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SHORT COMMUNICATION

Population Dynamics of *Wallago attu* (Bloch and Schneider 1801) (Osteichthyes, Siluridae) in Three Small Rivers of Southern India

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Abstract

The Asian sheat catfish, *Wallago attu* (Bloch and Schneider 1801) is a commercially important species harvested across tropical Asia owing to its high nutritional quality and consumer demand. Population dynamics and exploitation levels of *W. attu* based on catches from three small (< 245 km) river systems of southern India, revealed an asymptotic length (L_∞) of 99.75 cm, growth coefficient (K) between 0.89 and 1.3 year^{-1}, and total mortality rates between 2.23 and 3.36 year^{-1}. In each river system, the exploitation rate (E) was greater than where the stock is reduced to half its virgin biomass (E_{50}): Achenkovil (0.49 > 0.33); Pampa (0.51 > 0.30); Manimala (0.59 > 0.34), and close to the E_{max} (exploitation producing maximum relative yield per recruit of 0.58) in some, suggesting the immediate need for developing and implementing fishery management plans.

Keywords: freshwater fish, inland fisheries, population dynamics, silurid

Introduction

The ‘freshwater shark’ or ‘Asian sheat catfish’, *Wallago attu* (Bloch and Schneider 1801) with a distribution spanning the inland waters of South and South-East Asia from Pakistan to Indonesia, is one among the 10 largest catfish species on earth (Hogan 2011). Throughout its range, they form important fisheries in rivers, associated floodplains, lakes and reservoirs, from where they are mostly harvested by artisanal fishers (Poulsen et al. 2004; Islam et al. 2006; Montana et al. 2011; Renjithkumar et al. 2011).

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Despite declining population and the 'Near Threatened' status on the International Union for Conservation of Nature (IUCN) Red List (Ng 2010), *W. attu* continues to be the mainstay of riverine and reservoir fisheries in many regions across its natural range (Renjithkumar et al. 2011). However, little research has been undertaken on the population dynamics and/or exploitation levels of *W. attu* (Goswami and Devaraj 1992, 1996). Focusing on three small rivers in Southern India where *W. attu* is one of the major species caught, this study aims to understand the population dynamics of this species for the development of sustainable fisheries management plans.

Materials and Methods

Samples for this study originated from fish landing centres located on the banks of three small rivers in the southern Indian state of Kerala, viz., Pampa (176 km), Achenkovil (128 km) and Manimala (92 km), as shown in Fig. 1. From August 2015 to August 2016, length measurements (Total Length/TL and Standard Length/SL) of exploited (using set gill-nets) *W. attu* were collected at fortnightly intervals and were subsequently grouped into 10 cm class intervals. Number of fish specimens (n) for the study differed from one river system to the other: Achenkovil (n = 788); Manimala (n = 1091) and Pampa (n = 2544).

To determine the growth, mortality and fisheries exploitation of *W. attu*, we studied the length structured population dynamics. Asymptotic length (L_∞) and growth constant (K) of the von Bertalanffy growth function were estimated in the FiSAT II software (Gayanilo et al. 2005) using electronic length frequency analysis (ELEFAN) method (Pauly 1984). Final values of L_∞ and K were estimated using an iterative method by correcting the frequencies with a probability of capture (Pauly 1986; Amarasinghe and De Silva 1992; Athukorala and Amarasinghe 2010). Based on L_∞ and K, the growth performance index ($\phi' = 2 \times \log L_\infty + \log K$) was determined (Pauly and Munro 1984). Total mortality Z was estimated from catch curve analysis and natural mortality M was estimated using Pauly's M equation for tropical fish: $\ln(M) = -0.0152–0.279 \ln(L_\infty) + 0.6543 \ln(K) + 0.463 \ln(T)$, where T is mean annual temperature, which is 26 $^\circ$C. Fishing mortality (F) was calculated as $F = Z-M$ and the current exploitation level (E) was calculated as $E = F/Z$ (Pauly 1984).

