

*Short Communication*

**EXPLORING OF ALIEN FISH SPECIES DIVERSITY IN AMOCHHU OF BHUTAN**

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**ABSTRACT:** A number of alien fish species are introduced into aquatic ecosystem undermining their adverse impacts to the natural ecosystem, despite having a good ichthyofauna diversity inclusive of some endemic fish species in Bhutan. The survey was undertaken to explore and document alien fish species diversity in Amochhu and Haachhu due to high vulnerability from anthropogenic influences. A total of 13 sites -11 sites at Amochhu and one site each from adjoining fish hatcheries at National Research and Development Center for Riverine and Lake Fisheries, Haa and National Research and Development Center for Aquaculture, Gelephu were selected for the survey. The present survey recorded 37 fish species inclusive of five alien fish species namely *Cyprinus carpio*, *Cyprinus carpio*, *Ompok pabda*, *Clarias gariepinus* and *Salmo trutta*. The presence of *Cyprinus carpio*, *Clarias gariepinus* and *Salmo trutta* was confirmed in wild habitat; whereas, *Oreochromis mossambicus* was observed established under confinement. The current survey found out that the *Salmo trutta* had established a self-sustaining population, and *Ompok pabda* was recorded for the first time in Amochhu. However, this survey could not ascertain the pathway of introduction of those alien fish species. There is a need for the government to intervene and put in proper policy measures to control introduction of both alien and cultured fish species in waterbodies of Bhutan; and in parallel, it is felt important to educate general public on the consequences of introducing alien fish species into the waterbodies.

**Keywords:** Alien fish species; invasive species; *Cyprinus carpio*; *Clarias gariepinus*; *Oreochromis mossambicus*; *Salmo trutta*; tsethar.

**1.INTRODUCTION**

Alien fishes are introduced intentionally either for the enhancement of food fish production for species diversification, sport or recreational fishing and ornamental purpose. Introduction and/or spread of invasive alien species (IAS) threaten biological diversity (CBD 2002) by establishing natural or semi-natural ecosystems or habitat, as an agent of change (ICUN 2000), through increasing biological invasions worldwide (Juetter et al. 2014). Biological invasion is a process whereby a species is transported and introduced (intentionally or accidentally) beyond its native range, spreads and establishes self-sustaining populations into new habitats (Juetter et al. 2014).

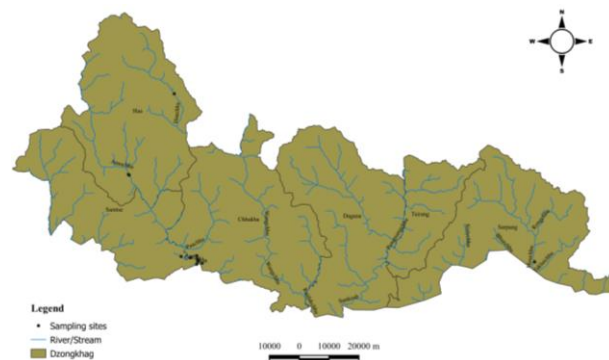
Introduction of alien fish dates back to 1930's in Bhutan. Brown trout (*Salmo trutta*) was introduced for the first time in 1930 for sport fishing (Rajbanshi and Csavas 1982) through release in rivers, streams and lakes of Bhutan (Dubey 1978; Peters 1999). Currently, brown trout are found in many lakes, rivers and their tributaries such as Wangchhu (Haachhu, Parochhu and Thimchhu), Punatshangchhu (Mochhu and Phochhu), Manas (Mangdechhu, Chamkharchhu and Nikachhu) (Dubey 1978; Peters 1999; Gurung 2013; Gurung & Thoni 2015 and NRDCRLF 2017) of Bhutan. In addition, the government had introduced seven warm-water and one cold-water aquaculture fish species in 1980's (Péteri 1987) and 2007 respectively, to enhance fish production. Besides, unauthorized introduction of highly invasive African sharp tooth catfish (*Clarias gariepinus*) to

Bhutanese water system in the form of Tsethar or life release (mercy release) are reported (Gurung 2013; Gurung et al. 2013). Such introduction of new fish species and their establishment with self-sustaining population in their introduced habitat (Kolar & Lodge 2001) is considered as an important phase of invasion process (Weyl et al. 2016). Cucherousset & Olen (2011) summarized and reported ecological impact of invasive alien freshwater fish according to five levels of biological organization into genetic, individual, population, community and ecosystem. Currently, empirical information on alien fish diversity in Bhutan river systems is lacking nor attempts are made to survey and document till date. Therefore, this survey attempts to assess and document alien fish species diversity along with their introduction pathways in Amochhu.

