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Population structure of alien fish species, *Oreochromis niloticus* (Linnaeus 1758) from lower stretch of the Yamuna river, India

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Abstract

For determination of population structure of alien fish species, *Oreochromis niloticus*, random samples were collected monthly from August 2011 to July 2012 in the lower stretch of the Yamuna river at Allahabad. This species is of great socio-economic importance for the region and keeps active a population of about 700 to 900 fishers at Allahabad. The samples were measuring from 10.4 to 44.5 cm in length which varied from 0+ to 6+ age groups. According to the percentage occurrence age group 2+ was dominant, male (38.62%) and female (41.15%) of the total population. Male population was dominated in 0+, 3+, 4+, 5+ and 6+ age groups which contributed 4.48%, 22.06%, 4.48%, 2.06% and 0.68%, respectively while female population was dominated in 1+ and 2+ age groups and shared 30.09% and 41.15%, respectively. In the stock, male population was greater than female. The 6+ age group indicated that the ecological condition was favorable for *O. niloticus* in the lower stretch of the Yamuna river. Approximately 90% of fishes were mature in the present samples. The present study indicates dominance of male population of *O. niloticus* in the Yamuna river. It is believed that this healthy age composition (0+ to 6+) of *O. niloticus* is due to habitat degradation and water quality of the river stretch.

Key word: Yamuna river, Alien species, Population structure and *Oreochromis niloticus.*

Introduction

Oreochromis niloticus (Nile tilapia), with a known ability to adjust to various environmental conditions, have high potential for aquaculture. The invasion of non-native environments by physiologically tolerant tilapiine fishes has been documented worldwide (Peterson *et al.* 2005). *O. niloticus* is a non-native fish species of India, commonly known as Tilapia, which had been introduced in natural waters into a large number of tropical and sub-tropical countries in over 100 countries in the world (Fryer & Iles 1972). *O. niloticus* is one of the top ten introduced species of the world and it prefers shallow, still waters on the edge of lakes and wide rivers with sufficient vegetation (Picker & Griffiths 2011).

Tilapia is the generic name of a group of cichlids endemic to Africa. The group consists of three important *genera* namely *Oreochromis*, *Sarotherodon* and *Tilapia*. Genus Tilapia contains more than 70 species (Trewavas 1983). Tilapias constitute one of the most productive and internationally traded food fish in the world (Modadugu & Belen 2004). This species represent fifth position of the world total fish production (Sugunan 1997). The total world production of tilapias and other associated with the cichlids reached 2.6 million tones in 2004 and continued rise to up to 3.6 million tones in 2008 (FAO 2010). After carp, Tilapias are the second most important group of farm raised fish in the world. They are the mainstay of many resource-poor fish farmers (Eknath *et al.* 1993). They are a major protein source in many of the developing countries. The commodity is not only the second most important farmed fish globally (next to carp) but also described as the most important aquaculture species of the 21st century (Shelton 2002).

Trexler *et al.* (2000) indicated that it is likely that the balance between native and non-indigenous species depends on local

environmental conditions, which vary with annual rainfall and minimum temperature patterns. In aquatic ecosystems, species introductions are a problem worldwide, and the threats of non-indigenous species have been fully recognized for decades (Goldburg *et al.* 2001, Dwivedi & Nautiyal 2010). Introduced species are considered the second greatest cause of biological diversity loss after habitat destruction (Vitousek *et al.* 1997). Members of the Cichlidae are recognized as having the potential to alter aquatic communities into which they are introduced (Courtenay 1997). This is, in part, because of their tolerance of variable environmental conditions (Trewavas 1983). They are also trophic generalists (Traxler & Murphy 1995) and their reproductive biology is characterized by short generation time, multiple clutches and extended breeding seasons (Naylor *et al.* 2000, 2001, Coward & Little 2001, Stickney 2002). In fact, population of tilapia species in non-native environments have become numerically dominant in a variety of habitats (Faunce & Paperno 1999, Pathak *et al.* 2011), in part, because of these adaptations.