Length converted catch curves were prepared to understand the length of first capture (L_c). Length-structured virtual population analysis was performed based on the b value of length-weight relationship provided by Rufus et al. (2015). To understand whether local populations are overexploited, we calculated the theoretical E_{50} (exploitation rate where the stock is reduced to half its virgin biomass) and E_{max} (exploitation producing maximum yield) using Beverton and Holt (1966) relative yield per recruit (Y/R) and biomass by recruit (B/R) analysis with Knife-Edge selection method by inputting the values for L_∞, L_c, M and K.

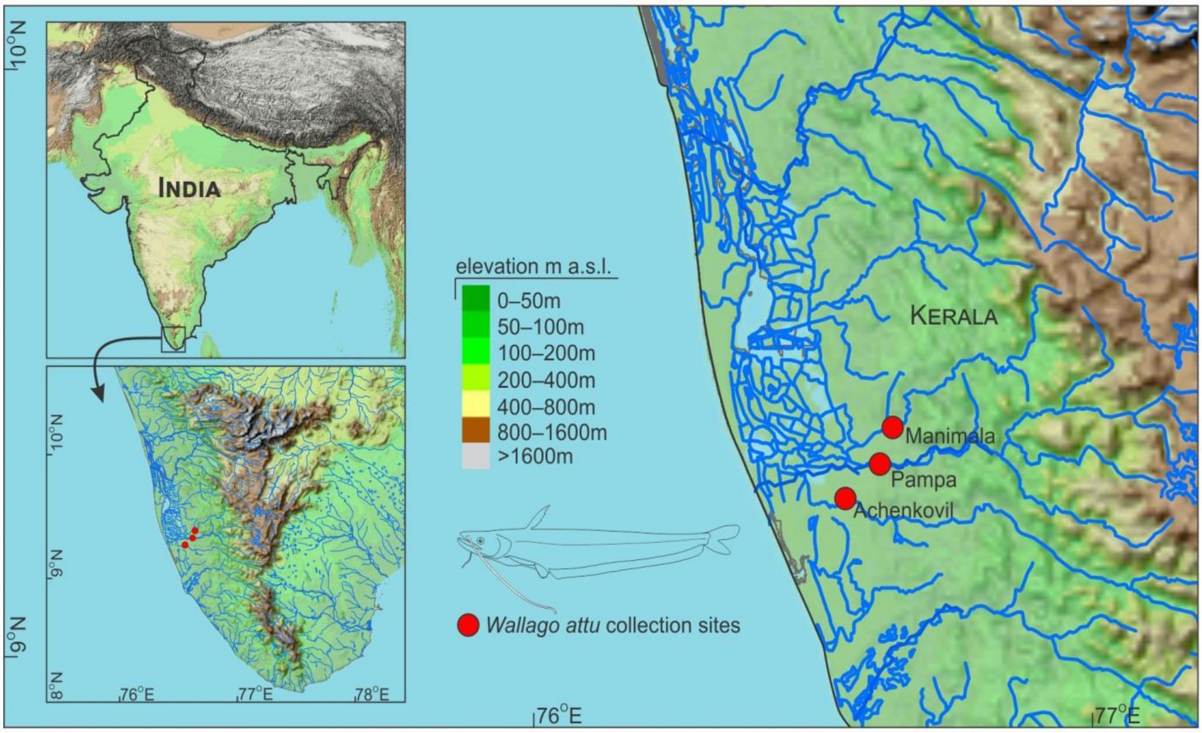

Fig. 1. Map showing fish landing centers in three small rivers of Peninsular India where catches of *Wallago attu* are sold.

Results and Discussion

Frequency distributions of length classes revealed that fish of between 400–500 mm dominated the catches in all three rivers with the largest individual (110.25 cm) caught in the River Pampa. The von Bertalanffy growth curve (Fig. 2a–c) indicated an asymptotic length (L_∞) of 99.75 cm for all the three riverine populations, but with differences in both the growth coefficient (K) and growth performance index (ϕ) (Table 1); highest values estimated for fish exploited in the River Manimala and the lowest in the River Achenkovil.

