



POPULATION DYNAMICS OF FRESHWATER MOLLUSCS IN THE LENTIC ECO – SYSTEMS IN AND AROUND CHENNAI

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Abstract

A population dynamics study of freshwater molluscs in and around Chennai (Tamil Nadu, India) was conducted at ten locations which include Koorvoo pond, Kunrathoor pond, Velachery Lake, Pallikaranai Lake, Chengalpet Lake, Chembarambakkam Lake, Puzhal Lake, Chetpet pond, Paranur Lake and Porur Lake during November 2006 to March 2007. A total of seven species of freshwater molluscs belonging to four families that comprises of Viviparidae, Pilidae, Thiaridae and Planorbidae and six genera (*Bellamya*, *Pila*, *Thiara*, *Sulcospira*, *Paludomus* and *Indoplanorbis*) were found in the lentic eco-systems in and around Chennai and identified at the Zoological Survey of India, Southern Regional Station. Physico-chemical parameters like pH, temperature, dissolved oxygen, salinity, alkalinity and its variation at all the collection sites were analyzed. An analysis was also conducted to study the variation and impact of aquatic (freshwater) plants in the life cycle of gastropods. As the molluscs are intermediary hosts between the parasites and animals, an overview study was also carried out on the known molluscs' various parasites and their diseases.

Keywords: Population dynamics, Gastropod, Molluscs, Eco-system, Taxonomy

Introduction

Phylum mollusca is a large assemblage of animal groups having diverse shapes, size, habits and occupy different habitats (Subba Rao 1993). Based on their habitat preference, molluscs can be classified into aquatic and land communities. Among the different classes of phylum mollusca, class – gastropoda is the largest and most diverse group comprising of some 65, 000 to 75, 000 species including that of marine, freshwater and terrestrial forms (Annandale 1907). Among these, approximately 5, 000 species are freshwater snails that inhabit lakes, ponds and streams worldwide (Abbot 1950).

There are only minimal studies carried out in Chennai and its surrounding areas on biodiversity with reference to freshwater samples, availability of specimens and physico-chemical parameters. Therefore, this present study on biodiversity of gastropods on these particular lentic eco-systems does not have much of previous influence. According to literature from 1902 till date, most of the gastropod-molluscan studies carried out were for a mere purpose of medicinal values than anything else. Apart from this inference, few research analysts have also worked on this aspect with reference to parasites. However, there are no detailed taxonomic and seasonal studies available to survey the species diversity, behavioural

expression etc. that would highlight the importance of preserving gastropod diversity.

Although, molluscs are common components of the benthic community, their role in the dynamics of aquatic eco-system and their contribution to biomass production is not very clear (Supian and Ikhwanuddin 2002). The freshwater habitats are taxonomically impoverished in comparison to the marine habitats. Marine molluscs have received more attention because of their aesthetic and gastronomic appeals (Subba Rao 1993) than the fresh water molluscs. In comparison, freshwater molluscs are drab coloured than the marine molluscs and are known to play significant roles in the public and veterinary health hence, needs to be significantly explored.

Mollusca – a word meaning 'soft' includes a variety of most conspicuous invertebrate animals such as clams, oysters, snails and octopuses. Gastropod is abbreviated as gastros – stomach; poda - foot (Annandale 1920). This present study becomes important since all the molluscan species including snails have wide range of economic importance like food, medicine, money, ornamentation, useful dyes, lime manufacture and miscellaneous uses like manufacture of tooth pastes, tooth powder, manure for gardens as well as coconut farms and fertilizers. Moreover, the major

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work of this present study involves biodiversity and its importance of the present scenario.