O. niloticus landing formed 38.88% (54.76 tones) with *Cyprinus carpio* of total in the Yamuna river at Allahabad. It is also observed that in the last five years Tilapia catch increased by seven fold (Anon 2011-12). Knowledge on the population structure of this commercially exploited species is an essential prerequisite for a more detailed study on its biology and to manage its fisheries. Because this species represent an important food and economical source in the Allahabad for poor fishers, trader and retailer. To date, not many studies on its ecology and population structure have been carried out in this region except the invader capacity, size composition realized by Mayank *et al.* (2011) and landing by Anon (2011-2012), Pathak *et al.* (2011). Only one study also conducted its heavy metal accumulation capacity in muscle, gills and livers from the Gomti river (Dwivedi *et al.* 2015). The present study was thus undertaken to estimate population structure of *O. niloticus* in the middle stretch of the Ganga river at Allahabad, Uttar Pradesh. This study will help in formulating the fishery management policies of *O. niloticus* in the Ganga river.

Material and Methods

Random fish samples of *Oreochromis niloticus* were collected from fish landing centre at Sadiapur, Allahabad. Monthly samples were collected during August 2011 to July 2012. Drag netting (Mahajal, Chaundi, Darwari), cast netting, gill netting and hook & line were used to catch the present fish species. This species is of great socio-economic importance for the region and keeps active a population of about 700-900 fishers. The key scales were used for determination of the age of *O. niloticus*. Prior to age determination, it becomes essential to establish the fact that the fish scale radius increases with the length of fish or not, since the scale may be regenerated. Hence, establishment of the fact that the annual increment in length of the scales maintains a constant ratio with increase in length of the fish and that too throughout the years, is of great importance implying the suitability of their scales for age determination. Key scales were removed from the row above lateral line and below dorsal fin region (Bagenal & Tesch 1978). The scales were cleaned in 5% KOH solution to remove adhering- tissues and finally washed in distilled water. The scales were then pressed between two glass plates while drying in order to avoid their curling.

A total of 516 fish specimens (male and female) were analyzed. The total length (cm) from the tip of snout to the end of caudal fin rays was measured and key scales were taken from below the dorsal fin (3 or 4 rows) and above the lateral line. The annulus formation was

determined according to the criterion suggested by (Bagenal & Tesch 1978); widely spaced ridges follow a zone of closely spaced ridges. The annulus is usually considered to be at the outer border of the closely spaced ridges. The number of annuli for each scale was recorded. Age was determined on the basis of annuli and designated as 1+, 2+ and so on. A percentage frequency table was prepared on the basis of age and to compute in different sexes (male and female). Population structures of male and female fish were determined on the basis of age group.

