Prianto, R.M. Purwoko, K. Kasim., Stock status of Nile tilapia (*Oreochromis niloticus*) in Aneuk Laot Lake, Sabang District, Aceh Province, Indonesia. Biodiversitas. **22**, 3364-3370 (2021). https://doi.org/10.13057/biodiv/d220833

22. Z.A. Muchlisin, N. Nurfadillah, I.I. Arisa, A. Rahmah, D.F. Putra, M. Nazir, A. Zulham, Fish fauna of Lake Lauik Tawar and Lake Laulo, Simeulue Island, Indonesia. Biodiversitas. **18**, 752-757 (2017). https://doi.org/10.13057/biodiv/d180242

23. M. Iqbal, I. Aprillia, G.A. Widayanti, Catatan distribusi ikan alien Tilapia *Oreochromis* spp. di Indonesia (Universitas Indo Global Mandiri, Palembang, 2024)

24. F.D.A. Maduwu., Studi biodeversitas ikan air tawar di Sungai Gewa sebagai indikator kesehatan lingkungan. Faguru. **1**, 10-17 (2020). https://doi.org/10.57094/faguru.v1i1.497

25. R.Q. Tambunan, L. Bathara, Kusai, To manage of Lubuk Larangan as a environmental wisdom in Salambue Village, Panyabungan Kota Subdistrict, Mandailing Natal Regency, North Sumatra Province. Jurnal Online Mahasiswa Bidang Perikanan dan Ilmu Kelautan. **2**, 1-9 (2015). Available: http://jom.unri.ac.id/index.php/JOMFAPERIKA/article/view/6469

26. I. Effendi, Elizal, Ecological analysis of Pacific White Shrimp (*Litopenaeus vannamei*) cultivation: Rokan Hilir and Dumai context. IOP Conference Series: Earth and Environmental Science. **469,** 012037 (2020). https://doi.org/10.1088/1755-1315/469/1/012037

27. T.H. Marsyitah., L. Bathara, Hamid, The business analysis of Tilapia red fish (*Oreochromis* sp.) Culture in ponds (tambak) at Teluk Papal Village, Bantan Subdistrict, Bengkalis Regency Riau Province. Jurnal Online Mahasiswa Bidang Perikanan dan Ilmu Kelautan. **4**, 1-11 (2017). Available: https://jnse.ejournal.unri.ac.id/index.php/JOMFAPERIKA/article/view/13052

28. D.I. Roesma, D.H. Tjong, D.R. Aidil, F.D.L. Prawira, A. Saputra, Freshwater fish diversity from Siberut Island, a small island in the western part of Sumatra, Indonesia. Biodiversitas. **25**, 836-845 (2024). https://doi.org/10.13057/biodiv/d250244

29. Y.P. Pamungkas, and B. Burnawi., Hubungan panjang berat ikan nila (*Oreochromis niloticus*) di Danau Kerinci, Jambi. Buletin Teknik Litkayasa Sumber Daya dan Penangkapan. **13**, 67-70 (2016). http://dx.doi.org/10.15578/btl.13.2.2015.67-70

30. V.E. Kurniati., Jenis-jenis ikan di Danau Dendam Tak Sudah Provinsi Bengkulu (Unversitas Andalas, Padang, 2010)

31. R.K. Hadiaty, and S. Sauri., Iktiofauna air tawar Pulau Enggano, Indonesia. Jurnal Iktiologi Indonesia. **17,** 273-287 (2018). https://doi.org/10.32491/jii.v17i3.365

32. I. Akhrianti., and A. Gustomi., Identifikasi Keanekaragaman dan Potensi Jenis-Jenis Ikan Air Tawar Pulau Bangka. Akuatik. **12**, 174-80 (2018). https://doi.org/10.33019/akuatik.v12i1.694

33. E. Utami., E. Prasetiyono, T. Iskandar, E.P. Isnawati, Produksi Ikan Nila Salin Pada Perairan Lokal Hutan Mangrove Kelurahan Air Jukung, Kecamatan Belinyu, Kabupaten Bangka. Insan Cita. **4**, 1-11 (2022). https://doi.org/10.32662/insancita.v4i2.1649

34. A.M. Hafidz, F.S. Vallen, Kehadiran ikan invasif Nila Tilapia Oreochromis niloticus (Perciformes: cichlidae) di kepulauan Belitung, Indonesia. Jurnal Akuakultur Sungai dan Danau. **9**, 1-7 (2024). http://dx.doi.org/10.33087/akuakultur.v9i1.190

35. P. Priyantini, N. Yuliana, S. Hidayati, Studi Kelayakan Agroindustri Fillet Ikan Nila (*Oreochromis niloticus*) di Kabupaten Mesuji. Jurnal Teknologi Industri dan Hasil Pertanian. **19**, 54-69 (2014). Available: https://jurnal.fp.unila.ac.id/index.php/JTHP/article/view/408

