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Distribution and zonation of shore crabs in the Pulicat lake

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Abstract. Twentynine species of crabs encountered along the shores of the Pulicat lake have been surveyed with special reference to their vertical distribution, zonation of discrete patches, seasonal variation in population densities and the extent of their penetration into the lake. Specific association between vertical range and moisture content of the soil, zonation of discrete patches and composition of the substratum and reduction in number or total disappearance of crabs and lowering of salinity caused by monsoonal floods were discussed.

Keywords. Pulicat; shore; crabs; distribution.

1. Introduction

Alcock (1896–1900) contributed comprehensive information on the taxonomy and geographical distribution of most of the Indian crabs. Further understanding of the distribution pattern of the shore crabs was mainly due to the works in the brackish ponds and on the bank of the Malta river of Port Canning (de Man 1908–09; Pearse 1932), in the littoral region of Krusadai Island (Gravely 1927), in the brackish waters around Madras (Panikkar and Aiyar 1937), on the Karwar coast and the neighbouring islands (Patil 1951), in the Mandapam area (Sankarankutty 1965), at the Vellar estuary (Balasubramanyan 1966) and on the shore of Bombay (Balani 1975).

A perusal of the literature reveals that investigations on ecological distribution of crabs have been confined either to the open shores, bays or to the river-mouth estuaries in India. Thus very little attention seems to have been paid to the major brackish water lakes. Therefore the present study was undertaken with a view to determining the factors behind the vertical distribution, zonation of discrete patches, seasonal fluctuations in population densities and penetration of shore crabs in the Pulicat lake on the east coast of India.

2. Materials and methods

The observations and results of monthly surveys were made for the year 1972 and further confirmative but irregular observations continued till 1978, on the shore crabs at 4 stations fixed along the length of the Pulicat lake from south to north (figure 1). The comparative and semiquantitative method of Endean *et al* (1956) was followed to estimate the relative abundance of crabs encountered along the traverse made at each station. The key to denote the abundance for a 50 metre radius

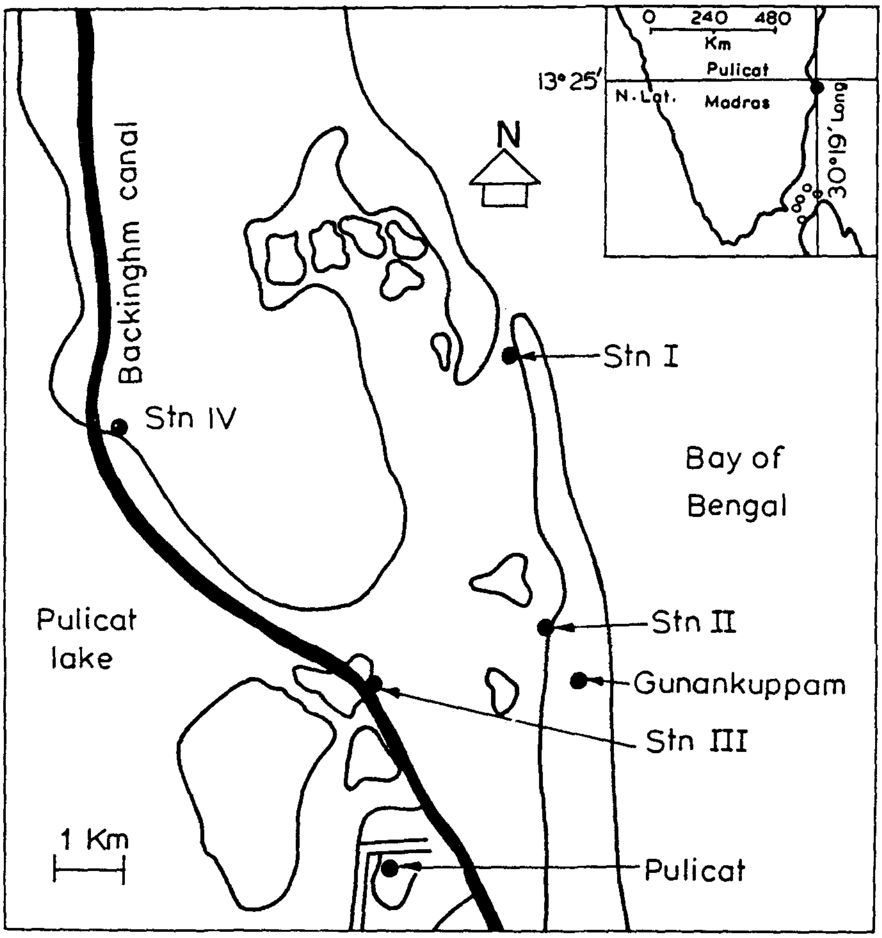

Figure 1. Sampling stations in Pulicat lake.

