CHAPTER -IV

DISTRIBUTION OF FORAMINIFERA IN RELATION TO ECOLOGICAL FACTORS

4.1. Introduction

In the present chapter a detailed analyses of the composition of the foraminiferal species of the study area, distribution and ecology of the abundant, rare, moderate, common and frequently occurring foraminiferal species have been made. Based on the analyses, inferences have been made regarding the distribution of foraminiferal species in relation to the ecological factors of the study area.

4.2. Specific Composition of the Foraminiferal Fauna

The foraminiferal studies of the sediments collected from the Vellar river estuary, have led to the recognition of 63 benthic species consisting of both living and dead. They belong to 31 genera, 24 families and 17 super families.

An alphabetical list of the foraminiferal species and their distribution in the study area are given in the distribution chart (Table 4.1 a-c, 4.2 a-c, 4.3 a-c and 4.4 a-c). Living and total (living + dead) foraminiferal population encountered in number of stations from the study area has also been presented in table 4.5-4.7. The interpretation of the data from these tables has helped to understand the distribution of foraminiferal species in relation to ecological factors of the study area.

All the 63 benthic foraminiferal species recognized from the Vellar river estuary are found in living condition in all the seasons. The following
species are considered as abundantly occurring since the total living population size for all the collections is more than 400 specimens. They are also found in more than 70% samples i.e., 45 samples out of the total 63 samples as living.

- *Ammonia beccarii*
- *Ammonia tepida*
- *Nonionoides boueanum*
- *Quinqueloculina seminulum*
- *Trochammina inflata*

The rest 58 species are considered to be either rarely (<20 samples as living and the living population size is <50 specimens), moderately (21-30 samples as living and the living population size is between 50 and 100 specimens), commonly (31-40 samples as living and the living population size is between 100 and 250 specimens) or frequently (>40 samples as living and the living population size is between 251 and 400 specimens) occurring species. The distribution of rare, moderate, common and frequently occurring species of the present area are given in the following pages. The frequency distribution of each species is given with respect to the living population.

### 4.2.1. Distribution of rarely occurring living foraminifera

The species that are present in less than 20 samples as living and the living population size is less than 50 specimens are considered as rarely occurring species of the study area. Among 63 species, there are sixteen rarely occurring species and their distribution is discussed in the following pages.
Cibicides variablis is a rarely distributed species in the study area. The living population is noticed in 17 samples. The living population was found to be maximum in May (18) and minimum in September (14). The maximum frequency observed by this species is 1.79% (station 2) in January.

Fursenkoina punctata is rarely found in the study area. The living specimens are observed in 15 samples (6 each in May and January, 3 in September). The living population was found to be maximum in May and January (10) and minimum in September (4). Higher salinity and temperature prevailed during May and January months support relatively higher population. The maximum living population frequency is in January (0.62%, station 5).

Lagena doveyensis is a rarely occurring species in the present study area. It is found that the living specimens are noticed in 20 samples. The living population was found to be maximum in May (23) and minimum in September (5). The fauna prefers a substrate with higher percentage of fines. The maximum living population frequency 0.98% (station 3), is in January.

Lagena gracillima is a rarely found species in the present study area. It is found that the living specimen is observed in 15 samples (5 in May, 5 in September and 5 in January). The living population was found to be maximum in May and January (10) and minimum in September (7). Temporally, the population is found to be more during May closely followed by January and September. The maximum living population frequency 0.98% (station 3), is in January.
Lagena setigera is a rarely distributed species in the study area. It is found that the living population is found in 14 samples (6 in May, 2 in September and 6 in January). The living population was found to be maximum in May (12) and minimum in September (2). The fauna prefers a substrate with higher percentage of fineness along with higher salinity values. The maximum frequency (0.65%) is in station 3, January.

Loxostomum limbatum is a rarely distributed species in the study area. It is found that the living population is noticed in 19 samples (7 in May, 5 in September and 7 in January). The living population was found to be maximum in May (18) and minimum in September (10). In general, the population is positively controlled by salinity, temperature, dissolved oxygen content, depth of bottom water and the fineness of the sediments. The maximum frequency is in January (0.98%, station 3).

Monalysidium politum is a rarely found species in the present study. The living population is noticed in 17 samples. The total living population for all the collections together is only 28. The living population was found to be maximum in May and January (11) and minimum in September (6). The maximum living frequency 0.65% (station 3) is observed in January.

