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Diversity and Distribution of Freshwater Fishes in Aceh Water, Northern-Sumatra, Indonesia*

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Abstract: The objective of the present study was to evaluate the diversity of freshwater fish and its distribution and to establish an inventory of the freshwater fish fauna in Aceh water. Sampling was done in five regions of NAD at 17 sites. Explorative research was conducted from January to June 2008 by investigating rivers based on information by local residents. Sampling was carried out in both lotic and lentic ecosystems. A total of 711 fishes belonging to 114 species, 69 genera, 41 families and 12 orders. Five families were distributed widely and observed in all the five regions i.e., Anguillidae, Clariidae, Cyprinidae, Anabantidae and Channidae. Sixteen families were found in only a single site. The diversity index of fishes in Aceh water ranged from 1.31 to 3.41 with an average of 2.17 indicating moderate values. The highest diversity was found in Lembang River of Aceh Selatan, while regionally, the North and south regions were higher but not significantly different from the West region. Highest similarity was found between Simpang dam and Sibreh irrigation canal of Sibreh. The similarity index between West and North region were relatively higher compared to other regional comparisons.

Key words: Biological indices, ecosystem leuser, Lembang River, Leuser, Alas River, Lake Laut Tawar

INTRODUCTION

Indonesia is labeled as one of the mega biodiversity country in the world next only to Brazil. Djajadireja *et al*. (1977) estimated that there are 4000 fish species in the Indonesian water and at least 900 freshwater or brackish water species can be found in Western Indonesia and Borneo. Indeed Suwelo (2004) further reported that there are 1000 species of freshwater fishes in the Indonesian water. For comparison, 212 freshwater species have been documented in the Korean Peninsnla of which 50 species are known to be endemic (Jang *et al*., 2003), 449 species in Malaysia, 49 species in Mexico of which 29 species are endemic (Salgado-Maldonado and Pineda-Lopez, 2003) and 27 species in Northern Queensland (Pusey and Kennard, 1996). Worldwide Vida and Kotai (2006) estimated a figure of approximately 50,000 fish species. Of these about 22,000-25,000 species have been named with valid description (Allen, 2000; Gilbert and Williams, 2002) and new species are being discovered or recognized at a rate of approximately 200 species per year of which 40% are freshwater fishes (Nelson, 1994).

The number of Indonesian fishes is probably an underestimation because many regions of the Indonesian water have not been explored and many fishes have not been found and described. To date the study on fish diversity especially on freshwater fishes in Aceh water has not been evaluated due to two major factors; the chaotic security condition during the last three decades and limitation of expertise. However, the Aceh Province is now developing rapidly and with it comes threats to the enviroument especially to the water resources due to pollution and intensive land use.

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The degradation of habitat has resulted in declines of species richness and diversity of fishes (Phillips and Johnston, 2004). A large portion of this decline in biodiversity has occurred in lotic ecosystem because of habitat degradation and alteration, often the result of impoundment (Richter *et al*., 1997).

Studies on fish diversity is needed to establish an inventory of the fish fauna present in the Aceh area and to serve as a baseline data that will be valuable to assess future environmental impacts of development and conservation in the future. Therefore, the present study is crucial and important.

MATERIALS AND METHODS

Sampling Sites and Qualification of Habitat

The study was conducted for 6 months from January to June 2008 at 17 sites in the Aceh Province (Fig. 1). Based on its topography and water characteristic Aceh can be divided into five regions namely, (1) Western Aceh with generally marshy topography, black water of high acid content but brackish in some areas, it covered the district of Aceh Jaya, Aceh Barat and Nagan Raya; (2) Southern Aceh with characteristically rust coloured water due to the presence of high concentration of total suspended solid during the rainy season and in general the sampling area was tropical rain forest (Leuser Ecosystem), it covered the district of Aceh Selatan; (3) Central Aceh has highland topography river stream with clear water and presence of a lake in the district of Aceh Tengah, it covered the district of Aceh Tengah and Aceh Tenggara; (4) Eastern Aceh which in general represented a lowland sampling area, most of the rivers had low water flows and some areas were in a tidal zone, it covered the districts of Pidie, Biruen And Tamiang/ Langkat and (5) Northern Aceh which represented an area of various water characteristic such as river with stream and tardy current and some rivers influenced by tide, it covered the district of Banda Aceh and Aceh Besar.

Sampling, Preservation and Identification of Fishes

Explorative research was conducted by investigating rivers based on information by local residents. Gillnets (mesh size of 0.75, 1, 2 and 3 inch-normally metric), hooks, acting nets (mesh size of 1, 2 and 3 inch) and traditional traps (bubu) were used to sample the fish. Sampling was carried out in both lotic (12 locations) and lentic (5 locations) ecosystems.