Results and Discussion

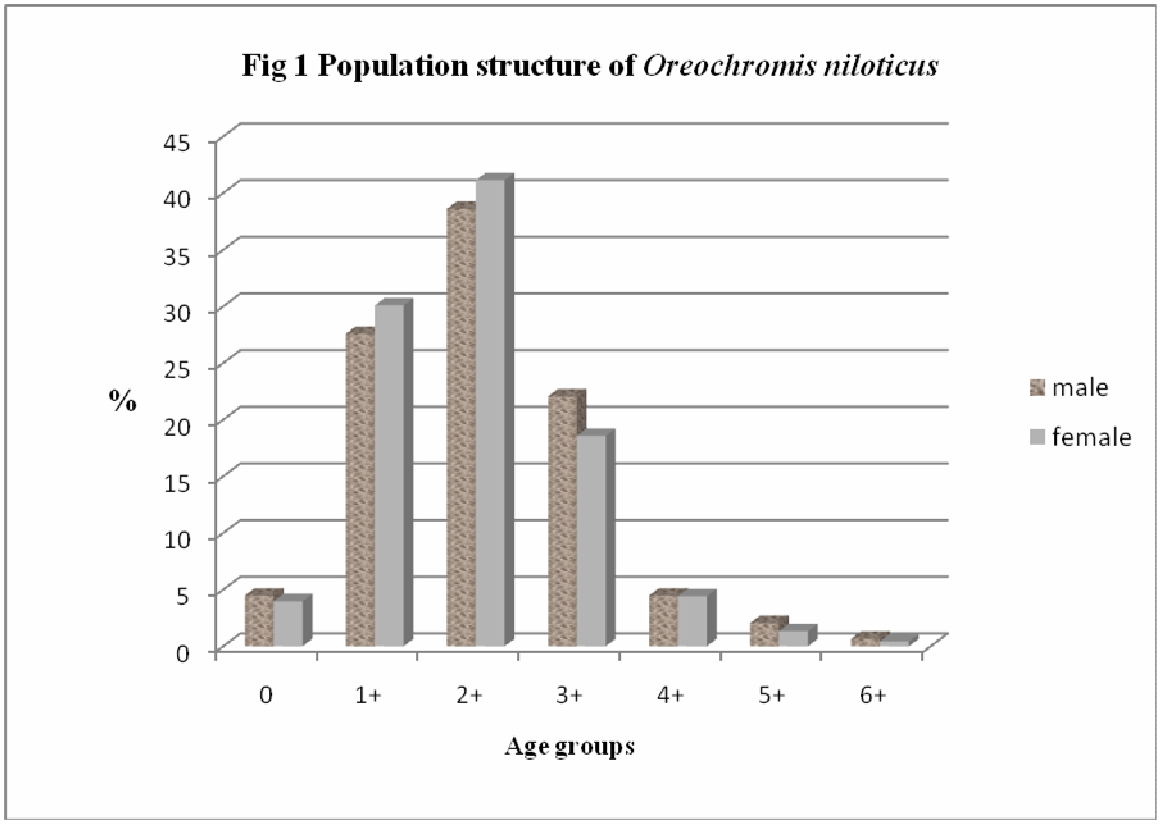
Monthly random samples were collected during August 2011 to July 2012, a total of 516 alien fish species, *O. niloticus* were collected from the lower stretch of the Yamuna river at Allahabad. Present time, population had a highly moderate natural size structure observed in the river. The Nile tilapia, *O. niloticus* is a deep-bodied fish with cycloid scales. Present time *O. niloticus* is a commercially exploited fish species in the Yamuna river at Allahabad. It is one of the most desirable fish species for food and commercial purposes by majority consumers. Fish lengths were ranged from 10.4 to 44.5 cm, with the majority between 19.0 to 30.0 cm of total lengths. The population structures of alien fish species, *O. niloticus* were varied from 0+ to 6+ age groups, male and female from the middle stretch of the Yamuna river at Allahabad. In stock, males population comprised 56.20% (n=290) and females population 43.80% (n=226) of the total catches. Population structure of male was greater than female in the stock. Present population structure (0+ to 6+ age groups) indicated that the ecological condition of the Yamuna river was very suitable for alien fish species, *O. niloticus* at Allahabad. 6+ age group indicated that the present fish population was well stable in the Yamuna river at Allahabad. Male population was also indicated that the ecological condition of the river was better (Table 1).

Table 1 Population structure of alien fish species, *Oreochromis niloticus* from lower stretch of the Yamuna river at Allahabad

Age	Male	Percentage	Female	Percentage
0	13	4.48	9	3.98
1+	80	27.59	68	30.09
2+	112	38.62	93	41.15
3+	64	22.06	42	18.58
4+	13	4.48	10	4.42
5+	6	2.06	3	1.33
6+	2	0.68	1	0.44
Stock	**290**	**56.20**	**226**	**43.80**

Male Population

The population structure of male *O. niloticus* was varied from 0+ to 6+ age groups in the lower stretch of the Yamuna river at Allahabad. The 0+ age group accounted for 4.48% of the total male population (Fig 1). The age group 2+ was dominated by virtue of numbers (38.62%). Hence, population of 0+ age group was very less than 2+ age group. The contribution of 1+ age group dramatically increased and shared with 27.59% of the male population. The age groups 3+, 4+ and 5+ were contributed 22.06%, 4.48% and 2.06%, respectively (Table 1). The population of 4+ age group dramatically decreased compared to 3+ age group. The age groups 6+ shared minute proportion 0.68%. The age groups 1+ to 3+ contributed 88.27% of the total male population. This population had good experience for reproduction and high fecundity level.



Female population

The population structure of female *O. niloticus* was also varied from 0+ to 6+ age groups in the lower stretch of the Yamuna river at Allahabad. The age group 2+ was also dominated population with 41.157% in the total female population (Fig. 1). The age group 0+ was contributed 3.98% (Table 1). Hence, population of 0+ age group was very less than dominant age group. The age groups 1+, 3+, 4+ and 5+ shared 30.09%, 18.58%, 4.42% and 1.339%, respectively (Table 1). The 6+ age group shared small proportion 0.44%. The age groups 1+ to 3+ population contribution 89.82%. The 1+ to 3+ age groups fishers had good experience for reproduction. The distribution of population was uneven between 0+ to 1+ age groups and difference was high (26.11%).