Mortality estimates indicated high levels of fishing mortality (F) and exploitation (E) in both Manimala and Pampa rivers, with the exploitation rate (E) greater than E_{50} in all three populations and almost close to the E_{max} in Manimala and Pampa (Table 1; Fig. 3). Virtual population analysis (Fig. 2d–f) suggested that the fishing pressure on the specimens of more than 25 cm drastically reduces the survival rate of all populations, which is likely to affect the recruitment pattern and result in severe population declines of the species.

Table 1. Growth and mortality related parameters of *Wallago attu* exploited in three small rivers of southern India.

Parameters	Manimala	Achankovil	Pampa
Asymptotic length (L_∞, cm)	99.75	99.75	99.75
Growth coefficient (K, y^{-1})	1.30	0.89	0.94
Growth performance index (ϕ')	4.11	3.95	3.97
Total mortality (Z, y^{-1})	3.36	2.23	2.42
Natural mortality (M, y^{-1})	1.47	1.14	1.19
Fishing mortality (F, y^{-1})	1.90	1.09	1.24
Exploitation rate (E, y^{-1})	0.56	0.49	0.51
Length at first capture (L_c, cm)	39.05	38.16	38.10
Exploitation rate reducing stock to half its virgin biomass (E_{50}, y^{-1})	0.34	0.33	0.30
Exploitation producing maximum yield (E_{max}, y^{-1})	0.58	0.58	0.58

