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INCIDENCE OF THE COMMON GARDEN SNAIL, *MACROCHLAMYS INDICA* BENSON, 1832 (GASTROPODA: ARIOPHANTIDAE) IN BANGALORE REGION

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ABSTRACT
Incidence of the common garden snail, *Macrochlamys indica* Benson, 1832 (Gastropoda: Ariophantidae) in different agri-horticultural ecosystems of Bangalore region is reported. Highest percentage of *M. indica* occurrence was in Bangalore North taluk (60%) and absent in Doddaballapur taluk (0%). The district wise distribution was found to be 22 (39%) villages in Bangalore urban district and 7 (12%) villages in Bangalore rural district. Co-occurrence of four different species of malacofauna *viz., Cryptozona bistrialis*, *Mariella dussumeri*(endemic) and *Achatina fulica*, *Laevicaulis alte* (invasive alien) with *M. indica* was assessed. *M. indica - C. bistrialis* combination co-occurred in 22 villages followed by *M. indica - L. alte* in 21, *M. indica - A.fulica* in 20 and *M. indica-M. dussumeri* in16 villages in Bangalore region. The findings are a first time prevalence records of the snail species in Bangalore region.

INTRODUCTION

Gastropoda are the largest class of phylum mollusca which have successfully invaded land. Among gastropods, land snails are one of the most numerous with almost 35,000 described species of the world. Many land snails species are destructive agricultural pests causing economic damage to agri-horticultural crops and forestry. The present study is part of a long term study undertaken to record the distribution of pestiferous malacofauna of Bangalore (now Bengaluru) region. The incidence of common garden snail, *Macrochlamys indica* Benson, 1832 (Gastropoda: Ariophantidae) (Fig. 1) is reported for the first time in detail from different horticultural areas of the study region. It is a native to India (Blanford and Godwin-Austen,.1908; Raheem and Naggs, 2006) reportedfrom different parts of country*viz.*, Eastern India (Blanford and Godwin-Austen, 1908), Assam (Borkakati *et al.* 2009), Karnataka (Mavinkurve *et al.,* 2004),West Bengal (Ghose, 1959; Palit and Palit, 2014)and also in other countries in the Indian sub-continent, Bangaladesh (Jahan *et al.*, 2002), Sri Lanka(http://www.nhm.ac.uk/). The snail is reported as pest inflicting damage to a wide arrange of vegetable and ornamental crops in India *viz.*, West Bengal, Orissa, Assam, Bihar, Kerala, Tamil Nadu, Delhi, Port Blair (Raut and Ghose, 1984), North Bihar (Thakur, 1999), Punjab (Kaur and Chhabra, 2011).*M. indica* is listed under the quarantine plant pest presenting the greatest threat to U.S. agriculture (http://www.aphis.usda.gov/plant_ health/ plant_pest_info/ pest_detection/ downloads/ farmbill/ Prioritized OffshorePestList.pdf). The snail caused 10-65% mortality to neem seedlings in India (Tewari, 1992; Ahmed, 1998). Horticulture (fruits, vegetables and flowers) including plantation, medicinal and tubers are widely cultivated in the study region especially in the Bangalore rural district. Peri-urban agriculture and commercial nurseries are an emerging trend in Bangalore urban district. Only basic information is known about taxonomy (1,129 recorded species) of land snails and little is known of their population biology, ecology and their conservation status (Sen *et al.,* 2012). Survey of malacofauna (pest/ non pest) has been undertaken in different parts of the world (Godan, 1983; Raut and Ghose, 1984; Barker, 2002; Sebay *et al.,* 2009; Sridhar *et al.*, 2014; http://www.issg.org/pdf/publications/Island_Invasives/pdfHQprint/1Brodie.pdf). Review of literature revealed scarcity of data pertaining to distribution of the snail in the study region hence the present survey was undertaken. The data generated provides distribution records of *M. indica* and other malacofauna co-occurring with the snail in the selected study area.

MATERIALS AND METHODS

A rapid biodiversity survey was undertaken to assess the terrestrial malacofaunal diversity in three localities (5 quadrates of 1 x 1 m in each study location) of Bangalore region (12º58'0"N, 77º34'0"E) *viz.*, Hebbal forest department nursery, Gandhi Bhavan forest department nursery and the premises of the Department of Zoology, Bangalore University. In order to estimate the species richness and species evenness, the randomly collected data on the malacofauna was subjected

to diversity indices *viz.*, Simpson's Dominance index (D) and Shannon-Wiener Index (H) were calculated.