36. M.H. Qulubi., Restocking Untuk Pelestarian Ikan Nila (*Oreochromis Niloticus*) Di Danau Kemuning Bandar Sribhawono Lampung Timur. Soeropati. **2**, 19-26 (2019). https://doi.org/10.35891/js.v2i1.1720

37. M. Rozik., Maryani., R. Djauhari, Yulintine, Prevalence and intensity of Nile tilapia (*Oreochromis niloticus*) ectoparasite in fish farmer group in Martapura River, South Kalimantan. AACL Bioflux. **15**, 2850-2860 (2022). http://www.bioflux.com.ro/docs/2022.2850-2860.pdf

38. P.D. Atmaja, Analisis finansial usaha pembesaran ikan nila (*Oreochromis* sp.) sistem kolam di Kota Puruk Cahu Kecamatan Murung Kabupaten Murung Raya Provinsi Kalimantan Tengah (Universitas Lambung Mangkurat, Banjarmasin, 2022)

39. A. Rizkiawan, Teknik pembesaran ikan nila salin (*Oreochromis niloticus*) menggunakan keramba jaring apung (KJA) di PT. Nuansa Ayu Karamba Pulau Pramuka Kepulauan Seribu DKI Jakarta (Universitas Airlangga, Surabaya, 2016)

40. V. Hasan, M.B. Tamam, First record of the invasive Nile Tilapia, Oreochromis niloticus (Linnaeus, 1758) (Perciformes, Cichlidae), on Bawean Island, Indonesia. Check List. **15**, 225-227 (2019). https://doi.org/10.15560/15.1.225

41. E.T. Wahyurini, Pengaruh perbedaan salinitas air terhadap tingkat kelangsungan hidup benih Ikan Nila Merah (*Oreochromis niloticus*). Agromix. **3**, 87-97 (2012). https://doi.org/10.35891

42. V. Hasan., F.S. Pratama., W.A.M. Malonga., andA.B. Cahyanurani., First record of the Mozambique Tilapia *Oreochromis mossambicus* Peters, 1852 (Perciformes: Cichlidae) on Kangean Island, Indonesia. Neotropical Biology and Conservation. **14**, 207-211 (2019). https://doi.org/10.3897/neotropical14.e35601

43. U.N. Manurung, F. Gaghenggang. Identifikasi dan prevalensi ektoparasit pada ikan Nila (*Oreochromis niloticus*) di kolam budidaya Kampung Hiung, Kecamatan Manganitu, Kabupaten Kepulauan Sangihe. Budidaya Perairan. **4**, 26-30 (2016). https://doi.org/10.35800/bdp.4.2.2016.13053

44. S.K. Ali, Y.Koniyo, Mulis, Identifikasi Ektoparasit Pada Ikan Nila (*Oreochromis nilotica*) di Danau Limboto Provinsi Gorontalo. Nike. **1**, 114-125 (2013). https://doi.org/10.37905/.v1i3.1231

45. I. W. Putri, Zaenudin, Pemanfaatan ampas kelapa sebagai bahan-bahan lokal di Kabupaten Tolitoli dalam meningkatkan pertumbuhan ikan nila (*Oreochromis niloticus*). Jurnal Tolis Ilmiah. **1**, 13-20 (2019). Available: https://ojs.umada.ac.id/index.php/Tolis_Ilmiah/article/download/3/3

46. Dirham M. Trianto, Analisis Isi Lambung Ikan Mujair (*Oreochromis mossambicus*) di Perairan Danau Talaga Kabupaten Donggala. Jurnal Bio-Edu. **5**, 118-128 (2020). https://doi.org/10.32938/jbe

47. N. Sukarni, Morphological identification of parasites in several types at Danau Towuti, Kabupaten Luwu Timur (Universitas Hasanuddin, Makassar, 2022). Available: http://repository.unhas.ac.id/id/eprint/16882/

48. A.I. Sari, M. Idris, I. Nur, Inventarisasi Parasit Ikan Nila (Oreochromis niloticus) yang Hidup pada Kolam Bekas Galian Penambangan Emas Rakyat Desa Watu-Watu Kecamatan Lantari Jaya Kabupaten Bombana. Media Akuatika. **4**, 118–124 (2019). http://ojs.uho.ac.id/index.php/JMA/article/download/9754/6892

49. I.R. Hamdan, A.N.R. Hutar, Analisis kelayakan investasi usaha budidaya ikan air tawar di Kabupaten Sumba Timur. Jurnal Ekonomi Manajemen dan Akuntansi. **19**, 103-114 (2023). Available: http://ejournal.iba.ac.id/index.php/jemasi

