DISTRIBUTION, ECOLOGY AND BIOLOGY OF FRESH WATER PRAWNS (*Macrobrachium* spp.) OF NORTH EASTERN REGION

ABSTRACT

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The freshwater prawns belonging to the genus Macrobrachium (Family : Palaemonidae; Sub-family : Palaemoninae) form an important group of edible decapod crustaceans. They are found in a wide variety of habitats in freshwater ecosystems. A notable decline in freshwater prawn populations from their natural environments calls for adequate attention for their culture and mass rearing of their larvae. The practices of paddy-cum-prawn culture or fish-cum-prawn culture offer a bright future prospective to improve socio-economic conditions for the people in rural areas. The former aspect can be more suitable to the low-land areas of hill-states of North-Eastern India wherein paddy-fields comprise an integral part of landscape and rural economy.

As a pre-requisite to any scientific measures for conservations of natural stocks and culture of these organisms, it is essential to acquire knowledge about distribution of different species together with investigation on various aspects of ecology and biology. In view of paucity of such information relating freshwater prawns from North-Eastern region, the present study was undertaken. This dissertation, therefore, deals with composition and distribution of Macrobrachium spp. in this region and observations on some aspects of ecology and biology of two commonly available prawns of Meghalaya state i.e., the hill-stream M. hendersoni hendersoni and a stream-dwelling population of M. lamarrei. The results obtained are presented in three chapters and are briefly summarised below :

Chapter I dealt with thirteen species and four sub-species examined in the collection from various parts of North-Eastern region. The documented taxa are suitably illustrated and their diagnostic features are mentioned in the systematic account. A majority of the reported taxa were known to exhibit exclusively inland aquatic ecosystems while some coastal elements (Vide Tiwari, 1955) were comprised by M. malcolmsonii, M. birmanicum choprae and M. rosenbergii. A notable feature of this study was the occurrence of two endemic taxa i.e., M. manipurensis and M. lamarrei lamarroides. The former species was apparently confined to Logtak lake in Manipur state; this rare and interesting element was distinguishable from its other Indo-Burmese relatives by the characteristic shape, proportions and colourations of its second pair of paraeiopods. M. lamarrei lamarroides, yet another biogeographically prawn occurred in Logtak lake (Manipur) and the tributaries of the streams draining into this lake. This sub-species differed from the nominate M. lamarrei lamarroides in the shape, length and dentition of the rostrum.

M. cavernicola and M. kempi were obtained from Siju cave in Garo Hills district of Meghalaya state. Of these, the former was the only species known from India which exhibited various cavernicolous adaptations. The occurrence of M. kempi in this cave was only accidental as it was originally described from a stream and its distributional range extended from Bangladesh to Mayurbhanj hills in Orissa state.

M. naso represented a new record from North-Eastern region even though it was reported earlier from Burma and recently from Gorakhpur (Uttar Pradesh). The present record might provide a biogeographical

link to account for its subsequent distribution in the Gangetic peninsula. The specimens of M. altifrons coincided with the Indo-Nepalese form which was found in the Ganga-Brahmaputra drainage systems. Its present occurrence in a beel in Assam state was of ecological interest as it was earlier collected from stream with clearwater. M. kistnensis, a Malayan element, was collected from Juri river in Tripura state and was of regional distributional importance as it was not earlier known from North-Eastern India.

Amongst the taxa included under hendersoni group, six species and sub-species were included in this study i.e., M. cavernicola, M. hendersoni hendersoni, M. hendersoni platyrostris, M. hendersoni cacharensis, M. assamensis and M. dayanum. These were apparently restricted to Indo-Burmese region; all these prawns except M. dayanum were generally found in hilly regions or in the areas adjacent to their bases. On the otherhand, M. dayanum was reported to be extensively distributed in plains as well as at lower altitudes in hills throughout a large part of India and Pakistan.