Pyrgo elongata is a rarely distributed species in the study area. This fauna is found in 30 samples and of these, living population is noticed in 18 samples. The living population was found to be maximum in May (16) and minimum in September (6). The maximum frequency observed by this species is 1.79% (station 2) in January.

Pyrgo subsphaerica is a rarely distributed species in the study area. This fauna is found in 18 samples and of these, the living population is observed in 11 samples. The living population was found to be maximum in May and January (7) and minimum in September (4). The maximum frequency observed by this species is 0.55% (station 4), in January.
Rectobolivina raphanus is another rarely distributed species in the study area. This fauna is found as living population in 18 samples (6 each in May, September and January). The living population was found to be maximum in May (16) and minimum in September (11). The maximum frequency observed by this species is 0.82% in January (station 4).

Sagrinella lobata is a rarely distributed species in the study area. This fauna is noticed as living population in 14 samples. The living population was found to be maximum in May and January (10) and minimum in September (5). The species prefers the silty clay sand substrate. The maximum frequency observed by this species is in January (0.65%, station 3).

Spirillina vivipara is a rarely occurring species in the study area. Though the living population is found in 23 samples, as the living population size is only 41, this species is discussed under rarely occurring species. The living population was found to be maximum in May (15) and minimum in September (11). The maximum frequency observed by this species is 0.72% (station 4), in September.

Spiroloculina angulata is a rarely occurring species in the study area. The living population is observed in 17 samples. The living population was found to be maximum in May (15) and minimum in September (10). The maximum frequency observed by this species is 0.82% (station 4), in January.

Stillostomella bradyi is a rarely found species in the study area. The living specimen is found in 15 samples (6 each in May and January, 3 in September). The living population was found to be maximum in May and January (8) and minimum in September (4). The maximum living population frequency is in January (0.51%, station 6).
*Textularia earlandi* is a rarely distributed species in the study area. The living population is found in 15 stations. The living population was found to be maximum in May and January (40) and minimum in September (4). The maximum frequency 0.62% is noticed in January (stations 5).

*Uvigerina proboscidea* is a rarely distributed species in the study area. The living population is found in 13 stations. The living population was found to be maximum in May and January (9) and minimum in September (5). The species prefers the silty clay sand substrate. The maximum frequency observed by this species is 0.62% (station 5) in January.

### 4.2.2. Distribution of moderately occurring living foraminifera

The species that are present at least in 21 – 30 samples as living with the living population size ranges between 51 - 100 specimens are consider as moderately occurring species in the study area. Among 63 species, there are sixteen moderately occurring species and their distribution is discussed in the following pages.

*Ammodiscus tenuis* is a moderately distributed species in the study area. It is found in 31 stations. The living population is observed in 23 samples (8 in May, 7 in September and 8 in January). The maximum living population size is found to be 20 in May. This species prefers higher depth and salinity of the bottom water and higher fineness of the substrate. The maximum frequency is noticed in stations 5, 6 of May and in station 7 of January (0.88%).
Bolivina pseudoplicata is a moderately distributed species in the study area. It is found in 33 stations and as living population is found in 27 stations (9 in May, 9 in September and 9 in January). The living population was found to be maximum in May and January (30) and minimum in September (21). Spatially, this species is found to be abundant between 3 and 7. The distribution of the fauna reveals that higher salinity, temperature and dissolved oxygen content favours thriving of this species. The maximum frequency is in January, station 4 (1.37%).

Buliminella milletti is a moderately represented species in the study area. It is found in 33 samples while the living specimen is noticed in 21 samples. The living population was found to be maximum in May (21) and minimum in September (12). The distribution of this fauna reveals that this species prefers silty clay sand substrate. The maximum living population frequency 0.98% is in January (station 3).

Cancris oblonga is a moderately distributed species in the study area. This fauna is found in 30 samples and of these, the living population is noticed in 21 stations. The living population was found to be maximum in May (25) and minimum in September (12). The distribution of this fauna reveals that its favourable salinity range is >30 ppt and substrate is silty clay sand. The maximum frequency observed by this species is 2.50% (station 1) in January.

Fissurina laevigata is a moderately distributed species in the study area. This fauna is found in 35 samples and of these, the living population is noticed in 23 stations. The living population was found to be maximum in May (35) and minimum in September (10). This is one of the species preferring a substrate with more silt and clay percentage. Spatially, this species is more populated in stations between 3 and 7. The maximum frequency observed by this species is 1.42% in May, station 3.
*Fissurina marginata* is a moderately found species in the study area. It is found in 36 samples. The living specimen is observed in 27 samples (10 in May, 7 in September and 10 in January). The living population was found to be maximum in May (32) and minimum in September (17). The fauna prefers a substrate with higher percentage of fines. The maximum living population frequency is in May (1.25%, station 11).