A extensive village was surveying 114 villages in Bangalore region (Map 1) comprising of urban and rural districts each with four taluks. Continuous questionnaire - Opinionnaire survey and field observations were conducted during 2009-10. Questionnaire was prepared consulting earlier surveys (Asamoah, 1999, USDA–APHIS, 2005). In terms of possession of agricultural land (acreage) by farmers (n = 150) interviewed, it was, <1(5.9%), 1-5 (80%), 5.1-6(7.6%) and >10 acres (5.9%). Since snails are nocturnal in habit being active during early morning, overcast and rainy days, surveys were carried out accordingly during such occasions, as surveys at night are logistically difficult. Visual search method was employed to gather information on distribution of pest snails. In the field, exact location of each sample collection site was recorded with a handheld Garmin e-trex, 12 Channel global positioning system (GPS) device for each study point and of district and taluk map (Land records of 2001) of Karnataka State Remote Sensing Applications Centre (KSRAC), Government of Karnataka. Arc GIS Software (8.1 version) was used for the data analysis and projection

RESULTS AND DISCUSSION

Biodiversity indices of malacofauna in three different locations

A rapid diversity assessment of terrestrial malacofauna in three different localities in the study area revealed rich diversity (Table 1). *M. indic*a was recorded in only two (Hebbal forest department nursery and Department of Zoology premises) recording second highest numerical count in both the localities. A measure that accounts for both richness and proportion (percent) of each species is the Simpson's diversity index. Simpson's Dominance index indicates the probability that two randomly selected individuals in the community belong to the same species and it ranges between 0 and 1. As D increases, diversity decreases, Hebbal nursery (D = 0.27) recorded higher diversity compared to Gandhi Bhavan nursery (D = 0.58) and Premises of Department of Zoology (D = 0.53). The same is reflected in the number of species/ m^2 in Table 1. The Shannon index (H) is a statistic information index, which means it assumes all species are represented in a sample and that they are randomly sampled. Values of the Shannon diversity index for real communities typically fall between 1.5 and 3.5. The Shannon index increases as both the richness and the evenness of the community increase. In the present study the Hebbal nursery (H = 1.43) has higher evenness compared to the other two locations, Premises of Department of Zoology (H = 0.93) and Gandhi Bhavan nursery (H = 0.81).

Village survey

The Global Positioning System (GPS) coordinates of villages of the detection survey are represented in map 2 (Geo-tagging), indicating the occurrence status (present or absent) of *M. indic*a in the villages. According to the results analyzed during the present survey, highest percentage of *M. indic*a occurrence was in Bangalore North taluk (60%) and absent in Doddaballapur taluk (0%) (Figure 2). The district wise distribution was found to be 22 (39%) villages in Bangalore urban district and 7 (12%) villages in Bangalore Rural district (Map 2). The higher incidence in urban areas is attributed to periurban agriculture wherein farmers have small land holdings compared to the rural district. Absentee landlordism, water scarcity and availability of other job opportunities have contributed to poor pest management initiatives in the urban areas. On the other hand intensive large scale farming and strict pest management initiatives in the rural areas may perhaps be the reason for lower incidence compared to urban areas. From Table 2, it is inferred that, since the p-value is less than 0.05, at 5% level of significance it is concluded that there is a strong evidence that, the occurrence of malacofauna between the five taluks *viz.*, Bangalore North, Bangalore South, Anekal, Devanahalli and Doddaballapur, is different for the four species *viz., Achatina fulica, Laevicaulis alte, Cryptozona bistrialis* and *Macrochlamys indic*a. Whereas, the p-value more than 0.05, at 5% level of significance indicates that, the occurrence of *Mariella dussumeri* between the five taluks *viz.,* Bangalore North, Bangalore South, Anekal, Devanahalli and

Table 1: Relative abundance (RA) of different malacofauna occurring in three locations, Hebbal forest department nursery (1), Gandhi Bhavan forest department nursery (2) and Premises of Department of Zoology (3)

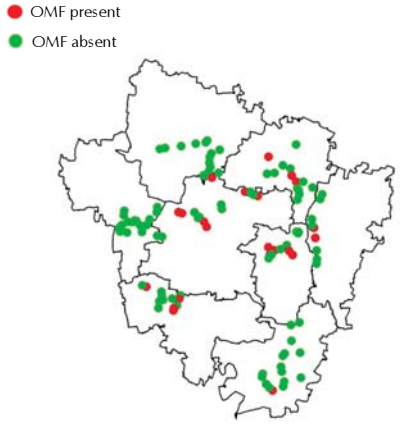
Malacofauna	1 Counts (m^2)	RA (%)	2 Counts (m^2)	RA (%)	3 Counts (m^2)	RA (%)
Achatina fulica	45 (9)	17.5	9 (1.8)	6.2	9 (1.8)	5.0
Macrochlamys indica	82 (16.4)	32.0	0 (0)	0	34 (6.8)	18.8
Laevicaulis alte	19 (3.8)	7.4	7 (1.4)	4.8	127 (25.4)	70.2
Mariella dussumeri	7 (1.4)	2.7	21 (4.2)	14.4	4 (0.8)	2.2
Deroceros laevi	12 (2.4)	4.6	0 (0)	0	0 (0)	0
Glessula bravis	91 (18.2)	35.5	109 (21.8)	74.7	1 (0.2)	0.6
Cyptozona bistrialis	0 (0)	0	0 (0)	0	6 (1.2)	3.3
Total (m^2)	256 (51.2)	100	146(29.2)	100	181 (36.2)	100
Simpson diversity (D)	0.27		0.58		0.53	
Shannon-Weiner ($H^{'}$)	1.43		0.81		0.93	