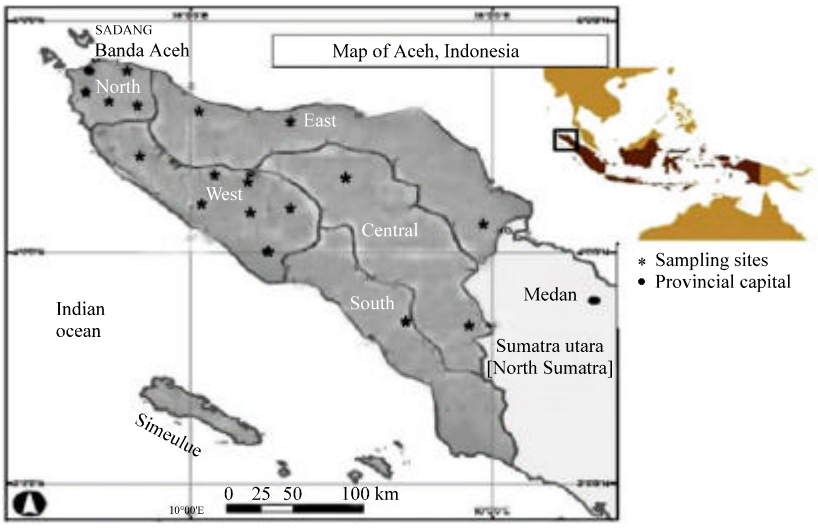

Fig. 1: Regions of Aceh Province showing sampling sites

Sampled fishes were counted; representatives were washed, photographed and then preserved in individual plastic bag containing 10% formalin. Each plastic bag was labeled with the site, date and local name of the fish. Those longer than 15 cm Standard Length (SL) were injected with absolute formalin prior for preservation in 10% formalin to ensure that interual organs did not decay. The samples were then transported to the laboratory and identified based on Kottelat *et al*. (1993), Nelson (1994), Gilbert and Williams (2002) and Vida and Kotai (2006). After identification the samples were transferred into absolute ethanol 95%. Any fish not covered in the above keys or of still dubious identity was sent to the relevant taxonomic authority for identification.

Analysis of Biological Indices

Data analysis of biological indices such as species richness, distribution, diversity and evenness were analyzed as follows:

- a: Local Distribution (D)

$$D = Ni.st/N.st \times 100\%$$

Where:
D = Local distribution
Ni.st = Total No. of locations where fishes were found
N.st = Total sampling sites

- b: Diversity Index (Shannon and Weiner Index) (H)

$$H = -\Sigma pi \ln pi$$

Where:
pi = N_i/N (N_i = Total number of individuals of species i)
N = Total No. of individuals of all species

- c: Species Richness (Margalef Index) (d)

$$d = S-1/\ln N$$

Where:
S = Total No. of species
N = Total No. of individuals of all species

- d: Evenness (Pielou Index) (E)

$$E = H/\ln S$$

Where:
H = Diversity index
S = Total number of species

Data Analysis

Data were analyzed using the software of Plymouth Routines in Multivariate Ecological Research (Primer E) Version 6.

RESULTS AND DISCUSSION

Distribution and Species Composition

Seven hundred and eleven fishes belonging to 114 species, 69 genera, 41 families and 12 orders were obtained from the survey (Annex 1). This can be compared to the study by Wargasasmita (2002), who recorded 589 fish species from the entire Sumatera island 58 of which were endemic. *Puntius brevis* had the highest local distribution (76.47%) followed by *Channa striata* (47.06%), *Anguilla bicolor* (41.18%), *Anabas testudineus* (35.29%), *Clarias teijsmani* (35.29%) and *Hampala macrolepidota* (35.29%). Moreover, these species were found in all the regions investigated (Annex 2).

Five families were found to be widely distributed and common to all regions; Anguillidae, Clariidae, Cyprinidae, Anabantidae and Channidae. However 16 families were found in only one region; Apogonidae, Aniidae Balitoridae, Bothidae, Engranlididae, Loricariidae, Muraenidae, Hemiramphidae, Haemnlidae, Microdesmidae, Mullidae, Scatophagidae, Siganidae, Siluridae, Sisoridae and Syngnathidae. While, the Northern region had the highest number of genera, most species were found in the Western and Southern regions (Fig. 2).

As in most other areas of the world apart from Australia, Madagascar, New Zealand and South America (Kottelat *et al*., 1993), Cyprinidae was the dominant fish in the Aceh water (12 genera and 26 species) with a wide distribution (Fig. 3a, b). Similarly, studies on several rivers and lake in Sumatera showed that fish communities were dominated by Cyprinidae (Hamidah, 2004; Siregar *et al*., 1993). This family also predominated in the river basin of Yangtze (Fu *et al*., 2003), Bario Kalabit Highland, Sarawak (Nyanti *et al*., 1999) and South Korean National Park (Jang *et al*., 2003).

Twenty four peripheral species (marine or estuary fishes) were documented during the survey. In general they were caught in estuarine water and mouth of the rivers (Table 1). According to Rahmatika *et al*. (2002), marine fishes were only found in the tidal reaches area, which stretched about 200 m from the mouth of the river and included; *Liza macrolepis*, *Caranx sexfaciatus*, *Microphis argulus*, *Ambassis buruensis*, *Vespicula depressifrons* and *Megalop cyprinoids*. *Megalobs cypronoides* larvae and *Kuhlia marginata*. Juveniles were also found, indicating that the lower reach was a nursery ground for some marine fishes (Rahmatika *et al*., 2002).

The same phenomenon was found in this study in that the peripheral fishes caught at the river mouth were small in size or was still in the juvenile stage. For example juveniles of *Kuhlia marginata*,