Since the study area is urban in nature, it becomes duly necessary to find out the number of species available with their systematic position is more. Along with the classification study, the different parameters such as pH, salinity, alkalinity and dissolved oxygen of each pond and lake were also discussed in detail regarding the availability of parasites in each species. This study becomes a base to find out the different molluscan species, since most of them act as intermediate hosts in causing Schistosomiasis and Amphistomiasis like diseases in animals, especially in man. Therefore, this particular study was important to understand the species diversity and distribution of the gastropod molluscan population in and around Chennai areas and the effect of habitat on their distribution. We hope that the results of this present study will ensure the safety and sustainable surveillance of these molluscs and their medical importance.

Materials and Methods

Study areas

This present study was carried out in and around Chennai, Tamil Nadu, India. Totally 10 places including Kovoor pond, Kunrathoor pond, Velachery Lake, Pallikaranai Lake, Chengalpet Lake, Chembarambakkam Lake, Puzhal Lake, Chetpet pond, Paranur Lake and Porur Lake were taken into account as freshwater bodies which are mostly used for drinking purpose. The study areas were taken into account as south, north and west directions of Chennai except east direction which is surrounded by sea. The selected sampling sites had a minimum distance of three kilometers among them to make a distinguished assessment of population dynamics, availability of aquatic plants and physico-chemical parameters.

The sampling time at each collection site was between 5 am and 8 am, as this particular timing is well known for the collection of any sampling or species for analytical purpose. Early morning hours are preferred for more number of specimen collection, water samples and aquatic plants, since their availability on the surface is abundant. Moreover, the selected sampling sites are different habitats which have either slight or large modification between each other in their location, abundance of species, variation in physico-chemical parameters and aquatic plant species.

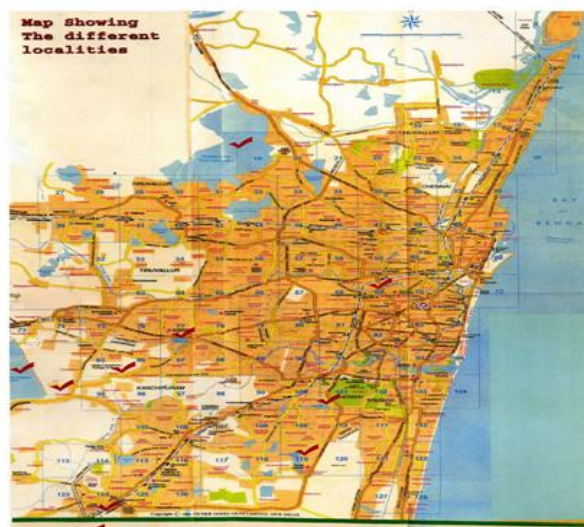
Specimen and sample collection

The collection of specimens, water samples and aquatic plants were done at ten collection sites in four locations as North, West, South and East directions and an extra effort was taken to collect at the centre of the

specific pond or lake. The samples were collected in few places at corners and in few places at a depth of about a meter to analyze the variation and specificity markings between the collection sites in order to study the difference among them. Six sampling trips were made to each venue at particular interval of about two weeks. The catch from each sampling trip was recorded separately for all the collection sites and were maintained at Zoological Survey of India (ZSI), Chennai. All the collected specimens were fixed in 10% formalin and later preserved in 70% ethanol. The identification of molluscan species was carried out at Zoological Survey of India (ZSI), Southern Regional Station, Chennai. The identification of molluscs were based on the published books by Subba Rao (1993): in his hand book on the 'Freshwater gastropods of India' and Annandale (1920): in his book on the 'Geographical distribution of the freshwater gastropod molluscs of the Indian empire' and Meenakshi (1954): in her book on the 'Distribution of gastropods in South India'.

Apart from the specimens, the water samples and aquatic plant species were also collected at each collection site to analyze the physico-chemical parameters such as pH, temperature, salinity and alkalinity. These parameters were analyzed using PC spec II, (Lovibond, Germany). Mostly, the submerged aquatic plants were collected from the surrounding water sample and specimens collected to make a thorough study on the specificity of habitat and life cycle of these species to find out their influence. Since the study areas are aquatic in nature, it is mandatory to study the impact of aquatic plant species available as they are the habitats for all mollusc population. The collected plant species are grouped under different categories according to their nomenclature of classification.

