PAPER • **OPEN ACCESS**

A mini review on endemic and threatened fish Rasbora tawarensis in Lake Laut Tawar, Indonesia

To cite this article: Z A Muchlisin *et al* 2018 *IOP Conf. Ser.: Earth Environ. Sci.* **216** 012045

A mini review on endemic and threatened fish *Rasbora tawarensis* in Lake Laut Tawar, Indonesia

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Abstract. *Rasbora tawarensis* or locally name Depik is an endemic and threatened fish species occurred in Lake Laut Tawar, Takengon City, Aceh Province, Indonesia. The population of the fish has been decreased over the years by over fishing, habitat perturbation and present of alien fish species in the Lake. Therefore, the conservation program is crucially needed, for this purposes the intensive studies have been conducted from 2009 to 2018. This paper presented the latest and previous findings on the bioecology, distribution, reproduction, feeding habits, genetic and breeding of this species.

1. Introduction

Lake Laut Tawar is one of the largest lakes in Aceh Province, this lake is located in the Gayo highlands 1200 meters above sea level. The lake is formed by an inactive volcanic mountain with approximately 16 km width and 5 km length, the average depth is 35 meters and the maximum depth is 80-115 meters [1]. The Laut Tawar Lake is surrounded by Bukit Barisan mountain with the highest peak is about 2000 meters above sea level. There are approximately 25 small rivers that flow into the lake (inlet) with one discharge of the lake (outlet), namely Peusangan River. The lake is surrounded by forests which have been intensively deforestation, plantations, rice fields and population settlements which have a negative impact on lake ecology [2].

Lake Laut Tawar has the important role for the indigenous Gayonese tribe, both as a source of clean water, irrigation, industries, and fisheries. This lake is a fishing ground and the location of cultivation of fish in cage nets for local fishermen. Currently, the dominant fishing activity in Lake Laut Tawar is capture fisheries. In 2008, there were approximately 225 fishermen in Lake Laut Tawar. They are mostly artisanal fishermen with low capital and technology with the average income is approximately 3.5 USD daily [3].

Lake Laut Tawar is a home to depik fish Rasbora tawarensis, this is an endemic species in this lake. Depik fish is a true freshwater fish, belong to the genus Rasbora. In general, the Rasbora lives in small rivers, lakes, peat swamps, and rice fields. There are approximately 60 species of Rasbora fish that have been described worldwide, one of the species is *Rasbora tawarensis* or depik in the local name (Figure 1), but it is predicted that the number of species of Rasbora is greater than that reported previously [4]. This fish has been listed as an endangered fish and included in the IUCN red list in the endangered critically endangered (CE) [5].

Depik fish is an economically important fish in Aceh Province, Indonesia; the selling price in the local market is reaching 8-10 USD per kg for fresh fish and 18-20 USD for dried or processed fish, thus this fish is becoming the main target by local fishermen in Lake Laut Tawar [3]. The previous study showed that fishing volume from Lake Laut Tawar has been dramatically declined (more than

83.5% declined) over the past twenty years, the same phenomenon also occurs in depik fish, even the decline has reached above 92% [6]. This has caused fishermen to modified the fishing gears to be environmentally unfriendly for example shrink the size of the mesh, extend the length and the depth of the gillnet. This practice gives the greater pressure for depik fish populations in Lake Laut Tawar. Aside, the fish is also threatened by broodstock harvesting, the presence of alien species in the lake and pollution [2]. Therefore, aquaculture development program of the depik is crucially needed to overcome this problem.