*Fursenkoina compressa* is a less moderately distributed species in the study area. It is found in 32 samples while the living population is noticed in 20 samples. Since the population size is 51, it is considered as moderately distributed species. The living population was found to be maximum in May (21) and minimum in September (11). The species prefers higher salinity, temperature and dissolved oxygen content for higher reproduction along with higher sediment fineness of the substrate. The maximum living frequency is in January (0.98%, station 3).

*Lagena laevis* is a moderately distributed species in the study area. This fauna is found in 39 samples and of these, the living population is noticed in 29 stations. The living population was found to be maximum in May (39) and minimum in September (21). The optimum conditions that prevail during May seem to provide a congenial environment for higher reproduction of the fauna. The maximum frequency observed by this species is in May (1.46%, Station 4).

*Lagena semistrriata* is a moderately distributed species in the study area. This fauna is found in 33 samples and of these, the living population is observed in 24 samples. The living population was found to be maximum in May (27) and minimum in September (11). Spatially this species is found to be more populated in stations between 3 and 7. The
distribution of the fauna reveals that higher salinity, temperature and dissolved oxygen content of the bottom water aided with the depth of the substrate favours higher reproduction. The maximum frequency observed by this species is in January (1.12%, station 10).

*Lagena striata* is a moderately distributed species in the study area. This fauna is found in 41 samples and of these, the living population is noticed in 30 samples (11 in May, 8 in September and 11 in January). The living population was found to be maximum in May (41) and minimum in September (22). Spatially, the higher population noticed in stations between 3 and 7 is mainly due to the optimum salinity values prevailed in these stations. The maximum living frequency observed by this species is in May (1.46%, station 4).

*Nonionella auris* is a moderately found species seen in 35 samples but the living population is noticed only in 26 stations. The living population was found to be maximum in May (22) and minimum in September (15). The distribution of fauna reveals that higher salinity and temperature of the bottom water along with higher CaCO$_3$ content of the substrate favours higher population. The maximum living frequency is observed in January (0.98%, station 3).

*Nonionella pulichella* is also a moderately distributed species in the study area. This fauna is found in 33 samples and of these, the living population is found in 24 samples (8 each in May, September and January). The living population was found to be maximum in May (19) and minimum in September (14). The spatial as well as seasonal distribution of the species reveals that the population abundance is directly proportional to temperature, dissolved oxygen and salinity content.
of the bottom water. The maximum frequency observed by this species is 0.88% (station 5) in May.

*Pseudomassilina australis* is a moderately found species of the study area and noticed in 35 samples. The living population is observed in 24 samples. The living population was found to be maximum in May (23) and minimum in September (18). In general, the population is found to correlate positively with salinity, temperature, dissolved oxygen content and depth of bottom water and the increasing fineness of the sediments. The maximum living frequency 1.79% (Station 2) is observed in January.

*Quinqueloculina bicostata* is a moderately represented species of the present study area. The living population is found in 27 samples (9 in May, 9 in September and 9 in January). The living population was found to be maximum in May (37) and minimum in September (28). The maximum frequency attained by the species is 1.81% (station 4), in September.

*Spiroloculina antillarum* is a moderately distributed species in the present study area. This fauna is noticed in 35 samples. Though the living population is found in 20 samples, as the living population size is 45, this species is considered as moderately distributed. The living population was found to be maximum in May (21) and minimum in September (15). The maximum frequency observed by this species is 0.98% (station 3), in January.

*Textularia foliaceous* is a moderately represented species of the present study area. The living population is found in 27 samples (9 in May, 9 in September and 9 in January). The living population was found to be maximum in May (30) and minimum in September (21). Distribution of this species reveals that its population is poor during the two collections (January and September) where the salinity, temperature and dissolved
oxygen content of bottom water is less and the substrate contain less percentage of fineness. The maximum frequency 1.28% is noticed in January (stations 9).

**4.2.3. Distribution of commonly occurring living foraminifera**

The species that are present at least in 31 – 40 samples as living or living population size is range between 101 - 250 specimens are consider as commonly occurring species of the study area. Among 63 species, there are nineteen commonly occurring species and their distribution is discussed in the following pages.

