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Invasion of the freshwater snail *Physella acuta* (Draparnaud, 1805) in selected ponds of North Dinajpur, India

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Abstract

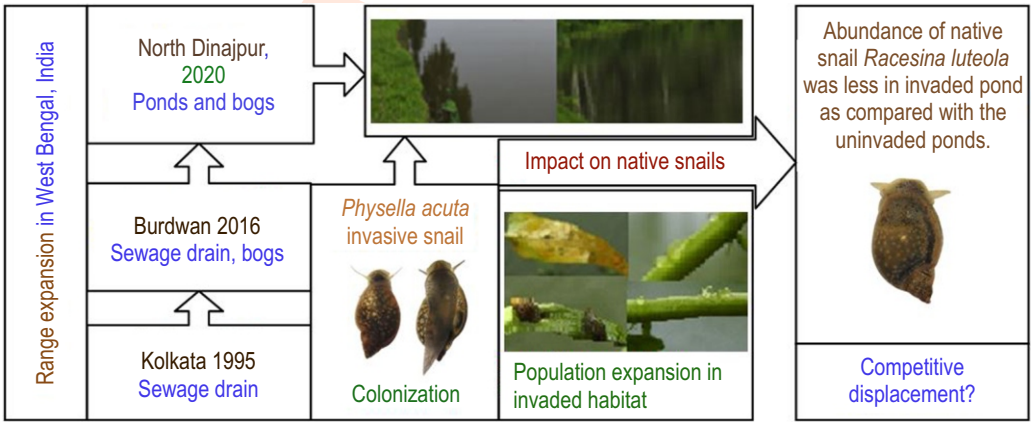
Aim: The dispersal and geographical range expansion of globally invasive snail *Physella acuta* (Draparnaud, 1805) (Gastropoda: Physidae) were little being monitored following the first report from Kolkata, India. An account of the encounter of *P. acuta* in two ponds of North Dinajpur district of West Bengal, India is recorded here.

Methodology: Multiple samples of freshwater snails were collected using aquatic nets from the invaded and non-invaded ponds for assessment and comparison. The shell lengths of the collected *P. acuta* were measured using a vernier calliper to represent size class variations of the population in the ponds.

Results: Varying numbers of *P. acuta* were present in the shoreline and the hydrophytes of littoral zone of invaded ponds. The size class distribution of *P. acuta* indicated the establishment of a stable population in the invaded ponds where a significant difference ($P < 0.05$) was observed in the abundance of a native snail *Racesina luteola* (Lamarck, 1822) when compared with the abundance in the non-invaded ponds.

Interpretation: Invasion of *P. acuta* in the ponds reflected its ability to overcome the predator-borne barriers and to coexist with the native snails. The geographic range of *P. acuta* seems to have extended, even though slower with reference to the first record in India.

Key words: Aquatic invasion, Freshwater habitat, Invasive species, Native snail, *Physella acuta*



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Introduction

The invasion by the freshwater molluscs in varied water bodies bears immense impacts on the local biodiversity (Karatayev *et al.,* 2009). The acute bladder snail *Physella acuta* (Draparnaud, 1805) (Gastropoda: Physidae) is a North American pulmonate snail that has invaded all continents, except Antarctica (Zukowski and Walker, 2009; Vinarski, 2017; Cieplok and Spyra, 2020). In India, the presence of live *P. acuta* was observed in Kolkata for the first time (Raut *et al.,* 1995), followed by discrete information from Guwahati, Assam (Devi *et al.,* 2008), Himayatsagar and Osman Sagar in Andhra Pradesh (Karuthapandi *et al.,* 2013), Burdwan, West Bengal (Saha *et al.,* 2016 a, b) and in Budhabalanga river, Odisha (Tripathy and Sajan, 2018). The globally invasive *P. acuta* is found and capable to thrive in a wide range of habitats including highly polluted freshwater bodies, sewage drains and puddles (Saha *et al.*, 2016 a, b; Cieplok and Spyra, 2020). For this reason, *P. acuta* often exploits newly disturbed habitats better than the native snails (Brackenbury and Appleton, 1993). The post-invasion impacts by *P. acuta* include competition with native snails and their displacement (Zukowski and Walker, 2009), damage of plants having economic importance and capability of transmitting vector-borne diseases (Barragán-Sáenz *et al.,* 2009; Kraus *et al.,* 2014).