Figure 1. Depik, *Rasbora tawarensis* endemic species in Danau Laut Tawar

2. Threat to depik

There are at least four factors that contribute to declining the depik population in Lake Laut Tawar, namely; ecological perturbations and global warming, introduced species, unfriendly fishing practices, and pollution. Besides the water level due to global warming and deforestation, other factors could be attributed to the decline in the Depik population of Lake Laut Tawar. These include ecological perturbation, pollution, overfishing, climate changes, fishing methods, and practices and also very likely predation and competition by introduced species. In a previous study at least six introduced species were reported in this lake namely *Cyprinus carpio, Oreochromis mossambicus, O. niloticus, Xiphophorus helleri, X. maculates,* and *Ctenopharyngodon idella* [7][8][9]. Personal observation and communication with local people showed that deforestation has been occurring for the last two decades to supply a pulp factory [3]. Furthermore, tourism activities such as the development of hotels and resorts as well as intensive aquaculture probably contribute to water pollution in the lake.

Fishing methods and practices also have a negative impact on the fisheries of the Depik. According to Muchlisin et al. [10] there are two method fishing techniques generally utilized by the local fishermen; gillnets (active and passive) and *dedeseun* trap. The *dedeseun* trap captures the migrating spawning *R. tawarensis* at the mouth of the tributaries, thus sacrificing many matured brood fish. In addition, the fishermen use small mesh size gillnets (0.5 inches, or equivalent to 1.4 cm), selective for small Depik. However, in accordance to a local regulation (Perda No. 5: 1999) on lakes and fisheries resources management, gillnet used should be 1.5 cm in mesh size and operated at least 100 m from the shore but this was not always adhered too and undersized fish (40 to 50 mm) are trapped.

3. Bioecology

Depik *Rasbora tawarensis* only occurs in Lake Laut Tawar; therefore makes them endemic in this lake. This species is not found in other parts of the world, therefore if this depik goes extinct, Indonesia and the world will lose their ecological germplasm that had science and economics values. The indication of extinction for depik has begun to be seen, one of which is the sharp declining in population over the past 30 years [13][14]. To overcome this problem, several studies on the bio-ecology of depik have been reported, herein we summarized the findings. This information is crucial to plan conservation and aquaculture programs.

Depik fish had a distribution pattern following into the depth of waters and distance from the coast. Muchlisin [11] reported that higher catches are found in waters with a depth of 10 meters compared to deeper waters (>10 meters) and at a distance of 100 meters from the coast; it was also reported that fish depik caught in shallow and near beaches are relatively smaller compared to fish caught in deeper waters and far from the coast. Besides that Muchlisin [6] also reported that catches volume of the depik was higher in the rainy season compared to the dry season. Besides being influenced by the season, the catch of the fish depik is also strongly influenced by the lunar, where the catch volume is higher in the dark month (old and new lunar month). However, it is generally reported that the size of fish caught is not affected by the season or lunar circulation, it is meaning that the size of the fish caught is relatively the same both in the dry and rainy seasons.

On the reproductive biology aspect, Muchlisin *et al.* [12] report that depik fish is a synchronous spawning type which can spawn several times a year, where spawning peaks occur in September, December and March. Depik fish populations in Lake Laut Tawar are dominated by females, however, the maturity of the male sex is relatively high in each month compared to female fish.

Muchlisin [3] reported that the size of matured female fish is 70.98 mm to 113.31 cm or weighs 3.52 grams to 11.83 grams (weight without gonads), and 58.06 mm to 102.47 mm or weighing 2.71 grams up to 8.75 grams for male, thus generally matured male is smaller than females or male is matured early than female Muchlisin *et al*. [13][14] further explained that 50% of the population was first matured at a size of 83.5 mm to 87.5 mm in females, 75.5 mm to 79.5 mm in male. Based on Muchlisin et al. (2011d) the total fecundity of female ranged from 2354 oocytes to 6277 oocytes (mean 3715 oocytes, while the relative fecundity ranged from 336-739 oocytes (mean 518 oocytes) per gram of parent body weight.