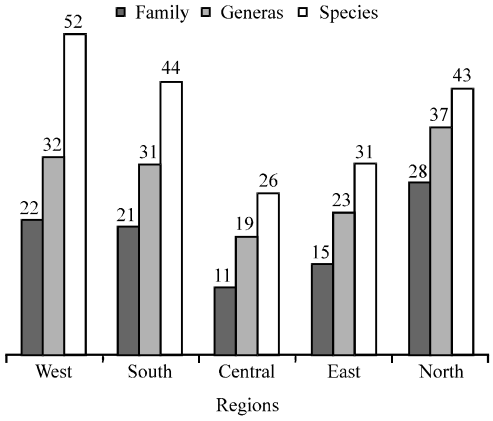

Fig. 2: Distribution of families, generas and species according to regions

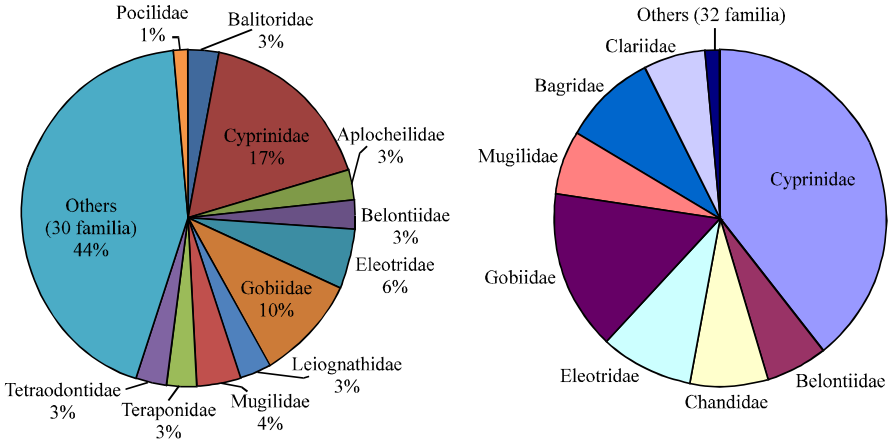

Fig. 3: Proportion of genera and species according to families, (a) Generas proportion according to family and (b) Species proportion according to family

Table 1: Peripheral fishes in Aceh water

	Species name	
No.	Scientific	Local
1	*Chanos-chanos*	Muloh
2	*Epinephelus tauvina*	Cerapei
3	*Caranx ignobilis*	Kitok, rambea
4	*Caranx sexfasciatus*	Kitok, rambea
5	*Liza melinopterus*	Belanet
6	*Lutjanus russellii*	Tanda
7	*Lutjanus argentimaculatus*	Tenga
8	*Mugil cephalus*	Belanet
9	*Valamugil cunnesius*	Kadra
10	*Valamugil speigleri*	Kadra
11	*Gerres acinaces*	Kapas-kapas
12	*Gerres macracanthus*	Kapas-kapas
13	*Pseudorhombus arsius*	Ikan sebelah
14	*Secutor interruptus*	Cirik
15	*Scatophagus argus*	Kitang
16	*Siganus guttatus*	Cabeh
17	*Siganus javus*	Cabeh
18	*Stelephorus indicus*	Bileh
19	*Terapon jarbua*	Kerong
20	*Upeneus vittatus*	Ikan kambing
21	*Megalop cypronoides*	Ikan bulan
22	*Plectorhinchus gibbosus*	-
23	*Tetraodon nigroviridis*	Bukum
24	*Zenarchopterus rasori*	Murung

Epinephelus tauvina, *Lutjanus argentimaculatus*, *Lutjanus russelli*, *Gerres macracanthus*, *Gerres acinaces* and *Secutor interruptus* were observed. Even though, *Caranx sexfaciatus* and some species of Ambassis (*A. kopsii*, *A. gymnocephalus* and *A. urotaenia*) were observed at the upper reach of Alue Pedeang River, which stretches more than 10 km from the mouth of the river. Their presence could most likely be attributed to sporadic visit or for feeding purposes.

According to Flannery *et al.* (2002), peripheral fishes move to low salinity and freshwater habitats to presumably take advantage of higher level of prey or feed resources and protection from marine predators afforded by the low salinity enviroument. Furthermore, Blaber (1997) reported that most estuarine fishes could tolerate salinity fluctuations, but their adaptability and distribution varied among species, depending on physiological tolerances, which may influence their distributions.

In addition, 9 species of introduced or invasive fishes were also discovered in the Aceh water i.e., *Clarias gariepinus*, *Cyprinus carpio*, *Hyposarcus pardalis*, *Oreochromis niloticus*, *O. mossambicus*, *Xiphophorus helleri* and *X. maculates*, *Poecilia* sp. and *Ctenopharyngodon idella*. Total number of exotic fishesin Aceh water was higher than in the wet tropical region of Northern Queensland with 2 species (Pussy and Kennard, 1996), however, it was lower than had been observed in the Israel water with 27 species (Roll *et al*., 2007). The presence of introduced fishes in Aceh water is a warning for local government to pay serious attention for fishery resources protection and conservation in the future. Provisions should be made to protect the native species, mainly the endemics and their habitat to ensure their survival.

The long-term key strategy remains the effective habitat conservation and rehabilitation, including prevention of the further spread of invasive alien fishes, the education of fishermen, public awareness and any others involved (Leonardus *et al*., 2007). Because, many invasive species are difficult or impossible to eradicate, the best option for limiting total impacts is often restriction.

Regardless of the management technique pursued, the identification and protection of high-risk lakes and rivers can produce greater benefits than protecting all or lakes even river (Keller *et al*., 2008).

In general fishes which could spread widely are those highly adaptable to adverse enviroumental factors particularly oxygen demand, water flow and temperature. For instance, the family Channidae has an additional respiratory organ called diverticula; Anguillidae has the ability to use free oxygen in the atmosphere through their skin; Clariidae is able to hold low dissolved oxygen because it has an additional respiratory organ in the form of the arborescent, while Anabantidae has a labyrinth organ.

On the other hand, narrowly distributed fishes mostly from the family Gobiidae, for example *Acentrogobius janthinopterus*, *Awaous megacephalus*, *Glossogobius circumpectus*, *G. giuris*, *Pseudogobius javanicus*, *Sicyopterus cyanocephalus*, *S. parvei* and *Sicyapus* sp. hide behind stream stones and holes of river bottom and in general they have an adhesive organ such as modified ventral fins. In contrast, Haryono *et al*. (2002) found that the gobiidae were widely distributed in Bogani Nani Wartabone National Park, North Sulawesi.

Among the freshwater fishes, the family Tor or *Keureling* is one of the very popular fish in Aceh, known as the king of the river. Three species of *Tor* were observed i.e., *Tor soro*, *T. Tambra* and *T. tambroides*. In general, Tor was found in the mighty rivers (upper stream), but occasionally *T. tambroides* could be found in the lower stream of Meurebo River and Woyla River in Aceh Barat (Annex 2).