Figure 1: Map showing the different collection localities



Taxonomic keys

Taxonomic keys are the basis for identification, classification of any single or group of plants or animals altogether to put them in a single linear chain if the characteristics are similar to each other. These

are the basis for classification or grouping of any species under different categories based on their individual character, size, shape, morphology, life history etc., that the reference becomes easy.

Table 1: Key to families

S. No	Characters	Family
1	Operculum horny, shell pyramidal, whorls regularly increasing in size, animals with gill only, no labial palps	Viviparidae
2	Operculum calcareous, shell globose and large, body whorl inflated and large than the spire, animal with both gill and lung, long and pili form labial palps	Pilidae
3	Shell mostly turreted or when globose operculum completely closing the aperture, mantle border fringed with a brood pouch	Thiaridae
4	Shell generally discoidal, when extended sinistrally coiled, columellar axis not twisted, animal with pili form tentacles	Planorbidae

Table 2: Key to Genera

S. No	Characters	Genera
1	Adult shell medium sized with or without colour bands and when no bands the shell feebly ridged or keeled, edge of mantle not so thickened and without a conspicuous sphincter, superior margin of gill lamella never thrown into folds, embryonic shell with three primary ridges bearing chaetae and a number of secondary ridges	<i>Bellamyia</i>
2	Shell large or very large, globose, aperture large, expanded, surface of shell smooth, body whorl inflated, umbilicus open, lateral teeth with five cusps, third or central one the largest and innermost reduced, the lungless capacious, small opening	<i>Pila</i>
3	Shell generally spinous or sharply nodulose, whorls angular between suture and the periphery, whorls descending in steps, pagoda-like	<i>Thiara</i>
4	Shell ovoid conical, not slender in thiara or brotia, yellowish-green or brown, spirally grooved, the basal region of whorls lusterless, aperture oval somewhat expanded at base but never with a species siphonal canal, operculum multispiral with a central nucleus, female ovoviviparous	<i>Sulcospira</i>
5	Operculum with a sub median nucleus displaced to the left, growth striae sub spiral than concentric on the inner surface distinctly marked, stair step like growth lines	<i>Paludomus</i>
6	Shell large, whorls rounded at periphery	<i>Indoplanorbis</i>

(Key source - Subba Rao, N.V (1993) – A hand book on freshwater molluscs of India)

An overview on the availability of parasites

The collected specimens were also taken into consideration for the available parasites to find out the fact of intermediary host behaviour of molluscs. The specimens were taken to the Department of Pathology, Madras Veterinary College, Vepery, Chennai to study the available parasites. It was made clear from the parasitological studies that there was nothing found new in the availability of parasites other than the previously reported old findings. Some of the well known parasites found in the collected specimens are *Echinostoma cercaria*, *Enteroxenos*, *Schistosoma indicum*, *Schistosoma nasalis*, *Schistosoma spindalis*, *Echinostoma species*, Mollusc polycheates and

Echinoderms stylifer (Mukherjee 1970; Muraleedharan et al. 1977).

Results

Taxonomic status

Seven species of freshwater gastropods were identified belonging to four families (Viviparidae, Pilidae, Thiaridae and Planorbidae) and six genera (*Bellamyia*, *Pila*, *Thiara*, *Sulcospira*, *Paludomus* and *Indoplanorbis*). The available species of this particular study were found in abundance and dominated all the 10 lentic collection sites. All the found species are basically native to a large part of Asia, Africa, throughout India and Malaysia. The identification keys of Subba Rao (1993) from his hand book on freshwater molluscs of India is the basis

for classification or grouping of the found species under different categories based on their individual character, size, shape, morphology, life history etc.