*Ammobaculites agglutinans* is a commonly occurring species in the study area. This fauna is noticed in 49 of the 63 samples and the living population is found in 35 samples. Though the living population size is 281, as they found only in 35 samples, it is represented as commonly occurring species. The living population was found to be maximum in May (111) and minimum in September (76). Spatially, this species prefers higher depth; higher sediment fineness and found to be abundant in stations 3 to 9. In general, salinity of the bottom water and higher organic matter content and fineness of the substrate favours the higher reproduction of this species. The maximum frequency 4.23% is noticed in May (station 9).

*Ammobaculites exiguis* is one of the commonly occurring species in the present area. This fauna is found in 43 of the 63 samples and the living population is noticed in 31 samples. Spatially, it is absent in the first 2 stations of all the collections. The living population was found to be maximum in May (72) and minimum in September (38). The distribution of this species reveals that the higher population is positively correlated
with increasing salinity values of the bottom water. The population is also controlled by the depth of water column and sediment fineness of the substrate. The maximum frequency 2.69% is noticed in May (stations 9).

*Ammobaculites foliaceous* is also a commonly distributed species of the genera in the study area. The living population is found in 33 samples of the 63 samples (12 in May, 9 in September and 12 in January). The living population was found to be maximum in May (74) and minimum in September (47). The distribution indicates that higher salinity values, higher sediment fineness favours higher reproduction and population. The maximum frequency 2.93% is noticed in September (stations 5).

*Asterorotalia inflata* is commonly found in the study area. It is found in 44 samples. The living specimen is found in 39 samples (14 each in May and January and 11 in September). The living population was found to be maximum in May (94) and minimum in September (66). This species prefers silty sand and silty clay sand substrate and higher salinity of the bottom water of May season for higher reproduction. The maximum living population frequency is 3.89% (station 9), in September.

*Bolivina doniezi* is one of the commonly occurring species in 39 samples. The living population is noticed in 33 samples (11 each in May, September and January). The living population was found to be maximum in May (84) and minimum in September (58). The spatial as well as seasonal distribution of the species reveals that the population abundance is directly proportional to higher temperature, dissolved oxygen and salinity content of the bottom water and sediment fineness of the substrate. The maximum living frequency is observed in May (3.52%, station 10).
Bolivina nobilis is a commonly distributed species in the study area. This fauna is found in 35 samples and of these, the living population is noticed in 33 samples (11 each in May, September and January). The living population was found to be maximum in May (51) and minimum in September (32). The favourable condition for higher reproduction is: salinity >31 ppt; temperature >31°C and silty clay sand and silty sand substrate. The maximum frequency observed by this species is in January (1.89%, station 12).

Cibicides lobatulus is one of the commonly found species in the present study area. It is found in 36 samples while the living specimens are observed in 24 samples (9 each in May and January, 6 in September). The living population was found to be maximum in May (31) and minimum in September (20). Spatial distribution of the fauna reveals that this species prefers salinity of >31.5 ppt. Temporally, increasing temperature, dissolved oxygen content of the bottom water and higher CaCO$_3$ content of the substrate favour higher population. The maximum frequency observed by this species is 2.50% (station 1) in January.

Eggerella advena is a commonly represented species of the present study area. The living population is found in 33 samples (11 each in May, September and January). The living population was found to be maximum in May (61) and minimum in September (48). Its distribution always coincides with the distribution of other arenaceous forms of the study area. The maximum frequency 2.41% is noticed in September (stations 7).

Eggerella australis is also a commonly distributed species in the study area. Among the 35 samples encountered, the living population is found in 33 samples. The living population was found to be maximum in
May (48) and minimum in September (32). In general, the population is positively controlled by salinity and depth of bottom water and the fineness of the sediments. The maximum frequency 1.83% is noticed in September (stations 8).

*Elphidium advenum* is found to be present in 48 samples of the study area and the living population is noticed in 41 samples (15 each in May and January and 11 in September). Though the living population is found 41 samples, as the population size is only 205, this species is consider as commonly occurring species. The living population was found to be maximum in May (84) and minimum in September (50). The spatial distribution of this fauna reveals that the optimum limit of salinity value is between 30.2 and 31.8 ppt. The maximum living frequency of this species is 4.88% in January (station 15).

*Elphidium excavatum* is a commonly found in the present study area. It is found in 42 samples. The living specimen is encountered in 34 samples (13 each in May and January and 8 in September). The living population was found to be maximum in May (45) and minimum in September (25). This species prefers silty clay sand substrate and higher salinity of the bottom water of May season for higher reproduction. The maximum living population frequency is in January (2.50%, station 1).