Diversity Index (Shannon Index)

The diversity indices ranging from 1.31 to 3.41, the highest diversity index was observed in the Lembang River while the loWest in Batee Iliek River. Regionally, diversity indices of North and South regions were higher than the rest, but not significantly different with West region (Table 2).

The diversity index of fish communities in Aceh water could be categorized as low to moderate level. Nine locations had moderate diversity indices i.e., Lembang River, Simpang Reservoir, Alue Pedeang River, Lagean River, Alas River, Langkat/Tamiang River, Sibreh Reservoir, Aceh River and Cut River while eight locations had low diversity indices i.e., Meurebo River, Woyla River, Knala

Table 2: Indices of diversity, evenness and species richness of fish community in Aceh by regions

Regions	Tot. sp.	Tot. ind.	Sp. richness (d)	Pielou's evenness (J')	Diversity (H')
West	52.0	204.0	9.59	0.86	3.38
South	44.0	122.0	8.95	0.90	3.41
Central	26.0	138.0	5.07	0.81	2.65
East	31.0	108.0	6.41	0.91	3.11
North	43.0	139.0	8.51	0.92	3.45
Average	39.2	142.2	7.71	0.88	3.20

Table 3: Indices of diversity, evenness and species richness of fish community in Aceh by sampling sites

Sampling sites	Tot. sp.	Tot. ind.	Sp. richness (d)	Pielou's evenness (J')	Diversity (H')
Lembang River	44.00	122.00	8.95	0.90	3.41
Simpang Reservoir	16.00	53.00	3.78	0.90	2.50
Meurebo River	6.00	11.00	2.09	0.92	1.64
Alue Pedeang River	11.00	23.00	3.19	0.93	2.22
Woyla River	5.00	18.00	1.38	0.86	1.39
Kuala Tuha	7.00	29.00	1.78	0.85	1.65
Nagan River	6.00	18.00	1.73	0.84	1.50
Lagean River	23.00	52.00	5.57	0.94	2.94
Lake Laut Tawar	11.00	91.00	2.22	0.78	1.88
Alas River	18.00	47.00	4.42	0.92	2.65
Tamiang River	22.00	84.00	4.74	0.91	2.80
Batei Iliek River	4.00	15.00	1.12	0.95	1.31
Pante Raja Canals	6.00	9.00	2.28	0.97	1.74
Sibreh Reservoir	16.00	53.00	3.78	0.94	2.60
Murtala River	6.00	18.00	1.73	0.89	1.59
Aceh River	17.00	40.00	4.34	0.95	2.70
Cut River	14.00	28.00	3.90	0.92	2.43
Average	13.65	41.82	3.35	0.90	2.17

Tuha, Nagan River, Lake Laut Tawar, Batee Iliek River, Pantee Raja Canals and Murtala River (Table 3). A low to moderate diversity indices of fish were also found in other regions of Sumatera, for example Lake Singkarak, Western Sumatera. However, both regionally and locally the diversity indices of Aceh water were moderate on the whole.

The higher diversity index shows the existence of a balance between total species and total individnal of every species. However, a region which has higher species richness does not necessarily have a higher index of diversity. It will depend on the total individnal of each species, on the eveuness, in other words whether that community was dominated by one or two species. For instance the Western region had a higher species richness compared to other locations. However, the diversity index was slightly lower compared to the northern and southern regions. Locally, the species richness and the diversity index in Lembang River were higher than at other locations. The Lembang River is located in National Park of Leuser. This park is protected by national regulation and thus its biodiversity richness is well protected and commercial fishing is prohibited.

Furthermore, the local people living in the vicinity of the park are very protective of their river resources especially fishes; they have their own style of dealing with any offence relating to it; whomsoever is caught using poison would be fined one buffalo or one sheep for installing gillnets across the river. This regulation applies to locals as well as outsiders. This local awareness of the importance of conservation and active participation in protecting the fish community of the Lembang River has ensured the maintenance of fish diversity here (personal communication with local fisherman). The total number of species of the Lembang River in the Leuser National Park Aceh was higher (44 species) compared to other Indonesian National Parks such as Wartabone National Park in North Sulawesi which had 25 species recorded (Haryono *et al*., 2002), Gunung Halimun National Park, Java with 29 species (Rahmatika *et al*., 2002) and Muller Mountain Areas, Central Kalimantan with 26 species (Haryono, 2004) even Crocker Range Park Sabah, Malaysia with 19 species (Kavanagh, 2002). Generally, the total species of freshwater fish of Aceh water was higher than wet region of Northern Queensland, 27 species (Pusey and Kennard, 1996), 49 species in Mexico (Salgado-Maldonado and Pineda-Lopez, 2003).

On the contrary in Lawe Alas, the fishes were poisoned and even electric fishing was commonly used by fishermen. The same trend was observed in other locations such as Batee Ileik River, Nagan River and Meurebo River etc. Regionally, the diversity index and species richness of the central region was lower than other regions. The central region has a highland topography with a stream of high water visibility, stony and low water temperature. Therefore, the freshwater ecology of the central region

with extreme stream water temperature could only support a limited number of species which are adapted to the extreme conditions. These few species dominated and resulted in low species richness and diversity.

According to Rahel and Hubert (1991) cited by Pegg and Pierce (2002) many abiotic factors, ranging from water quality to habitat availability, have been identified as influential factors in defining aquatic communities in lotic system. In addition biotic factors and the interaction with abiotic ones also play a vital role in the system. Kupschus and Tremain (2001) suggested that biotic interactions serve to mediate community relationships between the physical frame works (abiotic factors) of the envirounent. Water flow has been identified as one of the more important driving variables used to describe aquatic communities in smaller stream because it can have strong effect on many other abiotic factors (Poof and Allan, 1995; Pegg and Pierce, 2002) such as water temperature, dissolved oxygen, water clarity (Fraser, 1997). Two endemic species were found in the central region of Aceh i.e., *Rasbora tawarensis* and *Poropuntius tawarensis*.