followed: Dominant and co-dominent, more than 30 individuals; sub-dominent, between 25 and 30 crabs; very common, between 20 and 25 crabs; common, less than 20 but more than 5; present, between 5 and 2; rare, 1.

Month-wide density of each crab species was arrived at by averaging the populations by the corresponding number of the 4 southern stations wherein the respective species was distributed. Apparently if a single species was observed only in one particular station, that population alone was considered as the density. The fractions were rounded upto the nearest number.

3. Hydrography of the lake

3.1 *Salinity*

During the north east monsoon period (October–December) the salinity was generally brackish (table 1), but low salinity values (0·5–2·4%) immediately after

Table 1. Annual variations in temperature and salinity.

Parameters	Non-monsoon period	Monsoon period	During periods of closure of lake-mouth
Temperature of the atmosphere (°C)	26·0–32·3	26·2–31·1	26·6–32·0
Temperature of the substratum (°C)	27·7–32·5	26·5–30·5	27·1–30·0
Temperature of the surface water (°C)	23·0–30·5	19·5–24·5	32·5–35·4
Salinity (‰)	14·4–33·8	0·5–18·3	39·3–43·2

heavy rains during the monsoon period were not uncommon. Also, a slow but steady increase in salinity from January onwards was noticed till the end of September or even later until the onset of the next monsoon. The tidal amplitude at the mouth measured 1 m but there was a progressive decrease in the height from south to north.

3.2 *Temperature*

Temperature revealed marked variations either between that of the intertidal substratum and of the atmosphere or between monsoon and non-monsoon periods (table 1). When the mouth gets silted during south-west monsoon (June–September) due to beach drifting as happened in 1971 and 1972, both salinity and temperature shoot up in the subsequent summer post-monsoon months (January–October) (table 1) to the extent of harming much of the aquatic vegetation. If at such a time the lake is flooded with rain water, the whole of the intertidal area gets submerged below a top layer of freshwater until a new mouth is artificially cut open.

4. Vertical distribution

The intertidal substratum of the stations I–IV (figure 1) represented clean sandy to loamy nature, sometimes the loamy bottom interspersed with shell bits and also clayey to hard grassy ground composed of *Cyperus arenarius* and *C. procerus*. It was notable that the upper reaches of the eastern shore of the northern part of the lake was constituted of dry sand overlying black deoxidized layer immediately below the surface. In and around the mouth, the vertical distance between low water spring to high water spring varied from less than a metre to 2·5 metres. In contrast, in the northern region the tidal effect was so narrow and imperceptible, that the intertidal region could not be well delineated. Whereas *Ocypode cordimana* and *O. ceratophthalma* were typical terrestrial crabs, *Uca annulipes* and species of *Dotilla* and *Sesarma* were sub-terrestrial species, occurring in the intertidal region. *Matuta lunaris*, *Scylla tranquebarica*, *S. serrata* and *Portunus pelagicus* were examples of aquatic species. Station III recorded the largest number of species (21) followed by station I, harbouring 15 species. It was a regular feature to observe *O. ceratophthalma* as the only terrestrial species at a point, 23 km north of the lake-mouth. Total absence of sub-terrestrial crab species there, was conspicuous.

5. Seasonal variation

Marked variations in temperature, salinity and flooding of the intertidal region by flood water run-off between monsoon and non-monsoon periods brought in attendant changes in population and distribution of crab species. This apart, occasional closure of lake-mouth during the south-west monsoon due to beach drifting adversely raised the temperature and salinity to the detriment of the fauna and flora of the lake. In such a situation, the intertidal regions were fully submerged under flood water in the following flood season resulting in the upward movement of certain species and total disappearance of others.