In the present study *O. niloticus* indicates that occurrences of males and females are difference in number; this is possibly caused by the incidence of fish pairs near to the nest area where females take care of their broods. Gomex-Marque *et al.* (2003) reported that the 319 fishes ranged from 117 to 206 mm in total length, and 31.2 to 167.0 g in body weight with 161 females (50.4 %) and 158 males (49.6 %). Females were more numerous from July to November and the males from January to June, except April. Tilapias, in general, are known for their plasticity in growth, reproduction, age and size-at-maturity that not only make them excellent aquaculture taxa but also allow them the ability to invade and become established in nonnative environments (Peterson *et al.* 2004). It grows to a maximum length of 62 cm, weighing 3.65 kg (at an estimated 9 years of age) (FAO 2012). The average size (total length) of *O. niloticus* is 20 cm (Bwanika *et al.* 2004).

Fryer and Iles (1972) point out that in the African lakes it is common that in the populations of cichlids the males dominate

because they generally present more growth than the females, without this representing a risk situation for the fishery. Novaes & Carvalho (2012) reported that the *O. niloticus* of males comprised 56.1% and females 43.9% of the catches in Barra reservoir, Brazil. Dwivedi *et al.* (2011) reported that the population structure of *Labeo bata*, female was greater than male in the Ganga river at Allahabad.

References

Anon, 2011-2012. Annual report (2011-12) of the Central Inland Fisheries Research Institute (ICAR), Barrackpore, Kolkata West Bengal, Pp 23 and 41.

Bagenal, T. & F. Tesch 1978. Age and Growth. *In:* Methods for Assessment of Fish Production in Fresh Waters **Edited by** T. Bagenal, *Blackwell Scientific Publication Oxford 3rd Edition*,Pp 101-136.

Bwanika, G.N., B. Makanga, Y. Kizito, L.J. Chapman & J. Balirwa 2004. Observations on the biology of Nile tilapia, *Oreochromis niloticus*, L., in two Ugandan Crater lakes. *African J. Ecol.*, **42:** 93–101.

Courtenay, W.R. 1997. Tilapias as non-indigenous species in the Americas: environmental, regulatory and legal issues. *In:* Tilapia aquaculture in the Americas. Vol. 1, **Edited by** B. A. Costa-Pierce & J. E. Rakocy, *World Aquaculture Society, Baton Rouge, LA*, Pp. 18–33..

Coward, K. & D. Little 2001. Culture of the aquatic chicken: present concerns and future prospects. *Biologist*, **48:** 12–16.

Dwivedi, A. C. & P. Nautiyal 2010. Population dynamics of important fishes in the Vindhyan region, India. *LAP Lambert Academic Publishing, Germany*, Pp 220.

Dwivedi, A. C., S. Tripathi, S. Khan & P. Mayank 2011. Population structure of *Labeo bata* (Hamilton) from the middle stretch of the Ganga river. *Asian J. Ani. Sci.*, **6(2):** 188-190.

Dwivedi, A.C., A. Tiwari & P. Mayank 2015. Seasonal determination of heavy metals in muscle, gill and liver tissues of Nile tilapia *Oreochromis niloticus* (Linnaeus, 1758) from the tributary of the Ganga river, India. *Zool. Ecol.*, **DOI:** 10.1080/21658005.2015.1020012.

Eknath, A.E., M.M. Tayamen, M.S. Palada-de Vera, J.C. Danting, R.A. Reyes, E.E. Dionisio, J.B. Capili, H.L. Bolivar, T.A. Abella, A.V. Circa, H.B. Bentsen, B. Gjerde, T. Gjedrem & R.S.V. Pullin 1993. Genetic improvement of farmed tilapias: growth performance of eight strains of Oreochromis niloticus tested in different farm environments. *Aquacult.*, **111:** 171–188.

FAO, 2010. State of world fisheries and Aquaculture 2004, fisheries Department, Rome.

FAO, 2012. Cultured Aquatic Species Information Programme. *Oreochromis niloticus*. Cultured Aquatic Species Information Programme. Text by Rakocy, J. E. In: FAO Fisheries and Aquaculture Department [online]. Rome. Updated 18 February 2005. [Cited 11 September 2012].

Faunce, C.H. & R. Paperno 1999. Tilapia-dominated fish assemblages within an impounded mangrove ecosystem in east-central Florida. *Wetlands*. **19:** 126–138.

Fryer, G. and T.D. Iles 1972. The Cichlid Fishes of the Great Lakes of Africa, their Biology and Evolution. Oliver and Boyd; Edinburgh, Scotland, Pp 641.