The higher species richness in the Western and Southern region was probably due to the existence of various water types such as stream, blackwater and swamp and brackish water. Generally, we found that the species richness of the black-water of lotic ecosystem was higher than clear-water.

Evenness and Similarity Indices

The eveuness index varied from 0.78 to 0.97, the highest eveuness index was found at Pantee Raja, while the lowest was found in Lake Laut Tawar. Regionally, the eveuness index of the northern region was slightly higher than other regions and the lowest was found in the central region, indicating that the frequencies of dominant species present in this region especially in Lake Laut Tawar was low in comparison. The data showed that *Rasbora tawarensis* and *Rasbora* sp. were the dominant species there (Annex 2). However, in general, the eveuness index of fish in Aceh water was higher at an average of 0.90 (Table 3).

The similarity index between pair wise comparisons of sites ranged from 0 to 66.67%. The cluster analysis of 17 sites demonstrated a division of fish communities into 14 different groups. The highest similarity was found between Simpang Reservoird Sibreh Reservoir, followed by between Woyla River and Nagan River, then between Batee Iliek River and Murtala River (Fig. 4). The ecological characteristic of Simpang Reservoir in Aceh Barat and Sibreh Reservoir in Aceh Besar is relatively similar composing of a swamp, irrigated paddy fields which has a small river with slow flowing water.

The *Trichogaster* sp., *Anabas testudineus*, *Anguilla bicolor*, *Channa striata*, *Clarias* sp. and *Puntius brevis* were commonly found there. According to Hamidah (2004) *Trichogaster trichopterus* and *Channa striata* are swampy fishes. The irrigated paddy field is an agro-ecosystem that sustains

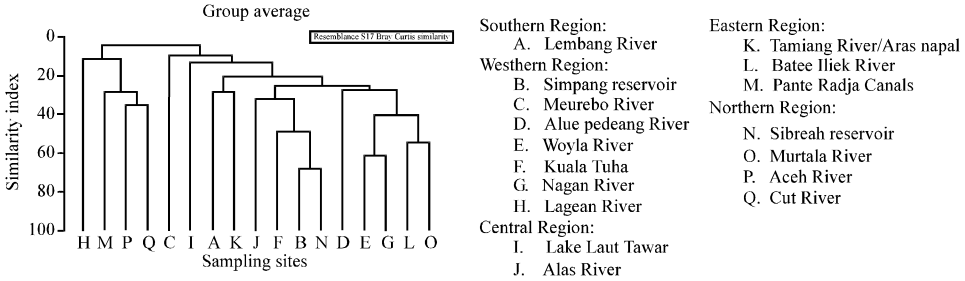

Fig. 4: Bray Curtis similarity plot of freshwater fish in Aceh water according to sampling sites

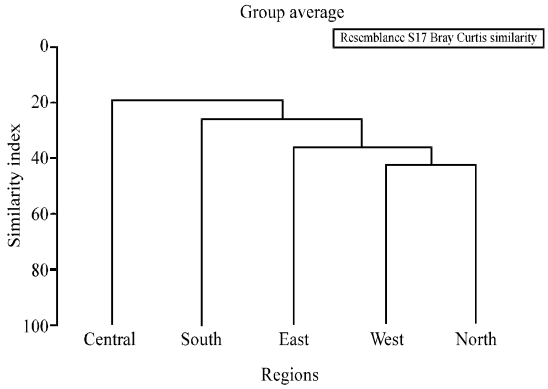

Fig. 5: Bray Curtis similarity plot of freshwater fish in Aceh water according to regions

a high species richness of invertebrate and vertebrate fauna, including fishes (Babaradeniya *et al*., 2004). Woyla and Nagan River also had a common spring source from Bukit Barisan Mountain that enabled fishes to move from one river to another. Therefore, these common factors presumably account for the high similarity index observed. Regionally, the similarity index of fish were low (below of 50%). However, the similarity between west and North regions was slightly higher compared to other comparisons, indicating their more similar species composition (Fig. 5).

The differentiation of the central region from the other regions reflected its fish community composition. Of the 26 species observed, eleven species were specific to this region namely *Barbucca diabolica*, *Glyptothorax major*, *Liposarcus pardalis*, *Neolissochilus* sp., *Protomyzon griswoldi*, *Rasbora tawarensis*, *Rasbora* sp., *Tor tambra*, *Xiphophorus helleri*, *Xiphophorus maculates* and *Poropuntius tawarensis*. Indeed, two of these species are endemic i.e., *Rasbora tawarensis* and *Poropuntius tawarensis*.

CONCLUSION

A total of 711 fishes corresponding to 114 species were sampled. These were categorized into 69 genera, 41 families and 12 orders. Five families were distributed evenly and observed in all the five defined regions i.e., Anguillidae, Clariidae, Cyprinidae, Anabantidae and Channidae. Sixteen families were found in only a single site. Six species of the fish species were widely distributed i.e., *Puntius brevis* (*gro*), *Channa striata* (*bacei*), *Anguila bicolor* (*kirai*), *Clarias teijsmani*, *Hampala macrolepidotai* (*kebarei*) and *Anabas testudeneus* (*krup*). A diversity index of fishes in Aceh water ranged from 1.31 to 3.41, indicating moderate values.

The highest diversity was found in Lembang River of Aceh Selatan, while regionally, the North and South regions were higher but not siguificantly different from the West region. The eveuness index of freshwater fish in Aceh was low at <50%. Highest similarity was found between Simpang Reservoir and Sibreh Serervoir of and regionally the similarity index between West and North region were relatively higher compared to other regions.