Six species namely *O. ceratophthalma, O. macrocera, U. annulipes, Sesarma* sp., *Metaplax distincta* and *Cardisoma carnifex* were found not affected by the change of seasons and the accompanying environmental changes. Eight species which conspicuously dwindled in number or completely disappeared in the rainy season were, *M. lunaris, M. planipes, Philyra scabriuscula, Charybdis* (*Charybdis*) *orientalis, Thalamita crenata, O. platytarsis, Macrophthalmus* sp. and *Plaqusia depressa tuberculata*. However, the rare species of *U. marionis* was observed in the monsoon and immediately after the monsoon. The rest of the 14 species did not exhibit striking fluctuation in population between the rainy and non-rainy months (tables 2 and 3).

6. Habitats

Most of the shore crabs in Pulicat lake lived in burrows. The notable exceptions were species of *Matuta, P. depressa tuberculata, P. pelagicus, T. crenata* and *Macrophthalmus* sp. which resort to burrying in the soil to ward off danger. *Grapsus strigosus, Metapograpsus messor* and *Metasesarma rouxii* were often found to prefer crevices in between stones. Species of *S. serrata* and *S. tranquebarica* burrowed in the shallow intertidal area primarily for the purpose of moulting.

7. Zonation of crabs

Four zonations based on dominance of species were noticed in this lake. There were two, *O. macrocera* zone and Scopimerinae zone in station I, only *Uca* zone in stations II and III and *O. ceratophthalma* zone in station IV. Whereas *O. macrocera* zone stretched out from high water spring to supralittoral fringe, the Scopimerinae zone consisting of *D. clepsydrodactylus, Dotilla* sp. and *Scopimera pilula* extended from mean low water spring to mean high water neap. *U. annulipes* alone constituted the *Uca* zone from mean low water to supralittoral fringe and the *O. ceratophthalma* zone was observed in the supralittoral zone.

8. Penetration of crabs

All the 29 species of crabs were recorded in the vicinity of the lake-mouth as evidenced in stations I–IV and a vast majority of them started dwindling sharply from north of station IV. Among the sub-terrestrial species, however, *U. annulipes* alone was noticed in attenuated number, a few kilometres further north.

Table 2. Density variations of the different crab species observed during 1972.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Matuta lunaris (Forskal)	1	2	2	1	0	2	1	2	2	0	0	1
Matuta planipes (Fabricius)	1	4	2	2	3	0	1	1	0	0	0	0
Philyra scabriuscula (Fabricius)	0	0	135	22	0	0	0	0	140	—	—	—
Scylla serrata (Forskal)	2	4	0	1	2	15	4	3	1	0	—	2
Scylla tranquebarica (Fabricius)	0	10	2	0	2	3	4	1	0	2	0	0
Portunus pelagicus Linnaeus	1	2	0	3	1	0	1	0	2	1	2	0
Charybdis (*Charybdis*) *orientalis* (Dana)	3	1	2	1	2	0	0	3	2	0	0	0
Thalamita crenata, Milne-Edwards	4	2	2	2	1	1	2	4	0	0	1	0
Ocypoda ceratophthalma (Pallas)	29	34	32	36	34	33	26	27	29	28	24	28
Ocypoda macrocera Milne-Edwards	24	28	32	33	31	32	34	29	29	22	21	24
Ocypoda cordimana Desmarest	13	4	4	3	5	3	3	4	2	4	1	5
Ocypoda platytarsis Milne-Edwards	1	0	1	0	0	2	0	1	0	1	0	0
Uca annulipes Latreille	33	45	50	35	69	53	54	57	63	40	37	43
Uca marionis (Desmarest)	1	0	0	0	0	0	0	0	0	1	0	0
Uca triangularis (Milne-Edwards)	12	4	0	5	4	2	0	1	3	7	8	4
Scopimera pilula Kamp	8	15	14	17	15	18	16	19	18	5	—	—
Dotilla clepsydrodactylus Alcock	—	—	15	40	38	40	60	35	41	35	—	—
Dotilla myctiroides (Milne-Edwards)	25	30	13	25	18	22	34	36	28	29	—	—
Dotilla sp.	14	13	17	21	23	20	18	17	15	26	—	—
Macrophthalmus sp.	1	3	0	0	1	2	1	—	—	1	—	—
Grapsus strigosus (Herbst)	16	8	12	6	3	4	5	8	3	5	1	2
Metapograpsus messor (Forskal)	4	2	3	5	4	1	2	4	2	2	5	0
Metasesarma rouxii (Milne-Edwards)	12	2	1	1	0	0	0	1	0	3	2	4
Sesarma (*Sesarma*) *quadratus* (Fabricius)	4	5	3	3	4	1	4	5	1	10	2	2
Sesarma (*Sesarma*) *oceanica* de Man	1	2	1	4	2	2	0	4	5	1	9	3
Sesarma sp.	5	5	10	6	13	7	10	9	4	12	12	13
Metaplax distincta (Milne-Edwards)	14	13	12	13	12	12	12	11	14	17	11	11
Plaqusia depressa tuberculata (Lamarck)	1	2	0	1	0	0	2	0	0	0	0	1
Cardisoma carnifex (Herbst)	8	7	6	9	10	11	11	11	10	12	10	8