## 2. MATERIALS AND METHODS

### 2.1 Survey areas

Amochhu (chhu is local name for river), Aiechhu and Haachhu were sampled to access the presence of alien fish species diversity in wild habitat. Amochhu and Omchhu at Phuntsholing and the headwater of Amochhu at Sombaykha Dungkhag, Haa is the core survey area. Further, Aiechhu (Maokhola) at Gelephu and Haachhu, at Haa was considered to access the escapement of feral population of aquaculture species in wild habitat as presented in Figure 1.



**Figure 1:** Map showing the survey area and sampling sites

### 2.2 Sites selection

A total of 13 sites - 11 sites are at Amochhu and one site each adjoining to fish hatcheries of National Research and Development Centre for Riverine and Lake Fisheries (NRDCRLF), Haa and National Research and

Development Centre for Aquaculture (NRDCA), Gelephu were identified.

### 2.3 Fish sampling

Fish sampling was conducted twice using handheld electrofisher. Initial sampling was conducted in from 25<sup>th</sup> September to 2<sup>nd</sup> October 2018 representing offset of monsoon season. The second fish sampling was conducted from 24<sup>th</sup> March to 4<sup>th</sup> April 2019 representing pre-monsoon season. Each sampling site was approximately 200 meters in length and uniform sampling effort of 30 minutes was considered. The samples of exotic fishes were collected and the live fish photographs were also taken at field level to record pictorial form of qualitative data (shape, colours, spots, patterns and other visible characters), as formalin decolorizes the fish.

### 2.4 Morphometric measurement

The total length (TL) of the captured alien fishes were measured on-sites using wooden board scale. The shape and size of the fish was analyzed in the laboratory at NRDCRLF using digital venire caliper.

### 2.5 Fish preservation

The fish samples collected from the field were preserved in 10 % formalin (Jayaram 1981), with head facing downward in the container to prevent damage to caudal fin (Mandal & Jha 2013). The samples containers were labelled properly against the datasheet of the sampling sites before transportation to fish laboratory at the NRDCRLF, Haa.

### 2.5 Fish identification

The fish species samples were identified at the laboratory with references to taxonomic characters of the fishes (Vishwanath et al. 2007; Talwar & Jhingran 1991; NRDCRLF 2017). The valid taxa names were followed from the Fish base. The ecological status on invasiveness fish species identified was reported in accordance to Global Invasive Species Database (GISD). The specimens collected after identification were then preserved in 70 % ethanol for future studies and references.

## 3. RESULTS AND DISCUSSIONS

### 3.1 Species diversity

Table 1 shows fish species diversity recorded from Amochhu at Phuntsholing and Sombaykha, Haa. The survey recorded 37 fish species inclusive of five alien fish species belonging to six orders, 14 families and 30 genera in Amochhu

**Table 1:** Ichthyofaunal diversity of Amochhu River.

Order	Family	Genera	Species	
Beloniformes	Belonidae	Xenentodon	<i>Xenentodon cancilla</i>	
		Cobitidae	<i>Lepidocephalichthys guntea</i>	
			Bangana	<i>Bangana dero</i>
			Barilius	<i>Barilius bendelisis</i>
			Barilius	<i>Barilius barna</i>
			Barilius	<i>Barilius vagra</i>
			Chagunius	<i>Chagunius chagunio</i>
			Crossocheilus	<i>Crossocheilus latius</i>
			Semiplotus	<i>Semiplotus semiplotus</i>
			Cyprinus	<i>Cyprinus carpio</i>
			Danio	<i>Danio rerio</i>
			Devario	<i>Devario aequipinnatus</i>
	Cypriniformes	Cyprinidae	Garra	<i>Garra annandalei</i>
			Garra	<i>Garra gotyla</i>
Neolissochilus			<i>Neolissochilus hexagonolepis</i>	
Oreochthys			<i>Oreochthys crenuchoides</i>	
Pethia			<i>Pethia conchoniensis</i>	
Pethia			<i>Pethia ticto</i>	
Puntius			<i>Puntius sophore</i>	
Schizothorax			<i>Schizothorax progastus</i>	
Schizothorax			<i>Schizothorax richardsonii</i>	
Tor			<i>Tor putitora</i>	
			Aborichthys	<i>Aborichthys</i> sp.
			Schistura	<i>Schistura reticulofasciata</i>
			Psilorhynchus	<i>Psilorhynchus balitora</i>
			Badis	<i>Badis badis</i>
Perciformes	Channidae	Channa	<i>Channa gachua</i>	
	Cichlidae	Oreochromis	<i>Oreochromis mossambicus</i>	
	Salmoniformes	Salmonidae	Salmo	<i>Salmo trutta</i>
Siluriformes	Amblycipitidae	Amblyceps	<i>Amblyceps cf. arunachalensis</i>	
	Clariidae	Clarias	<i>Clarias gariepinus</i>	
	Siluridae	Ompok	<i>Ompok pabda</i>	
	Sisoridae	Glyptothorax	<i>Glyptothorax</i> sp.	
		Glyptothorax	<i>Glyptothorax panda</i>	
		Parachilognan	<i>Parachilognan hodgarti</i>	
Pseudochenesis		<i>Pseudochenesis sulcate</i>		
Synbranchiformes	Mastacembelidae	Mastacembelus	<i>Mastacembelus armatus</i>	