M. hendersoni hendersoni occurred at altitudes between 1,500-5,000 feet in Eastern Himalayas, Burma, China and Pachmari in the Mahadeo hills of the Satpura range. M. hendersoni platyrostris exhibited distinct parallel to the altitudes not above 1,500 feet. The present observations confirmed the altitudinal limitations for the distribution of these two sub-species. M. hendersoni cacharensis was so far reported only from Cachar valley of Assam state and its range was now extended to Meghalaya state. This sub-species was presently regarded to be a

geographical counterpart of M. siwalikensis which was found at the foots of the Siwalik Hills in the Western Himalayas. M. assamensis assamensis was noticed to occur in the Brahmaputra valley in North-Eastern region.

M. birmanicum included two sub-species - M. birmanicum birmanicum and M. birmanicum choprae. The former was common in the Brahmaputra valley of Assam while the latter was collected from only one locality of this state. M. malcolmsonii, an Indo-Burmese elements comprised a new record from the N.E. region and was of regional distributional importance. M. rosenbergii, the largest freshwater species of this genus, was reported only from a riverine system (Fenny river) in Southern Tripura.

This aspect of the present study provided useful and important information about the occurrence and distribution of these seventeen taxa (thirteen species). The collections from this region appeared to fairly well diversified when compared with overall Macrobrachium species known from this country. It is believed that further samples from hitherto unexplored areas of this region might add some more rare and interesting taxa or extend the already mentioned distributional ranges.

Chapter 2 included observations on some aspects of water quality, seasonal variations, abundance of biotic communities i.e., benthic organisms, phytoplankton and zooplanktons and seasonal fluctuations in the density, sex-ratios, condition factor, fecundity and length frequency distribution of Macrobrachium hendersoni hendersoni and M. lamarrei. The data for the monthly fluctuations in various physical and chemical parameters of water quality were collected for two annual

cycles i.e., period from Janaury, 1983-December, 1984. In Umshing area various climatic factors viz., rainfall, relative humidity, sun-shine, maximum and minimum air temperature fluctuated in the range of 0.0-3.2 cm; 48.0-96.0% (at 8.30 hrs.) and 63.0%-93.0% (at 17.30 hrs), 0.0-11.4 hrs, 3.0$_c$-24°C and 4.0$_c$-17.0°C while in Min-Mintudu (stream) area, they varied in the range of 0.0-3.8 cm; 54.0-94.0% (at 8.30 hrs.) and 64.0%-92.0% (at 17.30 hrs.), 0.0-8.6 hrs, 13.2°C-25.0$_c$ and 4.0-18.0$_c$ respectively.

In Umshing stream, the habitat of M. hendersoni hendersoni the various physico-chemical variables, viz., water temperature, pH, conductivity, dissolved oxygen, free carbon-dioxide, total alkalinity, Calcium, Magnesium, Sodium, Potassium, Phosphate-phosphorus, Ammonia-nitrogen, Silicate and oxidisable organic matters fluctuated in the range of 9.5-18.5°C, 5.3-7.5, 12.0-62.0 umho/cm, 6.2-12.3 mg/l, 1.9-4.7 mg/l, 13.0-48.0 mg/l, 0.5-4.3 mg/l, 0.6-3.5 mg/l, 1.6-4.0 mg/l, 2.4-4.5 mg/l, 0.36-1.30 ug/l, 0.044-0.087 mg/l, 3.81-6.81 mg/l and 1.1-5.0 mg/l while in Min-Mintudu stream these variables fluctuated in the range of 15.8-25.8°C, 5.4-7.7, 34.0-72.0 umho/cm, 6.4-11.8 mg/l, 2.5-5.2 mg/l, 8.0-49.0 mg/l, 1.1-4.4 mg/l, 1.3-4.4 mg/l, 2.0-3.8 mg/l, 1.7-5.0 mg/l, 0.31-1.4 ug/l, 0.041-0.090 mg/l, 2.2-4.41 mg/l and 3.0-8.8 mg/l respectively. The observed temperature variations evidently resulted from altitudinal differences of these two lotic systems. This study indicated the lower temperature range for the occurrence of M. hendersoni hendersoni and M. lamarrei. The pattern of variations in the water temperature was broadly identical in the two streams. Hydrogen-ion concentration showed no definite trend of fluctuations in the various