50. S.J. Juanda, S.I. Edo, Histopatologi organ usus ikan nila (*Oreochromis niloticus*) yang diambil dari pembudidaya ikan di kota Kupang, Nusa Tenggara Timur. Jurnal Vokasi Ilmu-Ilmu Perikanan. **1**, 20-24 (2021). http://dx.doi.org/10.35726/jvip.v1i2.727

51. C.N. Eteke, H.S. Sinjal, E.L.A. Ngangi, S. Darwisito, Strategi Pengembangan Budidaya Ikan Nila (*Oreochromis niloticus*) di karamba jaring apung Danau Galela, Kabupaten Halmahera Utara, Provinsi Maluku Utara. Jurnal Ilmiah Platax. **7**, 449-454 (2019). https://doi.org/10.35800/jip.7.2.2019.26023

52. J.K. Bunga, A. Talib, S.S. Titaheluw, Pengaruh Pemberian Tambahan Tepung Tulang Ikan Terhadap Pertumbuhan Ikan Nila dengan Sistem Budidaya Bioflok. Jurnal Sains, Sosial dan Humaniora. **3**, 89-102 (2023). https://doi.org/10.52046/jssh.v3i2.1754

53. A. Talib, M. Marini, S. Titaheluw, A. Husen, S. Deni, The DNA Barcoding of Tilapia Species from Wasile, East Halmahera, North Maluku, Indonesia. Journal of Survey in Fisheries Sciences. **10**, 1772-1780 (2023). https://doi.org/10.17762/sfs.v10i4S.1333

54. L., Insani, V., Hasan, F. S., Valen, F. S., Pratama, M. S., Widodo, A. R., Faqih, R. A., Islamy, A. T. Mukti, W. Isroni, Presence of the invasive Nile tilapia *Oreochromis niloticus* linnaeus, 1758 (Perciformes, cichlidae) in the Yamdena Island, Indonesia. Ecology, Environment and Conservation. **26**, 1115-1118 (2020). Available: https://www.envirobiotechjournals.com/ecology-environment-and-conservation/

55. Frasawi, A., Rompas, R. & Watung, J. Potensi budidaya ikan di Waduk Embung Klamalu Kabupaten Sorong Provinsi Papua Barat: Kajian kualitas fisika kimia air. Budidaya Perairan. **1**(3), 24-30 (2013). https://doi.org/10.35800/bdp.1.3.2013.2719

56. D. Saleky, R. Sianturi, M. Dailami, andA. Kusuma., Kajian molekuler ikan *Oreochromis* spp. dari perairan daratan Merauke-Papua, berdasarkan DNA mitokondria fragmen gen sitokrom oksidase subunit I. Jurnal Perikanan Uniersitas Gadjah Mada. **23**: 37-41 (2021). https://doi.org/10.22146/jfs.61026

57. M. Iqbal, I. Yustian., Occurrence of the giant freshwater stingray *Urogymnus polylepis* in Sumatra, Indonesia (Chondrichthyes: Dasyatidae). Ichthyological Exploration of Freshwaters **27**: 333-336 (2016). Available at: https://pfeil-verlag.de/wp-content/uploads/2017/04/ief27_4_06.pdf

58. A. Setiawan, M. Iqbal, R.D. Tandjung, G. Pragustiandi, Sarno, Pormansyah, I. Yustian, Pelagic Small Fishes in Peat Swamp of Jeruju River, South Sumatra, Indonesia. Ecology, Environment and Conservation. **27**. 380-384 (2021). Available: https://www.envirobiotechjournals.com/ecology-environment-and-conservation/

59. A. Setiawan, M. Iqbal, Pormansyah, D. Setiawan, and I. Yustian., The burmese trout Raiamas guttatus (Day, 1870) (Cypriniformes: Cyprinidae) in South Sumatra revealed its southernmost record of its distributional range. Ecologica Montenegrina. **27**, 39-44 (2020). https://doi.org/10.37828/em.2020.27.5

60. E. Prianto, R. Puspasari, D.O. Oktaviani, Aisyah., Status pemanfaatan dan upaya pelestarian ikan endemik air tawar di Pulau Sumatera. Jurnal Kebijakan Perikanan Indonesia. **8,** 111-122 (2016). http://dx.doi.org/10.15578/jkpi.8.2.2016.101-110

61. M. Iqbal, I. Yustian, W. Indriati, D. Setiawan, A. Setiawan., *Crossocheilus obscurus* Tan & Kottelat, 2009 (Teleostei, Cyprinidae): distribution extension and first record for Musi basin, South Sumatra, Indonesia. Check List. **13**, 1121-1124 (2017). https://doi.org/10.15560/13.6.1121

62. S. Wargasasmita., 2002. Ikan air tawar endemik Sumatera yang terancam punah. Jurnal Iktiologi Indonesia. **2**: 41-49 (2002). https://doi.org/10.32491/jii.v2i2.276