ACKNOWLEDGMENT

This study was supported by PanEco-YEL. Therefore, the authors would like to thauk Dr. Ian Singleton the Director of Research and Development of PenEco for his support.

ANNEX

Annex 1: The phylogeny of fishes found during survey

Ordo: Anguilliformes
- Familia: Anguillidae
  - Genus: Anguilla
    - Spesies: *Anguilla bicolor*
    - *Anguilla mamormata*
- Familia: Muraenidae
  - Genus: Echidna
    - Spesies: *Echidna rhodochilus*

Ordo: Clupeiformes
- Familia: Engraulididae
  - Genus: Stelophorus
    - Spesies: *Stelophorus indicus*

Ordo: Cypriniformes
- Familia: Balitoridae
  - Genus: Gastromyzon
    - Spesies: *Gastromyzon* sp.
  - Genus: Nemacheilus
    - Spesies: *Nemacheilus pfeifferae*
- Familia: Cyprinidae
  - Genus: Barbodes
    - Spesies: *Barbodes collingwoodii*
  - Genus: Cyclocheilichthys
    - Spesies: *Cyclocheilichthys apogon*
    - *Cyclocheilichthys armatus*
  - Genus: Cyprinus
    - Spesies: *Cyprinus carpio*
  - Genus: Ctenopharyngodon
    - Species: *Ctenopharyngodon idella*
  - Genus: Hampala
    - Spesies: *Hampala macrolepidota*
  - Genus: Mystacoleucus
    - Spesies: *Mystacoleucus marginatus*
  - Genus: Neolissochilus
    - Spesies: *Neolissochilus* sp.
  - Genus: Osteochilus
    - Spesies: *Osteochilus hasseltii*
    - *Osteochilus kahajanensis*
    - *Osteochilus kappenii*
    - *Osteochilus* sp.
  - Genus: Poropuntius
    - Spesies: *Poropuntius tawarensis*
  - Genus: Puntius
    - Spesies: *Puntius binotatus*
    - *Puntius brevis*
    - *Puntius lateristriga*

Genus: Rasbora
Spesies: *Rasbora spilotaenia*
Rasbora maculata
Rasbora lateristriga
Rasbora meinkeni
Rasbora sp.
Rasbora sumatrana
Rasbora tawarensis
Genus: Tor
Spesies: *Tor tambra*
Tor tambroides
Tor soro

Ordo: Cyprinidontiformes
Familia: Aplocheilidae
Genus: Aplocheilus
Spesies: *Aplocheilus pancax*
Genus: Xiphophorus
Spesies: *Xiphophorus helleri*
Xiphophorus maculatus
Familia: Poeciliidae
Genus: Poecillia
Species: *Poecillia* sp.
Familia: Hemiramphidae
Genus: Zenarchopterus
Spesies: *Zenarchopterus rasori*

Ordo: Elopiformes
Familia: Megalopidae
Genus: Megalop
Spesies: *Megalop cyprinoides*

Ordo: Gonorhynchiformes
Familia: Chanidae
Genus: Chanos
Spesies: *Chanos chanos*

Ordo: Perciformes
Familia: Anabantidae
Genus: Anabas
Spesies: *Anabas testudineus*
Familia: Apogonidae
Genus: Apogon
Spesies: *Apogon hyalosoma*
Familia: Belontiidae
Genus: Betta
Spesies: *Betta editae*
Betta sp.
Genus: Trichogaster
Spesies: *Trichogaster pectoralis*
Trichogaster trichopterus

Familia: Cichlidae
- Genus: Oreochromis
  - Spesies: *Oreochromis mossambicus*
  - *Oreochromis niloticus*

Familia: Carangidae
- Genus: Caranx
  - Spesies: *Caranx ignobilis*
  - *Caranx sexfasciatus*

Familia: Chandidae
- Genus: Ambassis
  - Spesies: *Ambassis gymnocephalus*
  - *Ambassis interupta*
  - *Ambassis koopsii*
  - *Ambassis miops*
  - *Ambassis urotaenia*

Familia: Channidae
- Genus: Channa
  - Spesies: *Channa lucius*
  - *Channa cyanospilos*
  - *Channa striata*

Familia: Eleotrididae
- Genus: Butis
  - Spesies: *Butis amboinensis*
  - *Butis* sp.
- Genus: Oleotris
  - Spesies: *Oleotris acanthopomus*
  - *Oleotris melanosoma*
- Genus: Ophiocara
  - Spesies: *Ophiocara porocephala*
- Genus: Oxyeleotris
  - Spesies: *Oxyeleotris uropthalmus*

Familia: Gerreidae
- Genus: Gerres
  - Spesies: *Gerres acinensis*
  - *Gerres macracanthus*

Familia: Gobiidae
- Genus: Acentrogobius
  - Spesies: *Acentrogobius janthinopterus*
- Genus: Awaous
  - Spesies: *Awaous megacephalus*
- Genus: Glossogobius
  - Spesies: *Glossogobius celebius*
  - *Glossogobius circumpectus*
  - *Glossogobius giuris*
- Genus: Periphthalmus
  - Spesies: *Peripthalmus argentilineatus*
- Genus: Pseudogobius
  - Spesies: *Pseudogobius javanicus*