### 3.2 Alien fish species and mechanism of invasion

The survey with reference to Global Invasive Species Database (GISD) recorded five alien species namely *Clarias gariepinus*, *Cyprinus carpio*, *Oreochromis mossambicus*, *Ompok pabda* and *Salmo trutta* in Amochhu (Torsa). The *Clarias gariepinus* and *Cyprinus carpio* was presumed to be introduced in the country through *Tsethar* (life saving) and *Salmo trutta* was introduced in 1930s as sport fishing. The *Oreochromis mossambicus* was found only in Crocodile farm, used for feeding Crocodile, while *Clarias gariepinus* was captured from main Amochhu and small pools formed by the stream flowing from the right side of Omchhu located along the workshop area in Phuntsholing.

The survey also confirmed presence of *Ompok pabda* in Amochhu, and it was found sharing habitat with *Clarias gariepinus* along the pools. The introduction of *Clarias gariepinus* in Amochhu was also presumed to be through *Tsethar* as likelihood was reported very high (Gurung 2013). The presence of *Cyprinus carpio* in Amochhu was also established but did not record any feral population of aquaculture species in the sampling sites adjoining fish hatcheries. Nonetheless, the introduction mode of *Cyprinus carpio* in Amochhu remains uncertain as aquaculture activity was absent within the vicinity of sampling area. Although, brown trout was recorded in abundance in Haachhu, their pathway of introduction could not be established.



*Ompok pabda*



*Oreochromis mossambicus*



*Salmo trutta*



*Clarias gariepinus*



*Cyprinus carpio*

### 3.3 Alien fish species size (Length) and maturity

Morphometric measurement was recorded for the captured alien fish species. The mean total length recorded was 144.43 mm, 145 mm, 207.86±61.27 mm and 153.65±7.69 mm for *Cyprinus carpio* (n=1), *Ompok pabda* (n=1), *Clarias gariepinus* (n=3) and *Salmo trutta* (n=23), respectively.

According to Fish Base, the length at first maturity for *Cyprinus carpio* ranges between 250 - 360 mm, 340 mm for *Clarias gariepinus* and 100 - 600 mm for *Salmo trutta*. The length recorded by NRDCRLF for *Cyprinus carpio* (n=1) from Omchhu was 174 mm in 2014. The *Salmo trutta* captured in this survey was observed to be of biologically breed-able size; whereas the *Clarias gariepinus* and *Cyprinus carpio* have crossed half the length at first maturity. Therefore, if additional populations of same length-class are present these fish species are expected to attain maturity soon and develop self-sustaining population within Amochhu system. It was reported that the *Cyprinus carpio* had successfully spawned, established and constitute highest among fish

catch from Ganga River (Singh et al. 2010). The *Clarias gariepinus* was reported to have established itself in Brazil and South America (Weyl et al. 2016) and India among others (Singh et al. 2010).

#### 4. CONCLUSION

The current survey recorded 37 fish species inclusive of five invasive alien species in Amochhu. *Ompok pabda* was recorded for the very first time in Amochhu. The *Clarias gariepinus* and *Cyprinus carpio* are adapted and established within the Amochhu in Bhutan. Amochhu has high ichthyofaunal diversity and at the same time it is highly vulnerable to human influences. Currently, tshethar or live release of fish into river ecosystem remains a challenge with inevitable adverse consequences on indigenous fish faunal diversity. Thus, it is imperative to have proper policy strategies on introduction of exotic and cultured fish species into the river systems of Bhutan. In line, the government should also prioritize and intervene on the conservation and development of local fish species. The government should also advocate and educate general public on the consequences of introducing alien fish species into waterbodies of Bhutan.

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