stations. The pattern of fluctuation of dissolved oxygen concentration was more distinct in Min-Mintudu stream in comparison to Umshing stream. Moreover, free carbon-dioxide concentration showed no definite trend at the different sampling stations of these streams. The mode of fluctuations of total alkalinity was relatively more irregular in Umshing stream than Min-Mintudu stream. Calcium and Magnesium concentration was higher in Umshing stream in comparison to the Min-Mintudu stream. Variation of Sodium content in both the stations of Umshing stream was broadly identical. However, in Min-Mintudu stream it indicated different pattern at both the stations. Min-Mintudu stream accounted higher variations in Potassium values than the Umshing stream and followed identical patterns except for some minor differences. The monthly variations in Ammonia-nitrogen concentrations showed multiple maxima and minima at the different sampling sites. The differences in Silica concentrations in both the streams could be attributed to the lithological differences. High values of oxidisable organic matter during winter and spring was presumably due to reduced precipitation and water-logged conditions.

Umshing stream exhibited varied benthic fauna than Min-Mintudu stream. Insect larvae, Nematoda, Decapoda, Oligochaeta, Gastropoda and miscellaneous group comprised the main benthic components and fluctuated in the range of 30.0-50%, 17.0-26.9%, 6.1-19.8%, 3.7-19.4%, 3.8%-15.1% and 1.2-11.7 respectively in Umshing stream while in Min-Mintudu stream these groups fluctuated in the range of 26.1-52.9%, 12-53.0%, 4.0-22.0%, 5.0-21.0%, 3.0-14.0%, 2.0-11.0% respectively. The pattern of monthly variations in quantitative abundance of total

benthos did not confirm to any definite trend at various sampling stations. This community registered 87% overall similarity between Umshing and Min-Mintudu stream.

Based on the composition of different taxa, the total phytoplankton belonged to six different categories, i.e., Bacillariophyceae, Chlorophyceae, Chrysophyceae, Dinophyceae, Myxophyceae and Rhodophyceae. In Umshing stream, the seasonal fluctuations of the stated groups ranged between 16-47.0%, 15.0-31.0%, 11.0-29.0%, 9.1-19.1%, 11.0-18.0%, 3.0-16.0% respectively while in Min-Mintudu stream these fluctuated in the range of 15.0-3.0%, 11.0-24.0%, 9-22.3%, 7.0-23.0%, 11.0-19.0% and 3.0-22.0% respectively. Phytoplankton community of Umshing and Min-Mintudu streams reflected 72.0% similarities. Total phytoplanktons exhibited marked variations in their monthly abundance at different stations. In Umshing and Min-Mintudu stream it varied 100 ind./l - 255 ind./l respectively.

Zooplanktons exhibited a marked variations in their monthly abundance at both the streams and their abundance ranged between 61 ind./l - 203 ind./l in Umshing stream while in Min-Mintudu stream it ranged between 49 ind./l - 140 ind./l. Min-Mintudu stream supported a comparatively quite large number of zooplanktons throughout the study period and exhibited seasonal fluctuations. Categorically, the percentage composition of different groups of zooplankton viz., Protozoa, Rotifera, Copepoda and Cladocera varied in the range of 30.0-39.0%, 13.0-30.0%, 10.0-21.0%, 14.0-27.5% in Umshing stream while in Min-Mintudu stream it fluctuated in the range of 28.1-48.0%, 10.0-33.0%, 13.7-24.0%

and 8.0-36.0%. The values for percentage similarities between the qualitative occurrence of zooplanktons at different sampling stations ranged between Umshing and Min-Mintudu streams was noticed to be 70%.