Genus: Sicyopterus
Spesies: *Sicyopterus cyanocephalus*
Sicyopterus sp.
Genus: Sicyapus
Spesies: *Sicyapus* sp.
Familia: Haemulidae
Genus: Plectorhinchus
Spesies: *Plectorhinchus gibbosus*
Familia: Leiognathidae
Genus: Leiognathus
Spesies: *Leiognathus equulus*
Genus: Secutor
Spesies: *Secutor interruptus*
Familia: Lutjanidae
Genus: Lutjanus
Spesies: *Lutjanus argentimaculatus*
Lutjanus russelii
Familia: Microdesmidae
Genus: Parioglossus
Spesies: *Parioglossus* sp.
Familia: Monodactylidae
Genus: Monodactylus
Spesies: *Monodactylus argenteus*
Familia: Mugilidae
Genus: Liza
Spesies: *Liza melanopterus*
Genus: Valamugil
Spesies: *Valamugil cunnecius*
Valamugil speigleri
Genus: Mugil
Spesies: *Mugil cephalus*
Familia: Mullidae
Genus: Uppeneus
Spesies: *Uppeneus vittatus*
Familia: Scatophagidae
Genus: Scatophagus
Spesies: *Scatophagus argus*
Familia: Serranidae
Genus: Epinephelus
Spesies: *Epinephelus tauvina*
Familia: Siganidae
Genus: Siganus
Spesies: *Siganus guttatus*
Siganus javus
Familia: Teraponidae
Genus: Kuhlia
Spesies: *Kuhlia marginata*
Genus: Terapon
Spesies: *Terapon jarbua*

Ordo: Pleuronectiformes
- Familia: Bothidae
  - Genus: Pseudorhombus
    - Spesies: *Pseudorhombus arsius*

Ordo: Siluriformes
- Familia: Ariidae
  - Genus: Arius
    - Spesies: *Arius thalassinus*
- Familia: Bagridae
  - Genus: Mystus
    - Spesies: *Mystus bimaculatus*
      Mystus gulio
      Mystus micracanthus
      Mystus nigricep
      Mystus nemurus
      Mystus olyroides
- Familia: Clariidae
  - Genus: Clarias
    - Spesies: *Clarias batrachus*
      Clarias gariepinus
      Clarias niefhofii
      Clarias teijsmani
- Familia: Loricariidae
  - Genus: Lyposarcus
    - Spesies: *Lyposarcus pardalis*
- Familia: Siluridae
  - Genus: Kryptoterus
    - Spesies: *Kryptoterus minor*
- Familia: Sisoridae
  - Genus: Glyptothorax
    - Spesies: *Glyptothorax mayor*
      Glyptothorax platypogonoides
      Glyptothorax platypogon

Ordo: Synbranchiformes
- Familia: Synbranchidae
  - Genus: Monopterus
    - Spesies: *Monopterus albus*

Ordo: Syngnathiformes
- Familia: Syngnathidae
  - Genus: Doryichthys
    - Spesies: *Doryichthys heterosoma*

Ordo: Tetraodontiformes
- Familia: Tetraodontidae
  - Genus: Tetraodon
    - Spesies: *Tetraodon nigroviridis*
  - Genus: Chelonodon
    - Spesies: *Chelonodon patoca*

Annex 2: Freshwater fish distribution in Aceh water

		South	West							Central		East			North				Distr.
Local	Scientific	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	(%)
Pagab	*Acentrogobius janthinopterus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5.88
Serideng	*Ambasis gymnocephalus*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Serideng	*Ambassis urotaenia*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	17.65
Serideng	*Ambassis kopsii*	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	11.76
Serideng	*Ambassis miop*	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	5.88
Serideng	*Ambassis interupta*	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	5.88
Kirei	*Anguila bicolor*	1	2	0	0	0	0	0	4	0	1	1	0	0	4	0	0	1	41.18
Ileah	*Anguilla mamormata*	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.76
Kruep	*Anabas testudineus*	5	5	0	1	0	0	0	0	0	2	2	0	0	6	0	0	0	35.29
Kepala timah	*Aplocheilus panchax*	0	0	0	0	0	0	0	4	0	0	0	0	0	3	0	0	0	11.76
Serideng	*Apogon hyalosoma*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	5.88
Bagok	*Arius thalassinus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	5.88
Pagab	*Awaous megecephalus*	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	5.88
-	*Barbodes collingwoodii*	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Enggalu	*Gastromyzon* sp.	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	5.88
Ikan laga	*Betta editae*	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	5.88
Ikan laga	*Betta* sp.	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	5.88
Cnng	*Butis amboinensis*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5.88
Cnng	*Butis* sp.	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	11.76
Kitok, Rambe	*Caranx ignobilis*	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	5.88
Kitok, Rambe	*Caranx sexfasciatus*	2	0	0	2	0	0	0	5	0	0	0	0	0	0	0	3	0	23.53
Muloh	*Chanos chanos*	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	4	17.65
Jampak	*Channa cyanospilos*	3	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	17.65
Bacei	*Channa striata*	2	2	0	0	0	3	0	1	1	1	1	0	0	4	0	0	0	47.06
Bujuk	*Channa lucius*	6	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	11.76
Bukum	*Chelonodon patoca*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	5.88
Sengko	*Clarias teijsmanni*	2	3	0	0	0	2	0	0	0	1	2	0	0	3	0	0	0	35.29
Limbek	*Clarias nieuhofii*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Semu	*Carias batrachus*	1	5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	17.65
Dumbo	*Clarias gariepinus*	0	3	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	11.76
Merah mata	*Cyclocheilichthys armatus*	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Merah mata	*Cyclocheilichthys apogon*	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	5.88
Ika mas	*Cyprinus carpio*	0	1	0	0	0	0	0	0	2	0	0	0	0	2	0	3	0	23.53
Cocok teliga buya	*Doryichthys heterosoma*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Murei	*Echidna rhodochilus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5.88
Kerapei	*Epinephelus tauvina*	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	17.65
Kapas-kapas	*Gerres acinaces*	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	11.76
Kapas-kapas	*Gerres macracanthus*	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	5.88
Turak	*Glossogobius celebius*	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	11.76
Cnng	*Glossogobius circumpectus*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5.88
Turak	*Glossogobius giuris*	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5.88
Katel	*Glyptothorax platypogon*	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	11.76
Trop	*Glyptothorax platypogoniodes*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	5.88
Trop	*Glyptothorax major*	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	5.88
Kebarai	*Hampala macrolepidota*	3	0	0	2	1	0	1	0	0	1	1	0	0	0	0	0	0	35.29
Besi-besi	*Kuhlia marginata*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	11.76
Lepok	*Kryptoterus minor*	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	11.76
Cirik	*Leiognathus equulus*	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	11.76
Belanet	*Liza melinopterus*	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Indosiar	*Liposarcus pardalis*	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	5.88
Tanda	*Lutjanus russellii*	2	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	17.65
Tenga	*Lutjanus argentimaculatus*	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	11.76
Ikan bulan	*Megalop cypronoides*	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.76
Layangan	*Monodactylus argenteus*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	17.65
Lineang	*Monopterus albus*	0	0	0	0	0	0	0	0	0	2	1	0	0	2	0	0	0	17.65