Goldburg, R. J., M.S. Elliott & R.L. Naylor 2001. Marine aquaculture in the United States: environmental impacts and management options. Pew Oceans Commission, Arlington, VA.

Gómez-Márquez,, J.L., B. Peña-Mendoza1, I.H. Salgado-Ugarte1 & M. Guzmán-Arroyo 2003. Reproductive aspects of *Oreochromis niloticus* (Perciformes: Cichlidae) at Coatetelco lake, Morelos, Mexico. *Rev. Biol. Trop.*, **51(1):** 221-228.

Mayank, P., A. Kumar & A.C. Dwivedi 2011. Alien fish species *Oreochromis niloticus* (Linnaeus, 1757) as a powerful invader in the lower stretch of the Yamuna River. *Bioved*, **22 (1):** 65-71.

Modadugu V.G. & O.A. Belen 2004. A review of global tilapia farming practices. *Aquaculture Asia*, **IX(1):** 1- 16.

Naylor, R.L., R.J. Goldberg, J.H. Primavera, N. Kautsku, M.C.M. Veridge, J. Clay, C. Folks, J. Lubchenco, H. Mooney & M. Troell 2000. Effect of aquaculture on world fish supplies. *Nature*, **405:** 1017–1024.

Naylor, R.L., S.L. Williams & D.R. Strong. 2001. Aquaculture-a gateway for exotic species. *Science*, **294:** 1655–1656.

Novaes, J.L.C. & E.D. Carvalho 2012. Reproductive, food dynamics and exploitation level of *Oreochromis niloticus* (Perciformes: Cichlidae) from artisanal fisheries in Barra reservoir, Brazil. *Rev. Biol. Trop*., **60(2):** 721-734.

Pathak, R.K. A. Gopesh & A.C. Dwivedi 2011. Alien fish species, *Cyprinus carpio* var. *communis* (common carp) as a powerful invader in the Yamuna river at Allahabad, India. *Natl. Acad. Sci. Lett.*, **34 (9 & 10):** 367-373.

Peterson, M.S., W.T. Slack & C. M. Woodley 2005. The occurrence of non-indigenous Nile Tilapia, *Oreochromis niloticus* (Linnaeus) in coastal Mississippi, USA: Ties to aquaculture and thermal effluent. *Wetlands,* **25(1):** 112-121.

Peterson, M.S., W.T. Slack, N.J. Brown-Peterson & J.L. McDonald 2004. Reproduction in nonnative environments: establishment of Nile Tilapia, *Oreochromis niloticus,* in coastal Mississippi watersheds. *Copeia,* **2004(4):** 842-849.

Picker, M.D. & C.L. Griffiths 2011. Alien and Invasive Animals – A South African Perspective. Randomhouse/Struik, Cape Town, South Africa. 240 pp.

Shelton W.L. 2002. Tilapia culture in the 21st century. *In:* Proceedings of the International Forum on Tilapia Farming in the 21st Century (Tilapia Forum 2002) **Edited by** R.D. Gurrero III & M. R.Guerrero-del Castillo, *Philippine Fisheries Association Inc. Los Bonos, Laguna, Philippines,* Pp. 1-20.

Stickney, R.E. 2002. Issues associated with non-indigenous species in marine aquaculture. *In:* Responsible marine aquaculture **Edited by** R. R. Stickney & J. P. McVey, *CABI Publishing, New York,* Pp. 205–220.

Sugunan, V.V. 1997. Fisheries management of small water bodies in seven countries in Africa, Asia and Latin America. FAO Fish. Circ. No. 933, FAO, Rome.

Traxler, S. L. & B. Murphy. 1995. Experimental trophic ecology of juvenile largemouth bass, *Micropterus salmoides*, and blue tilapia, *Oreochromis aureus. Environ. Biol. Fish.,* **42:** 201–211.

Trewavas, E. 1983. Tilapiine fishes of the genera *Sarotherodon*, *Oreochromis* and *Danakilia*. British Museum (Natural History), London.

Trexler, J. C., W. F. Loftus, F. Jordan, J. J. Lorenz, J. H. Chick & R. M. Kobza 2000. Empirical assessment of fish introductions in a subtropical wetland: an evaluation of contrasting views. *Bio.l Inva.,* **2:** 265–277.

Vitousek, P.M., H.A. Mooney, J. Lubchenco & J. M. Melillo 1997. Human domination of earth's ecosystems. *Science,* **277:** 494–499.