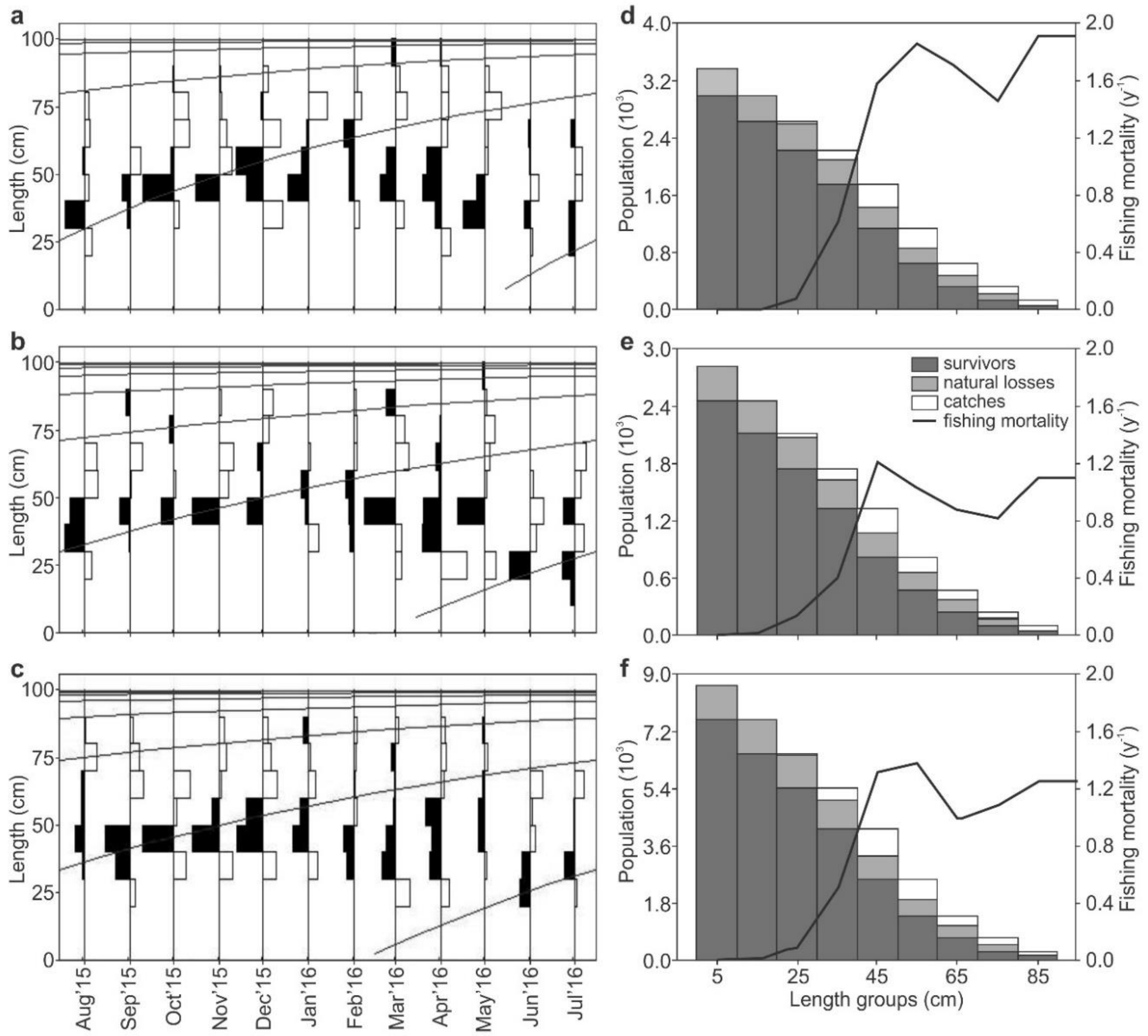

Fig. 2. von Bertalanffy growth curves (a–c) and length structured virtual population analysis of *Wallago attu* (d–f). Manimala River (a, d), Achenkovil River (b, e), and Pampa River (c, f).

Although *W. attu* grows to a maximum length of 240 cm (Pethiyagoda 1991), such large sizes are rarely encountered in today's fishery, and an average exploited size varies from 27.7 to 99.0 cm (Poulsen et al. 2004; Renjithkumar et al. 2011, 2016). The largest exploited individual encountered in our study was 110.25 cm and the estimated asymptotic length (L_∞) was 99.75 cm, lower than those observed in *W. attu* caught from the bheels of Assam (136.16 cm) (Goswami and Devraj 1992).