Table 2: Chi-square test for distribution of individual mollusc species between taluks

Species	Chi-square co-efficient	df	p-value
A. fulica	37.521	7	.000
L. alte	30.494	7	.000
M. dussumeri	13.943	7	.052
C. bistrialis	18.703	7	.009
M. indica	24.107	7	.001

Figure 1: *Macrochlamys indica* Benson, 1832

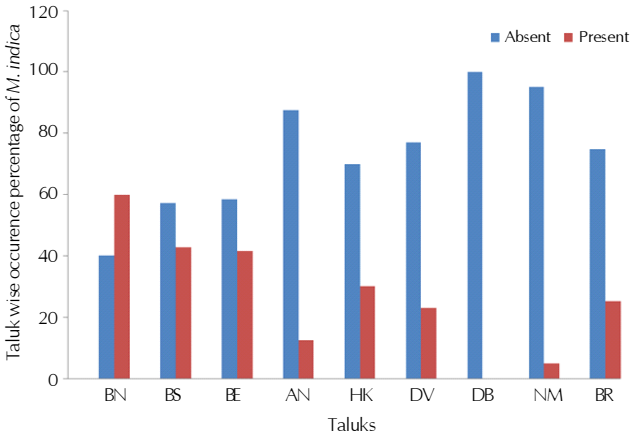
Map 1: Bangalore urban and rural districts of Bangalore region



Map 2: Occurrence of *M. indica* in (green circles) 114 villages of Bangalore region (OMF = Other Malacofauna)

Doddaballapur, is not significant.

Gastropods are reported to aggregate under stressful abiotic conditions (Rojas *et al.*, 2013). Patil *et al.*, (2012) have reported co-occurrence of *M. indica* with four other molluscs in Maharashtra. Co-occurrence of four different species of malacofauna *viz., Cryptozona bistrialis*(CB), *Mariella dussumeri* (MD)(endemic) and *Achatina fulica* (AF), *Laevicauli salte*(LA) (alien invasives) with *M. indica* (MI) was recorded in the study region. During the present survey it was found that, *M. indica* - *C. bistrialis* combination co-occurred in 22 villages followed by *M. indica* - *L. alte* in 21, *M. indica*- *A.fulica* in 20 and *M. indica*-*M. dussumeri* in16 villages in Bangalore region. Fernando (2010) observed *C. bistrialis* feeding on the flesh of the Caenogastropod *Aulopoma* sp. *A. fulica* is known to outcompete and devore native snails (Stocks *et al.,* 2011).Thus, the present study serves as baseline observation for interspecific coexistence involving endemic and alien malacofauna in the study area. Recent analysis of Indian land and freshwater molluscan literature has confirmed that there



Study sites: BN = Bangalore North, BS = Bangalore South, BE = Bangalore East, AN = Anekal, HK = Hoskote, DV = Devanahalli, DB = Doddaballapur and NM = Nelamangala , BR = Bangalore region.

Figure 2: Occurrence percentage of *Macrochlamys indica* in Bangalore region

are hardly any studies on the ecology and conservation of Indian land snails compared to the wide range of historical literature available on taxonomy (Aravind *et al.,* 2010). It is also true that information of their pest and vector status is also scarce. Land snails such as *M. indica* and others recorded in the region are hosts for the rat-lung worm and other disease causing organisms. Information on what are the health implications, the number of species acting as carriers for the same and the percent human population affected by this parasite is scanty (Jayashankar and Murthy, 2013); Hence, detailed research is needed in this direction as well. However the increasing pest status has triggered control measures in different species of India (Singh *et al.*, 2009; Jayashankar *et al.*, 2010; Shilpa *et al.*, 2014).

The main purpose of the present surveillance study was to generate information about the presence or absence of the endemic snail, *M. indica* in agri-horticultural areas across the study region. Since the snail is reported to have sudden population build up (Pillai and Koshy, 1970), further studies to understand its spread and eco-behaviour needs to be undertaken given the significant crop cultivation in the study area. There is also need to monitor invasive malacofauna in the region and their impact on the ecosystem and human health.

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