The total prawn population exhibited significant positive correlation with pH, dissolved oxygen, free carbon-dioxide, total alkalinity, and Calcium while monthly abundance of M. hendersoni hendersoni exhibited positive correlations with water temperature, specific conductivity, dissolved oxygen, free carbon-dioxide, calcium, phosphate-phosphorus, silicate and oxidisable organic matter in Umshing stream. On the other hand, in Min-Mintudu stream total prawns exhibited significant positive correlations with water temperature only while quantitative variations registered significant direct relationships M. lamarrei with water temperature, phosphate-phosphorus and oxidisable organic matter. Amongst biotic factors total benthos, total phytoplankton and total zooplankton exhibited positive correlations and individual groups i.e., Bacillariophyceae, Chlorophyceae, Chrysophyceae, Dinophyceae, Protozoa, Rotifera, Copepoda exhibited positive correlations with M. hendersoni hendersoni in Umshing stream while total prawn exhibited positive correlations with Bacillariophyceae, Chlorophyceae, Chrysophyceae, Dinophyceae, Protozoa, Rotifera and Cladocera in Umshing stream. In addition, total prawns exhibited positive correlations with total phytoplankton, chlorophyceae, Protozoa, Rotifera and Cladocera and M. lamarrei exhibited positive correlations with insecta, oligochaeta, total benthos, bacillariophyceae, chlorophyceae, dinophyceae, mycophyceae, Protozoa and rotifera in Min-Mintudu stream.

The monthly densities of total prawns in Umshing stream ranged between 36-71 ind./m^2 and 48-74 ind./m^2 at stations A and A_1. Quantitative abundance of total prawn populations at stations B and B_1 in Min-Mintudu stream ranged between 37-77 ind./m^2 and 38-76 ind./m^2. In comparison to M. lamarrei, M. hendersoni hendersoni exhibited higher population density throughout the course of the study.

The quantitative abundance of M. hendersoni hendersoni ranged between 22 ind./m^2 - 57 ind./m^2 and 21 ind./m^2 - 51 ind./m^2 at two sampling stations (A and A_1) in Umshing stream while the population density of M. lamarrei ranged between 16 ind./m^2 (December, 1983) - 44 ind./m^2 (October, 1983) at station B and between 16 ind./m^2 (December, 1983) - 58 ind./m^2 (September, 1983) at station B_1. In Umshing stream the males of M. hendersoni hendersoni in the first annual cycle ranged between 12 ind./m^2 (December, 1983) - 47 ind./m^2 (August, 1983) and 16 ind./m^2 (February, 1983) - 40 ind./m^2 (September, 1983) at stations A and A_1 respectively. In 1984, the male prawn population exhibited bimodal periodicity and indicated maxima in July (35 ind./m^2) and female population ranged between 2 ind./m^2 (April, 1983) - 17 ind./m^2 (July, 1984) and 4 ind./m^2 (April, 1983) - 18 ind./m^2 (September, 1984) in stations A and A_1 respectively. On the other hand, in Min-Mintudu stream, the male population of M. lamarrei ranged between 10 ind./m^2 (December, 1983) - 42 ind./m^2 (July, 1984) and 10 ind./m^2 (December, 1983) - 45 ind./m^2 (August, 1984) and female group ranged between 3 ind./m^2 (April, 1983) - 17 ind./m^2 (December, 1983) and 4 ind./m^2 (June, 1983) - 18 ind./m^2 at station B and B_1 respectively. The ovigerous females of M. hendersoni hendersoni occurred from April-September in both the two annual cycles