*Elphidium macellum* is one of commonly found species, encountered in 42 samples. The living population is noticed in 31 samples (12 each in May and January and 7 in September). The living population was found to be maximum in May (47) and minimum in September (21). In general, the population abundance is directly proportional to salinity, dissolved oxygen and temperature of the bottom water. The maximum living frequency is observed in January (1.79%, station 2).
*Helinina perlucida* is a commonly found species in the study area. It is found in 42 samples. The living population is noticed in 33 samples, 11 each in all the three collections. The living population was found to be maximum in May (42) and minimum in September (27). The distribution of the species reveals that the increasing salinity, temperature and dissolved oxygen content of the bottom water along with higher CaCO$_3$ content of the substrate favours higher population. The maximum living frequency observed in May (1.71%, station 4).

*Quinqueloculina agglutinans* is a commonly represented species of the present study area. The living population is found in 38 samples (14 in May, 10 in September and 14 in January). The living population was found to be maximum in May (75) and minimum in September (41). The population of this species positively correlates with salinity, temperature and dissolved oxygen content of bottom water. The maximum frequency attained by the species is 2.99% in May, station 1.

*Quinqueloculina lamarckiana* is the commonly distributed species in the study area. This fauna is found in 45 samples and of these the living population is noticed in 39 samples (14 each in May and January and 11 in September). The living population was found to be maximum in May (60) and minimum in September (38). Temporally, this species is controlled by higher temperature, dissolved oxygen and salinity of the bottom water. The maximum frequency observed by this species is 4.35% (station 2), in May.

*Spiroloculina communis* is a commonly represented species of the present study area. The living population is found in 38 samples (13 each in May and January and 12 in September). The living population was
found to be maximum in May (56) and minimum in September (37). In general, the population is positively correlated with salinity, temperature, dissolved oxygen content, depth of bottom water and the increasing fineness of the sediments. The maximum frequency attained by the species is 5.56% in station 2, September.

*Textularia agglutinans* is a commonly represented species of the present study area. The living population is found in 36 samples (12 each in May, September and January). The living population was found to be maximum in May (52) and minimum in September (42). The distribution pattern reveals that the species prefers the substrate with higher sediment fineness and higher salinity of the bottom water. The maximum frequency 2.78% is noticed in September (stations 2).

*Textularia aura* is an also commonly represented species of the present study area. Though the living population is found in 35 samples (13 each in May and January and 9 in September), as the population size is only 100, it is consider as commonly represented species. The living population was found to be maximum in May (39) and minimum in September (27). The higher population is restricted to stations between 3 and 7 where higher salinity of the bottom water and sediment fineness is observed. The maximum frequency 2.50% is noticed in January (stations 1).

*Triloculina oblonga* is a commonly distributed species in the study area. This fauna is found in 53 samples and of these, the living population is noticed in 45 samples (15 each in May, September and January). Though the living species are present in 45 samples of the study area, it is consider as commonly occurring species as the living population size is only 208. The living population was found to be maximum in May (76) and minimum in September (64). Spatially, this species is more
concentrated in stations 3 to 7. The distribution of the fauna reveals that higher salinity, temperature and dissolved oxygen content of the bottom water aided with the depth of the substrate favours higher reproduction. The maximum frequency observed by this species is 3.53% (station 12), in September.

4.2.4. Distribution of frequently occurring living foraminifera

The species that are present in more than 40 samples as living whose living population size ranges between 251 - 400 specimens are consider as frequently occurring species of the study area. Among 63 species, there are seven frequently occurring species and their distribution is discussed in the following pages.

*Brizalina striatula* is the frequently found species in the present study area. It is found in 50 samples. The living specimen are found in 41 (15 each in May and January and 11 in September) samples. The living population was found to be maximum in May (112) and minimum in September (78). The spatial as well as seasonal distribution of the species reveals that the population abundance is directly proportional to temperature, dissolved oxygen and salinity content of the bottom water. The maximum living population frequency is in January (4.88%, station 15).

*Elphidium crispum* is one of frequently distributed species in the study area. It is found in 53 samples. The living population is observed in 47 samples (16 each in May and January and 15 in September). The living population was found to be maximum in May (138) and minimum in September (110). The distribution of the fauna reveals that higher salinity, temperature and dissolved oxygen content of the bottom water aided with
the depth of the substrate favours higher reproduction. The maximum frequency as living is in September (7.34%, station 11).