The effect of the global warming is also recorded in Lake Laut tawar. For example, the survey in 2009 the author records as 13 spawning locations in Mendale, Bewang, Gegarang, Kelitu and Pademon villages (Table 1). However, based on the information of the local people, only 4 dedeusen still have water flow in the dry season, most of them dry in that season [14], and all of the active sites are located at Kelitu and Gegarang villages in the northern region of the lake. In the 1970s, there were more than one hundred *dedeseun* around the lake and most of them were located in the northern and western regions of the lake (personal communication with the head of the local fishermen organization, LANTAK). The numbers decreased to 48 *dedeseuns* in 2006 and 13 sites in 2009.

Table 1. GPS positions of spawning sites according to village based on the survey in 2009.

No.	Latitude	Longitude	Village name
1.	04° 64.073	096° 86.291	Mendale
2.	04° 64.232	096° 86.888	Mendale
3.	04° 64.198	096° 86.982	Mendale
4.	04° 64.019	096° 87.158	Mendale
5.	04° 63.880	096° 88.819	Mendale
6.	04° 62.878	096° 94.836	Kelitu
7.	04° 62.463	096° 95.775	Kelitu
8.	04° 62.352	096° 96.175	Gegarang
9.	04° 62.325	096° 96.354	Gegarang
10.	04° 57.927	096° 98.464	Bewang
11.	04° 58.021	096° 98.498	Bewang
12.	04° 57.734	096° 98.007	Bewang
13.	04° 60.453	096° 86.751	Pedemun

Field observations of the spawning habitat conditions (dedeusen) of depik fish are small rivers that flow from the foot of rocky hills around the lake, especially in the northern part of the lake. The river is generally 25-30 meters long with an average width of 1-1.5 meters and a water depth of 2 meters in the rainy season or 0.45 meters in the dry season. The river bed is rocky, clear water with temperature ranges 18-22 ºC.

The stomach content analysis showed that depik fish are plankton feeders, they fed on phytoplankton and zooplankton, where Closteropsis longisima (algae)and Arcella vulgaris (Protozoa) are vapored food items for depik, indicate that the main food is the algae. The diet overlap index between depik and kawan (*Poropuntius tawarensis*) another endemic fish in Lake Laut Tawar showed that fish depik and kawan had the diet overlapping index is 62.15 indicate the presence of moderate diet overlapping between depik and kawan [15].

4. Cultures

Aquaculture program for depik has been initiated by the Government of Aceh Tengah District and Faculty of Marine and Fisheries, Syiah Kuala University. Several efforts have been conducted, for example testing for hatching eggs that collected from dedeusen (natural spawning site), but the mortality rate of larvae is still high. To overcome this problem, several studies have also been conducted, for example, breeding and sperm cryopreservation [16], broodstock management [17] and larval feeding [18][19]. Several studies on breeding, culture and larvae rearing is being conducting and will be published soon after accomplished.

5. Conclusion and Recommendation

Establishing a lake sanctuary or lake protection area is one prominent option in relation to protect fish habitat in general and spawning sites in particular. Protection of lake does not only protect aquatic habitat, but this also protects terrestrial habitat comprehensively. Presently, spawning sites are privately owned and therefore the concept of community-based lake protection management should be introduced. The community and the owners living nearby should be actively involved at all stages of the management i.e. in the planning, implementing, monitoring and evaluation stages.

Presently, there is no effective dialogue between the fisheries stakeholders (for example fishermen, government agencies, NGOs, businessman etc.) those agencies responsible for the lake management. Therefore, promoting effective dialogue and consultation between all those involved in lake management is an important task in relation to improving outcomes for fisheries of Lake Laut Tawar in the future.

Other recommendations include a limitation of fishing activities during the spawning season in March, September, and December and the strict prohibition of new exotic species into the lake. Reforestation of the jungle around the lake should be considered in relation to the rehabilitation of degraded habitats and the rejuvenation of old inactive *dedeseun* by increasing the water level of the lake. Building the capacity of fishermen and fisheries officers should be a high priority. Research and management should be linked within comprehensive management plans of the lake to make sure both programs are in synergy and effective. However, all these recommendations if accepted should be followed with strict law enforcement and constant monitoring.

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