Aunex 2: Continued

		South	West							Central		East			North				Distr.
Local	Scientific	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	(%)
Belanet	*Mugil cephalus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5.88
Cencen	*Mystacoleucus marginatus*	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	11.76
Suik bintik hitam	*Mystus bimaculatus*	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Baung	*Mystus nemurus*	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Baung kecil mata	*Mystus negricep*	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.76
Suik	*Mystus gulio*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5.88
Baung	*Mystus micracanthus*	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.76
Baung akar	*Mystus olyroides*	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	5.88
Jurung	*Neolissochilus* sp.	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	5.88
Serukan putih	*Osteochilus kahajenensis*	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Serukan, paitan	*Osteochilus kappenii*	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	11.76
Serukan hitam/gelap	*Osteochilus hasselti*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Serukan merah perut	*Osteochilus* sp.	5	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	11.76
Dhet minyeak	*Oleotris acanthopomus*	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Mbong	*Oleotris melanosoma*	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	5.88
Ketutu	*Oxyeleotris uropthalmus*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Luntuk	*Ophiocara porocephala*	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	17.65
Mujair	*Oreochromis mosambicus*	0	3	0	0	0	0	0	0	6	3	0	4	0	2	0	0	0	29.41
Nila	*Oreochromis niloticus*	0	0	0	0	0	0	0	1	2	0	0	2	0	1	0	0	0	23.53
-	*Parioglossus* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5.88
Blodok	*Periophthalmus argentilineatus*	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	4	1	17.65
Grot	*Plectorhinchus gibbosus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5.88
Dhet	*Pseudogobius javanicus*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Seribu	*Poecillia* sp.	0	4	0	0	0	6	0	0	0	0	0	0	0	6	0	0	0	17.65
Ikan sebelah	*Pseudorhombus arsius*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Kepras	*Puntius binotatus*	0	0	2	0	6	0	4	0	0	0	11	0	0	0	0	0	0	23.53
Gro	*Puntius brevis*	8	12	0	5	6	12	8	0	7	9	6	6	0	8	6	4	0	76.47
Gempual	*Puntius lateristriga*	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	5.88
Ijer	*Nemacheilus pfeifferae*	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	5.88
Kawan	*Poropuntius tawarensis*	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	5.88
Bileh	*Rasbora spilotaenia*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5.88
Bileh	*Rasbora maculata*	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	5.88
Bileh	*Rasbora lateristriata*	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	11.76
Bileh	*Rasbora meinkeni*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5.88
Kedawah	*Rasbora sumatrana*	13	0	4	0	4	0	0	0	0	0	6	0	0	0	5	0	0	29.41
Relo	*Rasbora* sp.	0	0	0	0	0	0	0	0	34	0	0	0	0	0	0	0	0	5.88
Depik	*Rasbora tawarensis*	0	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	5.88
Cirik	*Secutor interruptus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5.88
Kitang	*Scatophagus argus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	11.76
Dhet	*Sicyopterus cynocephalus*	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Dhet	*Sicyopterus* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	5.88
Jangko	*Sicyapus* sp.	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Cabeh	*Siganus guttatus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	5.88
Cabeh	*Siganus javus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5.88
Bileh	*Stelephorus indicus*	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5.88
Kerong	*Terapon jarbua*	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	2	3	23.53
Bukum	*Tetraodon nigroviridis*	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	5.88
Sepat	*Trichogaster trichopterus*	0	6	0	4	0	0	0	0	0	0	6	0	0	4	0	0	0	23.53
Sepat siam	*Trichogaster pectoralis*	0	3	0	3	0	0	0	0	0	0	4	0	0	4	0	0	0	23.53
Jurung	*Tor soro*	0	0	0	0	0	0	0	0	0	6	0	3	0	0	3	0	0	17.65
Jurung	*Tor tambra*	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	5.88

Annex 2: Continued

		South	West							Central		East			North				
Local	Scientific	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	Distr. (%)
Keureling, jurung	*Tor tombroides*	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	17.65
Ikan kambing	*Uppeneus vittatus*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Kadra panjang	*Valamugil cunnesius*	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Kadra	*Valamugil speigleri*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Bnntok	*Xiphophorus helleri*	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	5.88
Bontok merah	*Xiphophorus maculatus*	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	5.88
Ikan cina	*Ctenopharyngodon idella*	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	11.76
Murnng	*Zenarchopterus rasori*	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5.88
Total		122	53	11	23	18	29	18	52	91	47	84	15	9	53	18	40	28	

Southern Region:
- A. Lembang River

Western Region:
- B. Simpang reservoir
- C. Meurebo River
- D. Alue Pedeang River
- E. Woyla River
- F. Kuala Tuha
- G. Nagan River
- H. Lagean River

Central Region:
- I. Lake Laut Tawar
- J. Alas River

Eastern Region:
- K. Tamiang River/Aras napal
- L. Batee Iliek River
- M. Pante Raqja Canals

Northern Region:
- N. Sibreah Reservoir
- O. Murtala River
- P. Aceh River
- Q. Cut River

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