Species population

A total of 125 specimens belonging to seven species were collected from all the 10 sampling sites. The encountered seven species from the field collections are *Pila globosa*, *Bellamyia bengalensis*, *Indoplanorbis exustus*, *Thiara punctata*, *Sulcospira huegily*, *Paludomus acuta* and *Paludomus tanschauricus*. From the survey, around 80% of the species were caught from Chembarambakkam, Puzhal (Red Hills) and Chengalpet Lakes. These Lakes had a wide range of species mostly belonging to *Pila globosa* and *Sulcospira huegily* alone. Porur Lake recorded the next highest number of specimens while Pallikaranai and Chetpet Lakes had the lowest number of specimens among the 10 collection sites. The other collection sites were found with moderate number of specimens belonging to one or two species varieties.

Ecology and habitat

From each collection site different specimen sizes were obtained while the highest number of collection was from the shallow part of the Lakes and ponds where the vegetation was more. The majority of collection sites were found mostly with *Pila* and that dominated more than the other found molluscan species. Each of the study area has its own specificity of species and different parameters like pH, salinity, alkalinity, dissolved oxygen, specificity of parasites and availability of aquatic plant species. All the collection sites are normal grounds with slight modifications as depth, shallow and medium depth. Among the 10 collection sites, few are not deep enough (Kovoor pond, Kunrathoor pond, Paranur Lake and Pallikaranai Lake) while the other places are deep enough (Chengalpet, Chembarambakkam, Puzhal and Porur Lakes) to contain water throughout the year. Most of the ponds and lakes are clear even after rain except two oldest ponds (Kovoor and Chetpet) which have more aquatic plants than water. All the collection sites contain aquatic plants namely *Eichornia* sp (water hyacinth), *Azolla* sp (mosquito fern), *Potamogeton* sp (pond weeds), *Typha* sp (cattails) and algae of genera – *Cyanophyceae*, *Anabaena* & *Gymnodinium* respectively without any differentiation. At few places (Chengalpet, Chembarambakkam, and Puzhal Lakes), *Potamogeton* sp (pond weeds) and *Typha* sp (cattails) were not found to occur but at all the other places it was found equally with the above mentioned plant species.

The availability of aquatic plant species in each lake and pond was found more at corners than at the depth. The molluscs belonging to family Thiaridae,

Planorbidae, Pilidae, Milanatrinae and Paludominae were found extensively in all the collection sites. Most of the collection sites recorded the species of *Pila globosa*, *Thiara punctata* and *Sulcospira huegily*. Among the seven species found (*Pila globosa*, *Thiara punctata*, *Bellamyia bengalensis*, *Paludomus tanschauricus*, *Indoplanorbis exustus*, *Paludomus acuta* and *Sulcospira huegily*), except *Bellamyia bengalensis*, all the other species were found to occur at Chembarambakkam Lake. The reason is due to the ecological conditions found at this particular site, since this lake is the biggest and largest in and around Chennai. It receives a large amount of water through rain, canals and streams from the surrounding areas and so the possibility of molluscan and aquatic plant species were more than the other study areas. The lowest number of molluscan species was recorded at Pallikaranai Lake which is a marsh land having only one species (*Pila globosa*) variety. The reason is due to lack of maintenance, dumping of solid wastes and less availability of aquatic plant species in this particular site.

An overview of the physico-chemical parameters

Table -3 clearly indicates the various physico-chemical parameters observed at the collection sites. The water samples were collected at each site at every collection in a two liter container to study the different parameters at *in vitro* conditions with PC spec II, (Lovibond, Germany). Only the fresh water samples were used for the analysis of physico-chemical parameters analysis. This study was carried out within 2-4 hrs of sampling to get the original value without much variation. From the above table, it is observed that the pH of all the sampling sites remain constant as 7-8 without any change. It is due to the fact that the sampling sites are linked in one way or the other, since all are in the surroundings of Chennai where the climate and other environmental factors are same without much difference. The temperature is also the same for all the sampling sites with slight variation ranging from 26°C to 28°C with a variation of 2°C. The reason for a low temperature is due to the collection timings i.e between 5 am and 8 am early morning.