Table 3. Population density in relation to seasonal and other effects.

X	m	$\frac{S}{X}$ 100
1·1667	0·7993	68·51
1·1667	1·2802	109·73
24·75	50·7923	205·22
2·75	3·9396	143·26
2·00	2·7386	136·93
1·0833	0·9538	88·04
1·1667	1·1426	97·94
1·5833	1·3202	83·38
30·00	3·5590	11·86
28·1667	4·2785	15·19
4·25	2·8613	67·33
0·5	0·6455	129·09
48·1667	10·8308	22·49
0·1667	0·3727	223·61
5·0	4·3205	86·41
12·0833	6·6890	55·36
25·3333	20·2045	79·75
21·6667	11·4407	52·80
15·3333	7·7280	50·40
0·75	0·9242	123·23
6·00	4·2622	71·04
2·8333	1·5184	53·59
2·3333	3·1972	137·02
3·6667	2·3214	63·31
3·5	2·8723	82·07
8·8333	3·1842	36·05
12·6667	1·6499	13·03
0·5833	0·7592	130·15
9·4167	1·7540	18·63

Co-efficient of variation below 40 denotes distribution density is not governed by seasons; above 100 denotes distribution density governed by seasonal changes; in between 40 and 100 denotes density being governed by some other outside factors.

O. ceratophthalma was the only terrestrial species which was observed to have penetrated upto the northern most part on the eastern shore of the lake and 3 aquatic swimming crabs viz *S. serrata, S. tranquebarica* and *P. pelagicus*, enjoyed wide and uniform distribution over the entire lake.

9. Discussion

A review of the literature on the vertical distribution of brachyuran fauna from different parts of the world clearly indicates that each species prefers a specific moisture content in the substratum, on the basis of the physiological ability to withstand varying degrees of drying of the gills in the atmospheric air. In the Pulicat lake, *O. cordimana* extends to the arid, sandy regions, sometimes as far as 200 metres from the actual shore, with a water content of 8–12%. Rao (1968) reports that this species can maintain normal levels of hydration by setal uptake, since these levels are within the range of moisture content of sandy soils for which capillary forces and suction should suffice to lift interstitial moisture. *O. ceratophthalma* occupies the arid supralittoral zone and *O. macrocera*, the moist supralittoral fringe, the substrates of these regions contain about 20% of water by weight. Species of *Uca, Scopimera* and *Dotilla*, occupies varying but specific ranges in the wet intertidal belt. The portunid crabs for that matter dwell below tide level, but move back and forth with tides for feeding. This pattern of distribution undoubtedly confirms that specific moisture content of the substratum governs the vertical distribution as concluded by Dahl (1953) and Snelling (1959).

However, the adverse synergistic effect of high temperature in combination with low moisture content cannot altogether be excluded. As an illustration, the habitats of both *O. cordimana* and *O. ceratophthalma* are relatively hot and dry, compared with that of *O. macrocera*, the former species tiding over the unfavourable conditions by turning to nocturnal activity and hiding in their moist burrows during daytime, while the outside temperature is relatively higher. In contrast, the moist habitat of *O. macrocera* is not subject to serious temperature fluctuations and consequently the feeding and other activities are tuned to the rhythm of tides. Perhaps, for this reason, *O. platytarsis* which lives close to station I, prefers surf-beaten open shores to wet its gills frequently. This observation is in agreement with the statement of Dahl (1953) that the activity of the terrestrial crabs is controlled by diurnal rhythm of that of the subterrestrial species by the tidal rhythm.