Since the first report of *P. acuta* from sewage drains in Kolkata, India, the range expansion was little traced until recently, where the snails were observed from Burdwan, India (Saha *et al.*, 2016 a, b). While the information on the predatory potential of water bugs and leeches (Aditya and Raut, 2002 a, b, c) on *P. acuta* was documented from Kolkata populations, little effort was made to highlight the population growth and the range expansion of the snail in other regions of India. The estimates of relative abundance of the snail in the sewage drains and puddles in suburbs of Burdwan indicated the dispersal, colonization and establishment beyond the urban boundaries of Kolkata, India. The geographical range expansion can be considered as an indicator of the invasive nature of a species like *P. acuta* (Vianrski, 2017) that tends to show continued colonization and establishment in the newer habitats (Cieplok and Spyra, 2020). Thus, the chance observation of *P. acuta* in the rural ponds of North Dinajpur, West Bengal, India, provided an opportunity to explore the population pattern and the effect on the community, if any. The present narrative is an attempt to provide an overview of *P. acuta* recorded from the ponds in North Dinajpur as evidence of range expansion and suspected impact on the native snail community. The results will be useful in understanding the colonization pattern in the rural areas and enable framing strategies for the management of snails beyond the region of the first record in West Bengal, India.

Materials and Methods

In the course of a survey of the freshwater snails from different regions of West Bengal, India, random sampling of the ponds and bogs of North Dinajpur was carried out in June 2020. In two of the ponds (25°34'15.8"N, 88°18'27.6"E and 25°35'42.1"N, 88°18'36.1"E), the population of invasive snail *P. acuta* was observed along with other snails. The snails were collected using a sampling net of 200 µm mesh size fitted with a long handle. The identification and species-specific confirmation of *P. acuta* were done by observing the morphological features according to Taylor (2003). The snails collected from each pond were sampled in 15 different positions and each sampling comprised of 3 surfing of sampling net in different depths ranging from surface to sediments. Following the same procedure, snails were sampled from adjacent ponds (n=2) having no record of *P. acuta* (25°34'10.9"N, 88°18'34.6"E and 25°35'44.9"N, 88°18'19.4"E). For each sample from the ponds, the collected snails were segregated following identification and recorded for the relative abundance of the representative species. The shell lengths (mm) of *P. acuta* were measured with a vernier caliper (Insize, Brazil) to estimate the size group distribution patterns (population structure) in the invaded ponds. One-way ANOVA was applied to find out if any significant difference was present between the abundance of native snails in the invaded and non-invaded ponds.

Results and Discussion

The invasive snail *P. acuta* was observed in the littoral zone of the ponds, crawling near the shoreline or on the hydrophytes. The egg capsules were noted on the wet soil near shoreline, stems and leaves of *Ipomoea aquatica* and the movement of the snails was also observed in the stems and leaves of *Alternanthera philoxeroides* growing at the edge of the ponds. In 30 discrete samples from both ponds, 143 individuals (n= 70 and n= 73 from two separate ponds) of *P. acuta* were collected through sampling and the size group distribution pattern indicated the presence of stable populations (Fig.1). In the surveyed ponds, snails such as *Racesina luteola* (Lamarck, 1822) (Heterobranchia: Lymnaeidae), *Indoplanorbis exustus* (Deshayes, 1834) (Heterobranchia: Planorbidae), *Gyraulus convexiusculus* (Hutton, 1849) (Heterobranchia: Planorbidae), *Bellamya bengalensis* (Lamarck, 1822) (Caenogastropoda: Viviparidae), *Pila globosa* (Swainson, 1822) (Caenogastropoda: Ampullariidae) and *Gabbia orcula* (Frauenfeld, 1862) (Caenogastropoda: Bithyniidae) were observed in addition to being present with *P. acuta*. Variations in the relative abundance of these snails were observed in both the invaded (n= 30 discrete samples) and non-invaded ponds (n= 30 discrete samples) (Fig. 2), but the differences in the abundance pattern were not significant, except for *R. luteola*.