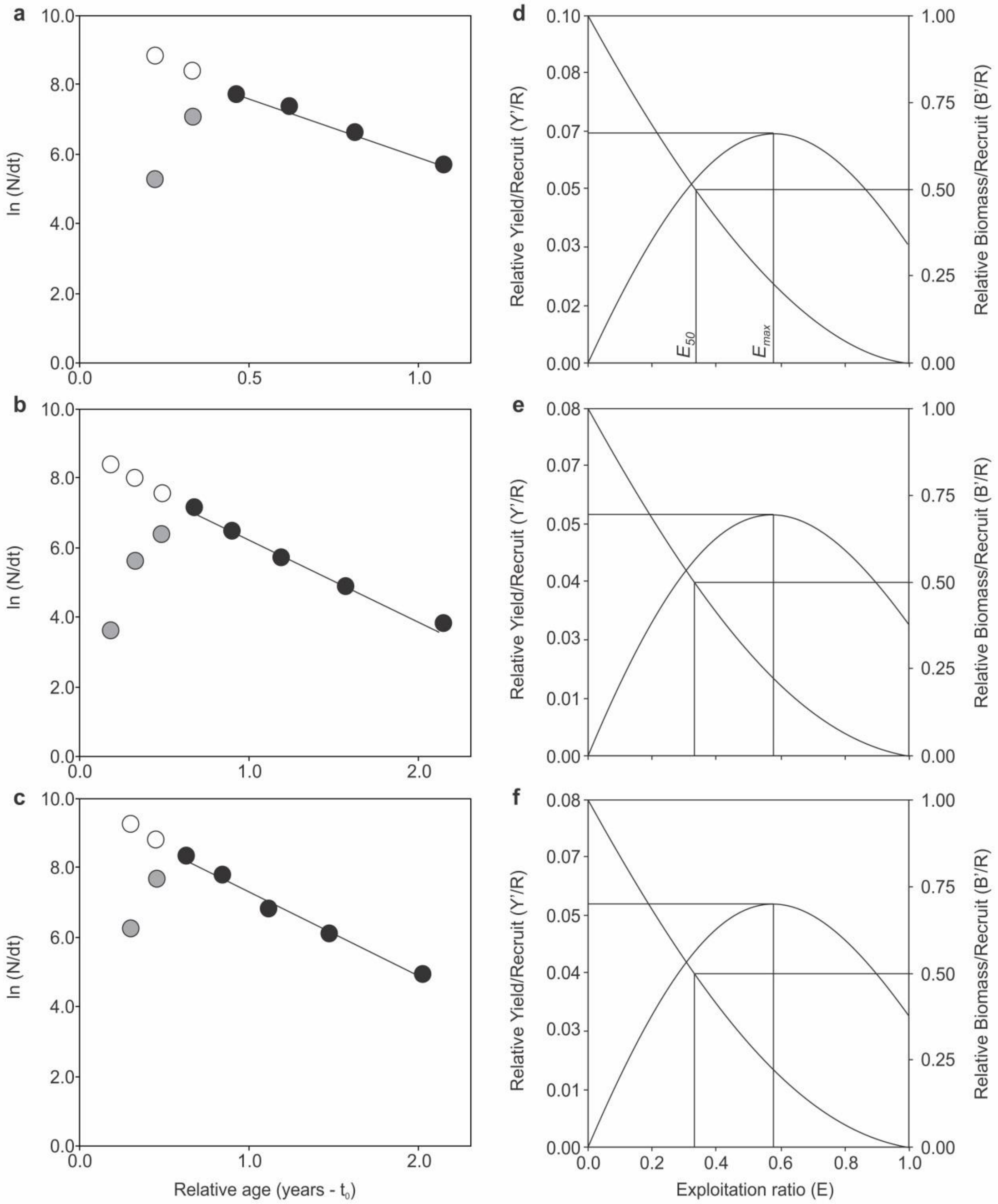

Fig. 3. Length converted catch curves (a–c) and Relative Yield/Recruit and Relative Biomass/Recruit as a function of exploitation rate of *Wallago attu* exploited from three small rivers in Peninsular India E_{50} (exploitation rate where the stock is reduced to half of its virgin biomass and E_{max} (exploitation rate producing maximum yield-per-recruit) are also shown here.

There are limited studies on population dynamics of *W. attu* except by Goswami and Devraj (1992, 1996), therefore the comparison between geographic populations becomes difficult. The riverine populations of *W. attu* in Kerala grows at a faster rate than those in the bheels of Assam as evidenced by higher K values (0.89 to 1.3 year^{-1} *vs*. 0.65 year^{-1}) (Goswami and Devraj 1992). The difference in growth rates is interesting given the fact that the *W. attu* showed poor values of condition factor in the same river systems (Rufus et al. 2015). Estimates of growth performance index (ϕ') obtained in this study (3.95 to 4.11 year^{-1}) are similar (4.08) to those observed for the species from the wetlands of Assam (Goswami and Devraj 1996).

Although *W. attu* is known to be intensively harvested in its natural distribution range resulting in severe population declines (Patra et al. 2005; Vass et al. 2010; Hogan 2011; Montana et al. 2011), there have been little effort to understand the exploitation rates *vis-a-vis* its population dynamics. The results revealed that the exploitation rate (E) of *W. attu* is greater than E_{50} and very close to the predicted $E_{\max}$ suggestive of high rates of overfishing. Therefore there is a need for implementing fishery management plans, including mesh size regulations and catch limits. Similar studies should be undertaken in major fishing sites (both rivers, wetlands and reservoirs) across its range, especially in systems like the Ganges and the Mekong, where large scale population declines have been documented.

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