Four distinct zonations were recorded in the Pulicat lake. Over and above the *Ocypoda* and *Uca* zones recorded in the Vellar estuary, Scopimerinae zone and *Ocypoda ceratophthalma* zone are observed. While *O. macrocera* and *D. clepsydrodactylus* are confined to only 1·5 km length in station I, the other two dominant species, *U. annulipes* and *O. ceratophthalma* are more widely distributed. This may be because that the former two species need clean sandy substrate with constant tidal action so as to ensure the continued existence there. This is more particularly true with *D. clepsydrodactylus* and *Dotilla* sp. since they disappear completely once the mouth of the lake gets silted resulting in the absence of tidal currents and the associated accumulation of organic substances in the once clean sand. Dahl (1953) also stresses the soil composition as a factor of great importance.

Zonation of discrete patches is conspicuous in the Pulicat lake as in the Durban Bay (Day and Morgan 1956), in the Brisbane river (Snelling 1959) and in the Vellar Estuary (Balasubrahmanyan 1966). *O. macrocera* zone and Scopimerinae zone are observed in the clean sandy region of station I and when this changed to an admixture of sand, mud and broken bits of shells as in stations II and III, the faunal components changed to *Uca* zone. Further *Ocypode* zone is observed only where there is sand. *Uca* species need clay with sand in the substratum for the construction of their non-collapsible burrows and hence they are conspicuously absent in station I, where the sandy bottom deters it (Day and Morgan 1956). The present study also confirms that patchy zonation is mainly due to the composition of the substratum.

The terrestrial species are not much affected by floods, but most of the subterrestrial species either disappear or dwindle in number during the flood season. Particularly noteworthy are *O. macrocera, D. clepsydrodactylus, S. pilula* and *Macrophthalmus* sp., and *U. annulipes* which move up to the upper reaches from their normal habitat to avoid flood water as observed by Balasubrahmanyan (1966).

The two species of *S. tranquebarica* and *S. serrata* which normally burrow in the intertidal regions for moulting were never observed there during the flood season, presumably to avoid flood water. Another factor which brings about marked physico-chemical changes is the sporadic siltation of the lake-mouth.

In the Pulicat lake only *O. ceratophthalma*, *P. pelagicus*, *S. serrata* and *S. tranquebarica* penetrate upto the northern extremities of the lake. All the subterrestrial species are confined to the southern most portion of the lake. Low salinity was reported as the limiting barrier in the penetration of intertidal crabs in the Brisbane river (Snelling 1959). In the Pulicat lake salinity and temperature are more or less uniform both at the southern and northern region at any one particular time of the year. Teal (1958) and Balasubrahmanyan (1966) are of the opinion that along with salinity, preference of habitat limit the distribution of crabs. It is pertinent to point out here that there is practically no tidal effect leading to the absence of a well defined intertidal region in the northern shores of the lake to provide the required feeding and dwelling area. Dahl (1953) and Teal (1958) concluded that food is unimportant in the distribution of those species which inhabit the sandy beaches and Georgia salt marshes respectively. However, the subterrestrial crab species depend completely on the organic matter left behind in the exposed intertidal area by the receding tide for their food supply. As such the absence of intertidal belt leads to lack of proper food supply which, in turn, perhaps leads to the absence of subterrestrial crabs in the northern portion of the lake. Over and above, the accumulation and decomposition of the drift weeds in the shores produce a large quantity of hydrogen sulphide just below surface layers. Consequently the tidal current is also important to remove the toxic substances as well as to oxygenate the area. The importance of tidal flow gains strength from the fact that in the narrow mouth region where the tidal influence is the maximum, all the 29 species of crabs are represented. Being a scavenger, *O. ceratophthalma* does not depend on the intertidal area for its food and therefore it can live wherever there is sandy supralittoral tract. The aquatic portunids, such as *S. serrata*, *S. tranquebarica* and *P. pelagicus* on the other hand tolerate wide fluctuations in salinity and temperature and feed on a wide variety of molluscs, crustaceans and other live or dead organisms below the tide level. Hence these may be the permitting factors for their wide and uniform distribution in the Pulicat lake.

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