and their quantitative abundance ranged between 1-12 ind./m^2 and 2-11 ind./m^2 at stations A and A_1 respectively. Abundance of ovigerous females of M. lamarrei ranged between 3 ind./m^2 (August, 1984) - 10 ind./m^2 (July, 1984) in Min-Mintudu streams. The average fecundity in M. hendersoni hendersoni ranged between 22 ± 4 eggs./ind - 46 ± 4 egg./ind and 20 ± 5 eggs/ind - 46 ± 6 eggs/ind. at station A and A_1 respectively while production of eggs ranged between 9 ± 13 eggs./ind - 26 ± 4 eggs/ind and 10 ± 1 egg/ind - 29 ± 3 eggs/ind at station B and B_1 in Min-Mintudu stream respectively. The increased fecundity during summer could be related to higher water temperature. The extent of structural and functional dynamicity of the studied palaemonid prawn populations was reflected from length frequency distribution study and was noted to be closely associated with their breeding and growth phases. In all the sampling sites of these studied streams, males predominated the females. On the basis of length measurements, M. hendersoni hendersoni and M. lamarrei specimens were grouped into six size-classes viz., 20-0 - 30.0 mm; 30.0-40.0 mm; 40.0-50.0 mm; 50.0-60.0 mm; 60.0-70.0 mm and 70.0-80.0 mm. Females of size groups 30.0-40 mm represented the juvinile group; 40.0-60.0 actively breeding group. Ovigerous females of M. hendersoni hendersoni and M. lamarrei were recorded between April-September and May-October in both the annual cycles. Further, analysis month-wise variation in condition factor ('k') for two categories of prawn populations was based on two size groups (20.0-50.0 mm; 50.1-80.0 mm). The 'k' factor exhibited higher values in case of young populations than the mature individuals. The 'k' values were recorded higher in males than females in both the presently studied palaemonid prawns.

Chapter 3 included the observations on the general food and feeding habits, seasonal variations in different food items and fluctuations in the gastro-somatic indices and larval development of M. hendersoni hendersoni and M. lamarrei. Both these prawns were noticed to be omnivorous in terms of their food habits and their gut contents included a variety of benthic and periphytic elements. The dominant food-items of M. hendersoni hendersoni (in terms of average yearly composition) were found to be diatoms (17.59%), the other groups as mentioned in the decreasing order included : insect larvae (16.27%), detritus (12.57%), sand and silt particles (11.72%), filamentous algae (9.64%), other algae (9.47%), nematodes (9.39%), crustaceans (6.97%), mosses and plant matter (5.57%) and miscellaneous group (0.64%). An average yearly percentage composition of different food items in M. lamarrei was observed and it included insect larvae (14.25%), sand and silt (11.48%), filamentous algae (11.28%), detritus (10.28%), other algae (9.19%), nematodes (8.5%), crustacea (8.39%), mosses and plant matter (6.74%) and a miscellaneous group (0.62%). The miscellaneous group material might be regarded as accidental food owing to the fact this formed a small fraction of the gut contents and occurred without any regularity in the different months of the year. The foregut contents analysis of both M. hendersoni hendersoni and M. lamarrei showed that all the food items available in the matter were also represented in the gut. The present observations indicated a degree of opportunitism and versatility in terms of food preferences of the stated two species. The monthly variations in the food-items in the stated species coincided with their occurrences under natural conditions. Further, it was observed

that in M. hendersoni hendersoni and M. lamarrei the food size group II populations (50.1 mm - 80.0 mm) was predominated by detritus, diatoms, insects, sand and silt. This reflected their semi-benthic habit.

The observations in monthly variations in the percentage composition of the different food-items of M. hendersoni hendersoni in size group I reflected that diatoms, insect larvae, detritus, sand and silt particles, filamentous algae, other algae, nematodes, crustaceans, mosses and plant matter and miscellaneous group fluctuated between 14.6 (May) - 21.2 (November), 14.7 (February) - 25.0 (July), 6.8 (February) - 10.6 (July) and 5.4 (February) - 9.3 (October), 8.8 (July) - 13.7 (November), 3.8 (January) - 10.3 (May), 2.7 (February) - 7.8 (September) and 0.2 (Janaury) - 1.0 (August). In size group II these components ranged between 12.6 (May) - 15.8 (November), 13.2 (May)- 22.5 (December), 6.2 (February) - 25.8 (September), 5.6 (May) - 15.7 (December), 8.7 (March) - 13.4 (November), 6.8 (February) - 13.9 (October), 6.4 (April) - 10.7 (October), 6.9 (May) - 10.0 (October), 4.5 (February) - 8.6 (September) and 0.3 (January) - 1.2 (April) respectively. In M. lamarrei (size group I), the monthly variations of insect larvae, diatoms, sand and silt particles, filamentous algae, detritus, other algae, nematodes, crustaceans, mosses and plant matter and miscellaneous group were found to be slightly lower than the size group I of M. hendersoni hendersoni and in size group II and the same ranged between 12.0 (August) - 24.5 (December), 10.5 (March) - 17.7 (July), 9.0 (January) - 15.0 (May), 9.6 (February) - 15.0 (July), 3.4 (April), 15.8 (December), 6.6 (February) - 12.8 (November), 9.0 (Janaury) - 14.0 (April), 2.8 (February) - 24.0 (October), 1.5 (February) - 10.6 (July)