Chetpet pond and Pallikaranai Lake were found to have high amount of dissolved oxygen content (DO) of 4.234 mg/O₂/l and 4.163 mg/O₂/l respectively. The range of DO varied from 1.734 mg/O₂/l as minimum to 4.234 mg/O₂/l as maximum. Puzhal Lake had the minimum DO value due to the fact of high content of aquatic plants present over there. Both the values of alkalinity and salinity were moderate at all the collection sites ranging from 0.01% to 0.03% without much differentiation. This is because, the collection sites are fresh water in nature and therefore they are prone to have low content of alkalinity and salinity.

Table 3: The evaluated parameters of collection localities

Collection localities	Physico-Chemical parameters				
	pH	Temperature (°C)	Dissolved Oxygen (mg/O ₂ /l)	Salinity (%)	Alkalinity (%)
Porur lake	7-8	26	2.368	0.02	0.01
Chembarambakkam Lake	7-8	26	2.725	0.01	0.03
Kovoor pond	7-8	28	3.247	0.01	0.02
Puzhal Lake	7-8	27	1.734	0.01	0.02
Pallikaranai Lake	7-8	28	4.163	0.01	0.02
Velachery Lake	7-8	26	3.157	0.01	0.02
Chetpet pond	7-8	26	4.234	0.02	0.03
Kunrathoor pond	7-8	26	2.256	0.02	0.03
Chengalpet lake	7-8	27	3.178	0.03	0.01
Paranur lake	7-8	28	2.046	0.02	0.03

Molluscs as intermediate hosts

Most of the gastropods collected are intermediary hosts between parasites and animals including human beings. The species' from the family Pyramidallidae (eg. *Brachystomia*) and Tulinidae (Das Gupta 1973) are ectoparasites that suck blood from bivalves (Bentham and Jutting 1956). 'Polychaetes' and '*Echinoderms stylifer*' are endoparasites in the wall of echinoderms whereas, *Ectoconcha* (Patnaik 1968) is an endoparasite of sea cucumber feeding on the blood of the host after being transferred from molluscs. Digestive tract is absent in enteroxenos and it absorbs food through its body wall (Anjaneyalu 1967).

Snails are of considerable importance from a medicinal stand point as many of them serve as intermediate hosts for parasitic flat worms such as *Fasciola*, human blood fluke and *Schistosoma* (Gadgil and Shah 1955). As the molluscs are found mostly in the shallow and stagnant water bodies, the transmission of parasites from primary hosts to secondary hosts becomes easy. Major part of the life cycle of parasites starting from egg till larval stage is completed in mollusc itself and therefore the transfer of parasites to the secondary hosts occurs comfortably as animals including man have constant touch with the shallow water bodies. Among the seven species found, *Indoplanorbis exustus* has large number of parasites with two types of parasitic forms namely Amphistomes / Amphistoma and Schistosomes / *Schistosoma*. Schistosomes naturally found to cause diseases in animals like blood fluke formation, granuloma formation

as well as cancerous growth in intestine and nasal cavity due to which performance reduction occurs where as, Amphistomes are found to cause diarrhea, weight loss, death in young ones and fleece loss in sheep (Biswas and Subramanian 1978).

Discussion

During the present study, a total of seven species of freshwater gastropods belonging to six genera and four families were recorded. All the reported species were found in the freshwaters in and around Chennai. Among the 10 different freshwater collection sites comprising of Paranur Lake, Chembarambakkam Lake, Kovoor pond, Puzhal Lake, Pallikaranai Lake, Velachery Lake, Chetpet pond, Kunrathoor pond, Chengalpet Lake and Porur Lake, more number of species were collected from Chembarambakkam Lake. Among all the collection sites, at Puzhal Lake (Red Hills) and Pallikaranai marshland, the pH ranged between 7-8 while dissolved oxygen values ranged from the lowest of 1.73 mg/O₂/l to a highest of 4.234 mg/O₂/l. Since the study areas are of fresh water in nature, the alkalinity and salinity levels were minimal, while the macrophytes were found moderate in all the water bodies. Among the study areas, Chembarambakkam and Puzhal lakes were found to have more number of macrophytes.