63. T.R. Roberts., The Freshwater fishes of Western Borneo (Cal. Acad. Sci., California, 1989)

64. Y. Windusari, M. Iqbal, H. Laila, Z. Hilda, I. Yustian, Contemporary distribution records of the giant freshwater stingray *Urogymnus polylepis* in Borneo (Chondrichthyes: Dasyatidae). Ichthyological Exploration of Freshwaters. **1089**, 1-6 (2019). https://doi.org/10.23788/IEF-1089

65. M. Iqbal, D. Setiawan, A. Setiawan, and I. Yustian., Second record of goblin shark *Mitsukurina owstoni* (Lamniformes: Mitsukurinidae) in Indonesian waters. Ecologica Montenegrina, **30**, 119-123 (2020). https://doi.org/10.37828/em.2020.30.11

66. Dina, R., G. Wahyudewantoro, S. Larashati, S. Aisyah, Lukman, Sulastri, Imroatushshoolikhah, S. Sauri, Distributional mapping and impacts of invasive alien fish in indonesia: an alert to inland waters sustainability. Sains Malaysiana. **51**(8), 2377-2401 (2022). http://doi.org/10.17576/jsm-2022-5108-04

67. S. Mubarak., Studi Spesies Ikan Invasif di Perairan Sungai Kayan Kabupaten Bulungan Kalimantan Utara (Universitas Borneo Tarakan, Tarakan, 2021)

68. J.H. Brown, and B. Prayitno., Backyard Fish Farming in Java, Indonesia. Community Development Journal. **22**, 237-241 (1987). Available at: https://www.jstor.org/stable/44256666
69. J. Constance, D.A. Ebert, Fahmi, B. Finucci, B. Simeon, P.M. Kyne, *Urolophus javanicus* (The IUCN Red List of Threatened Species 2023: e.T60095A229337053, 2023)
70. M. Iqbal, A. Setiawan, Y. Windusari, I. Yustian, H. Zulkifli, Updating status of the distributional records of giant freshwater stingray *Urogymnus polylepis* (Bleeker, 1852) in Indonesia. AIP Conference Proceedings. **2260**, 020004 (2020). https://doi.org/10.1063/5.0016554
71. F.W. Miesen, F. Droppelmann, S. Hüllen, R.K. Hadiaty, F. Herder, An annotated checklist of the inland fishes of Sulawesi. Bonn zoological Bulletin. **64**, 77-106 (2016). Available at: https://www.biodiversitylibrary.org/page/53023606#page/18/mode/1up
72. D. Yanuarita, D.F. Inaku1, N. Nurdin, S.W. Rahim, H. Kudsiah, B.S. Parawansa, N. Rukminasari, Irmawati, W. Moka, Aquatic invasive species distribution within Wallace region: a preliminary review. IOP Conference Series: Earth and Environmental Science. **564**, 012038 (2020). https://doi.org/10.1088/1755-1315/564/1/012038
73. K.A. Monk, Y. Fretes, Reksodiharjo, and G. Lilley., The ecology of Nusa Tenggara and Maluku (Periplus Editions, Singapore, 1996)
74. A. Tjakrawidjaja, Freshwater fishes of Manggarai Flores, with the various limnology aspect. Jurnal Iktiologi Indonesia. **2**, 15-22 (2017). https://doi.org/10.32491/jii.v2i2.273
75. A.H. Abdullah, Studi Bioekologi Ikan Air Tawar di Danau Galela Kabupaten Halmahera Utara Provinsi Maluku Utara (IPB University, Bogor, 2020). Available: https://repository.ipb.ac.id/handle/123456789/6375
76. A.J. Marshall, B.M. Beehler, The ecology of Papua: part one (Periplus Editions, Singapore, 2007)
77. G.R. Allen, Field guide to the freshwater fishes of New Guinea (Christensen Research Institute, Madang, 1991)
78. M. Iqbal, R.F. Saputra, A. Setiawan, I. Yustian, First description of an immature Sumatran striped rabbit (Nesolagus netscheri), with special reference to the wildlife trade in South Sumatra. Mammalia. **84**, 250-252 (2020). https://doi.org/10.1515/mammalia-2018-0217
79. Y. Windusari, L. Hanum, D. Setiawan, M. Iqbal, Photographic evidence of freshwater whipray Urogymnus dalyensis (Myliobatiformes: Dasyatidae) in Indonesian waters. Ecologica Montenegrina. **22**, 166-170 (2019). https://doi.org/10.37828/em.2019.22.13
80. T. Hidayah, D. Muthmainnah, Marson, N.K. Suryati, Fishery of Urisa River in West Papua. IOP Conf. Series: Earth and Environmental Science. **995**, 012031 (2022). https://doi.org/10.1088/1755-1315/995/1/012031