and 0.5 (March) - 1.4 (August) in the year 1983 respectively. The observed wide range of components in the food spectrum of these two species did not reflect any specific feeding activity even though some groups seemed to be dominant at times. The variations, however, might be attributed to the routine variations in the occurrence of the different components under natural conditions.

The gastro-somatic index in M. hendersoni hendersoni (size group I : 20.0-50.0 mm) was recorded to be maximum in October, 1983 (1.983), whereas in size group II (50.1-80.0 mm) maximum value of 3.154 was noticed in August, 1984 and minimum (2.032) in February, 1983. In M. lamarrei gastro-somatic index maximum values (3.409) was recorded in March, 1984 in size group I (20.0-50.0 mm) and minimum (2.0535) in December, 1984. The size group II (50.1-80.0 mm) exhibited maximum GSI value (3.509) in August, 1984 and minimum (2.0692) in December, 1983. The increased intensity of feeding in both these prawn populations might be due to recuperative process where the prawn became voracious eaters. The drop in feeding intensity in both the individuals were recorded mostly during winter. This could be attributed to the prevailing low temperatures of the habitat during these months and that lead to reduce general activity of the prawns.

The larval development in M. hendersoni hendersoni and M. lamarrei as observed in the present study was noticed to be abbreviated and was assigned to second category of Sollaud's scheme. M. hendersoni hendersoni showed two larval stages before hatching into post-larva while three larval stages were noticed in stream-dweling population

of M. lamarrei. The first larval stage of M. hendersoni hendersoni was characterised by serrated rostrum, short antennal flagellum and settation of antennal scale mostly confined to its distal margin. The distinct appendix interna bearing 2-3 minute hooks on all pleopods except the first and epigastral hump was noticed on carapace and uropod biramous, telson with a terminal tooth with a movable accessory spine on its inner side on outer ramus of the second larval stage of M. hendersoni hendersoni. The newly hatched out larvae of M. hendersoni hendersoni were noticed to be attached to the body of mother for sometimes while the newly emerged larvae of M. lamarrei attached themselves to the walls of the container before becoming free swimming. The first larval stage of M. lamarrei was characterised by sharply pointed antero-lateral spines on antennule, and inner boarder of antenna carrying 10-11 plumose setae, each pleopod with a distinct basal segment. Fifth pair of peraeiopods uniramous, third to fifth pleopods with endopods reaching more than 2/3rd of the exopods. The suppression of exopod in this larvae were noticed to be extended to the fifth pair of peraeiopods. The second larval stage characterised by prominent supraorbital and branchiostegal spines, endopod long and multijointed and third larval stage was characterised by a strong stylocerite, outer flagellum of antennule divided into two distally. The number of larval stages in M. lamarrei agreed with the land locked and riverine population examined earlier from peninsular India. The occurrence of two larval stages in M. hendersoni hendersoni is strickingly contrast to the earlier unpublished report of only one larval stage. The first larval stage corresponded to the second stages of M. hendersodayanum in which this stage evidently appeared

to be suppressed. Embryonic development lasted for 10-14 days in M. lamarrei. Before emergence, the larvae showed distinct heart-beat and wriggling movements lasted for 7-11 days in M. hendersoni hendersoni.