All the collected specimens were identified as seven species namely *Pila globosa*, *Bellamya bengalensis*, *Indoplanorbis exustus*, *Thiara punctata*, *Sulcospira huegily*, *Paludomus acuta* and *Paludomus tanschauricus* belonging to four families Viviparidae,

Pilidae, Thiaridae and Planorbidae and six genera including *Bellamya*, *Pila*, *Thiara*, *Sulcospira*, *Paludomus* and *Indoplanorbis* based on the identification and classification of molluscs by Subba Rao (1973). The collected specimens were identified at the Zoological Survey of India, Southern Regional Station, Chennai. All the freshwater collection sites are normal grounds with slight modifications as few lakes and ponds like Chembarambakkam, Puzhal, Chengalpet and Porur Lakes are deep enough and the ponds consisting of Kovoov, Kunrathoor, Pallikaranai and Paranur have superficial depth of water bodies. Most of the collection sites contain water throughout the year and are clear even after rain. The molluscan families of Thiaridae, Planorbidae, Pilidae, Milanatrinae and Paludominae were found at all the collection sites, while among the seven species, only *Pila globosa*, *Thiara punctata* and *Sulcospira huegily* were found extensively than the other species.

Among the seven species encountered, except *Bellamya bengalensis* all the other species were found to occur at Chembarambakkam Lake which may be due to the ecological factors and conditions found at this site. Among the collection sites, Chembarambakkam Lake is the largest, situated south-west of Chennai, Tamil Nadu and is the main water resource to the whole Chennai city getting water from surrounding areas as well as ponds including that of Andhra Pradesh. It is having a depth of about 110 feet and therefore, it is viable to contain more number of molluscan and aquatic plant species.

Apart from the above studies, molluscs are also found as intermediate hosts to most of the parasites which cause few deteriorating effects to animals like goat, sheep and pig and at times even to human beings. Molluscs serve as intermediate host for parasitic flat worms such as *Fasciola*, human blood fluke and schistosoma. Among the available 7 species from the 10 collection sites, *Indoplanorbis exustus* was found to have two types of parasitic forms namely Schistosomes and Amphistomes (Subba Rao and Mitra 1989). Thomas Sathyamoorthy (1977) first identified the gastropods around Chennai and his collections are available at Connemara museum. This forms the key basis of this present study. Seshaiya (1929), Meenakshi (1956), and Ramamoorthy (1958) have done a remarkable collection of molluscs pertaining to the studies on the biological aspects of gastropod molluscan biodiversity. The basic inputs of Subba Rao (1975) gives details on the perspectives of gastropods and most of the present molluscan biodiversity work are referred from his hand book alone.

The above mentioned physico-chemical parameters (Table - 3) do play a vital role in the population dynamics of molluscan species. It is made

clear from the results that Puzhal Lake is one of the collection sites that had more number of species with low DO content. It can be inferred from the above points that DO content plays a vital role in affecting the population dynamics of a particular species than the other physico-chemical factors like pH, temperature, alkalinity and salinity. Moreover the molluscan population is abundant in a place where the aquatic plants are available in diverse forms. Since there is not much variation in pH, temperature, alkalinity and salinity in the collection sites, they do not have much influence in the availability of specimens in this present study. Through this analysis, it is inferred that the possibility of variation in pH, temperature, alkalinity and salinity can play a vital role in the life cycle of any plant or animal group and when it is moderate or in low, it can not have much influence on the population dynamics.

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