The result of ANOVA indicated that there was a significant difference ($F_{1, 58} = 9.516$, $p < 0.001$) in the abundance of *R. luteola* but not in case of other snails in the presence and absence of the invasive snail *P. acuta* (Fig. 2). Such variations in the relative abundance of *R. luteola* in the presence and absence of *P. acuta* is indicative of possible competition mediated population decline of a native snail as a result of species invasion (Cieplok and Spyra, 2020). In Argentina, *P. acuta* has successfully established in the freshwater habitats which were previously dominated by

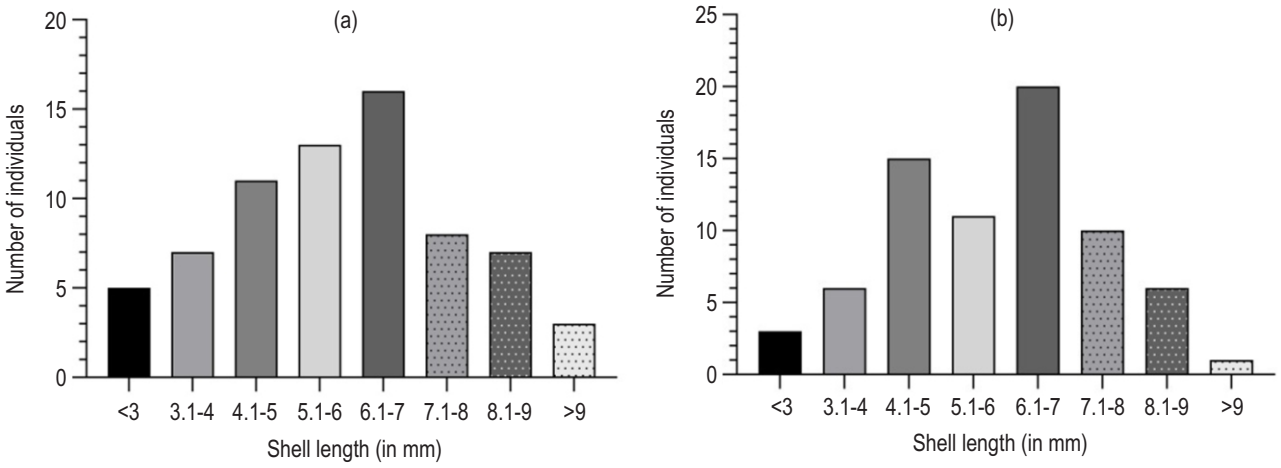

Fig. 1: The number of *P. acuta* belong to different size classes indicates stable established population in two separate ponds, (a) and (b), in North Dinajpur, West Bengal, India. The last three columns belong to the reproductive size classes.

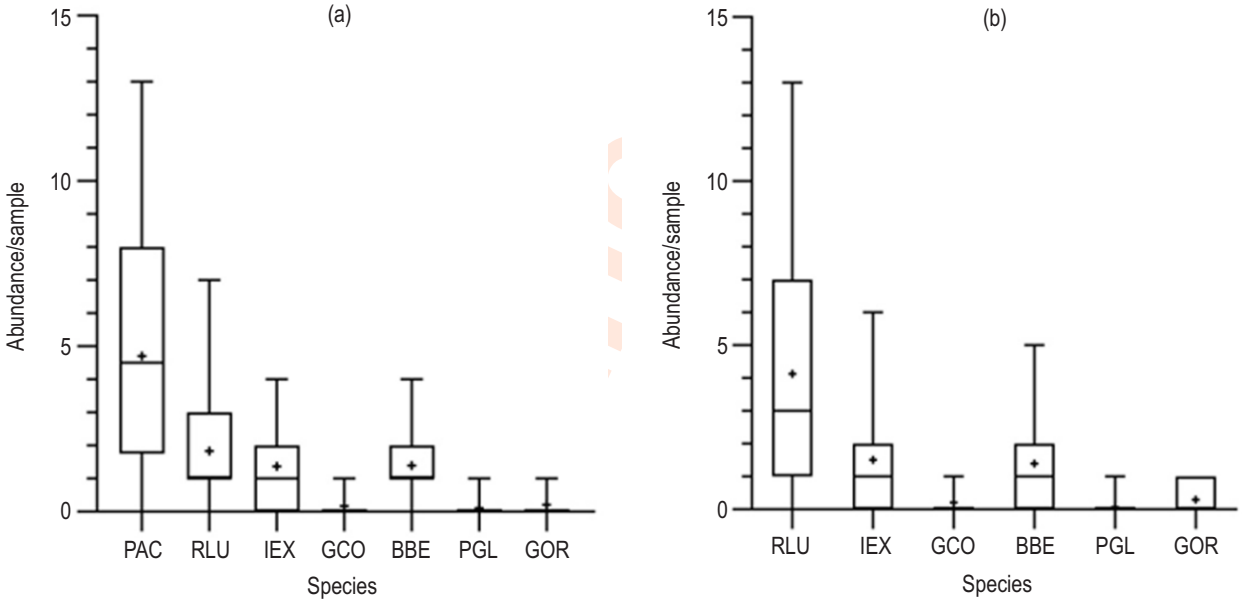

Fig. 2: Comparison between the abundance / sample (n=30 for each type of pond) of different snails found in the ponds (a) with the presence of *P. acuta* and (b) without the presence of *P. acuta*. The abundance/ sample of *R. luteola* was significantly lower in the presence of invasive snail *P. acuta* compared to the ponds where *P. acuta* was absent ($F_{1,58}$= 9.516, p <0.003). (Acronyms: PAC- *P. acuta*, RLU- *R. luteola*, IEX- *I. exustus*, GCO- *G. convexiusculus*, BBE- *B. bengalensis*, PGL- *P. globosa* and GOR- *G. orcula*).

native snail *Stenophysa marmorata* (Núñez, 2011). In a similar way, *P. acuta* declined the population of the morphologically and ecologically similar native snail *Glyptophysa gibbosa* in the River Murray, South Australia (Zukowski and Walker, 2009). The observations in the present instance are indicative of the possible displacement of native snail *R. luteola* by the invasive *P. acuta* as both the snail species were observed in the shallow littoral zone with vegetations and share similar feeding habits. Therefore, invasion of *P. acuta* in the pond and diverse freshwater wetlands in West Bengal and similar regions of India poses serious risk and concern for the competitive displacement of the native snails like *R. luteola*. In addition, higher tolerance of *P. acuta* to the

anthropogenic disturbances and adverse ecological conditions (Brackenbury and Appleton, 1993; Cieplok and Spyra, 2020) may provide more advantages over *R. luteola* as many ponds are often subjected to vigorous netting and pesticide exposure (fish ponds) along with fertilizer and pesticide contamination due to agricultural runoff in the rural areas. Such features are highlighted as factors facilitating the colonization and establishment of *P. acuta* (Cieplok and Spyra, 2020). The introduction of *P. acuta* in non-native regions is facilitated by aquarium trade (Vinarski, 2017; Ng *et al.,* 2016). Once introduced, the ability to adapt in a wide range of habitat conditions and plasticity of life-history traits as higher fecundity and shorter hatching time of eggs than many of the native snails enable *P. acuta* to establish as a superior and successful competitor (Zukowski and Walker, 2009; Núñez, 2011; Dillon and Jacquemin, 2015). This proposition is substantiated through the established colonies of *P. acuta* is sewage drains and the associated puddle of Burdwan (Saha *et al.,* 2016 a, b). Unlike other instances in India, *P. acuta* was observed in the ponds which raise a serious concern about the ill effects on the native snails (Cieplok and Spyra, 2020) as *P. acuta* appears to extend its range considerably in West Bengal, India in latitudinal scale. However, the malacophagous predators like leeches, insects, crustaceans and fishes may pose a barrier to the establishment of *P. acuta* in the ponds (Ben-Ami and Heller, 2001; Aditya and Raut, 2002 a, b, c; Yamanishi and Yoshida, 2012). It is worth mentioning that the predatory efficacy of leech *Glossiphonia weberi* and water bug *Diplonychus* (=*Sphaerodema*) *rusticus* seems quite satisfactory against *P. acuta* (Aditya and Raut, 2002 a, b, c). Nonetheless, with the present report, it seems evident that the invasion of *P. acuta* in the ponds reflects that the snails were able to overcome the predator borne barriers for their colonization and establishment in the newer habitats.

Empirical evidence suggests that the foraging pattern and spatial orientation of *P. acuta* vary with the presence of predators like water bugs (Wojdak, 2009). The varied ability of refuge use pattern (surface swimming) by *P. acuta* can be considered as a behavioural manifestation developed to evade predators (Wojdak, 2009) and therefore successfully colonize and establish in newer habitats. Such behavioural pattern and plasticity in the life history traits of *P. acuta* may facilitate in alteration of the native snail population, other macroinvertebrate species and macrophytes composition of the invaded ponds. Thus, a slow yet effective extension of invasion of *P. acuta* has occurred in West Bengal, since the first report from Kolkata, India. Continued surveillance of the freshwater habitats is therefore required to monitor and predict the range expansion of *P. acuta* as well as for framing effective management strategies.

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Add-on Information

Authors' contribution: P. Paul: Field observation, data collection and compilation; **G. Aditya:** Concept, data analysis and compilation.

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