*Elphidium norvangi* is one of the frequently distributed species in the study area. This fauna is found in 55 stations and of these, the living population is noticed in 47 stations (16 each in May and January and 15 in September). The living population was found to be maximum in May (102) and minimum in September (73). Spatially, this species is found to be abundant between stations 3 and 9, controlled mainly by salinity values. The temporal distribution of this species reveals that the population abundance is directly proportional to increasing salinity and temperature of the bottom water along with CaCO$_3$ content of the substrate. The maximum frequency observed by this species is in September (10.34%, station 1).

*Nonionoides grateloupi* is one of the frequently distributed species in the study area. It is found in 59 samples. The living population is noticed in 52 samples (18 each in May and January and 16 in September). The living population was found to be maximum in May (126) and minimum in September (96). This species is one of the cosmopolitan species of the present area. Spatial distribution of this species reveals that salinity is the main controlling factor for higher population while temporally, higher temperature, salinity and dissolved oxygen content of the bottom water along with higher CaCO$_3$ content of the substrate favours higher reproduction. The maximum frequency 14.29% (station 16) is noticed in May and September.

*Nonionoides labradoricum* is also a frequently distributed species in the study area. This fauna is found in 56 samples and of these, the living population is observed in 49 samples (17 each in May and January and 15 in September). Though the population size is 229, as it is observed in 49
stations, it is discussed under frequently distributed species. The living population was found to be maximum in May (88) and minimum in September (66). In general, salinity of the bottom water and higher organic matter content and fineness of the substrate favours the higher reproduction of this species. The maximum living frequency observed by this species is in May and January (7.69%, station 17).

*Triloculina trigonula* is a frequently occurring species found in 57 samples. The living population is noticed in 48 samples (16 each in May, September and January). The living population was found to be maximum in May (107) and minimum in January (90). The spatial distribution of the species reveals that the species is more populated in stations from 3 to 9 coinciding with higher salinity values of the bottom water. The maximum living frequency 10.34% is observed in September (station 1).

*Trochammina advena* is a frequently occurring species in the study area. In total, it is found in 47 samples. The living population is found in 41 samples (15 in May, 13 each in September and January). The living population was found to be maximum in May (110) and minimum in September (87). The spatial distribution reveals that the species prefers sediments with higher percentage of fineness and organic matter content along with higher salinity values. The maximum frequency 7.32% is noticed in January (stations 15).

### 4.2.5. Distribution and ecology of abundant foraminifera

The species that are present in more than 45 samples as living whose living population size is more than 400 specimens are consider as
abundant occurring species of the study area. Among 63 species, there are five abundant occurring species. The distribution and ecology of the five abundant foraminifera of the study area are discussed in the following section. The relation between the cumulative percent distribution of abundant living foraminifera and the various environmental characters are given in Figs. 4.1 a-c.

4.2.5.1. **Trochammina inflata** (Montagu)

4.2.5.1. a. Living population

*T. inflata* was found in living condition in 46 out of the total 69 samples collected. The population size for a station varies from 1 specimens (station 17 of January) to 21 (station 5 of May) specimens.

The occurrences of living and total population of *T. inflata* in actual number of specimens and in percent of the living population are given in tables 4.8 a-b. Its distribution in the study area is shown in figs. 4.1 a-c and 4.2.

The population size of a station consists of >20 specimens in 1 station (5 of May); 16 - 20 specimens in 6 stations (1 in September, 3 in May and 2 in January); 11 - 15 specimens in 15 stations (6 in September, 5 in May and 4 in January); 6 - 10 specimens in 12 stations (3 in September, 4 in May and 5 in January) and 1 - 5 specimens in 13 stations (5 in September, 4 in May and 4 in January). They are absent in living conditions in the first two stations and the last six stations (station 18 -23) of all the collections except in station 2 of May. Spatially, the mean values of living population are found to be more between stations 3 and 9.
Temporally the living population is found to be maximum (164 specimens) during May and minimum (127 specimens) during September. The relative abundance of living population ranges from 2.2% (station 2 of May) to 15.4% (station 17 of May and January).

4.2.5.1. b. Total population

This species occurs in 51 out of the total 69 samples collected and studied as living and / or dead. The population size for a station varies from 2 to 59 specimens (minimum at station 18 of September and the maximum being at station 5 of May). The total population consists of >40 specimens in 9 samples (2 in September, 4 in May and 3 in January); 26-40 specimens in 17 samples (6 in September, 5 in May and 6 in January); 11-25 specimens are found in 14 samples (5 in September, 5 in May and 4 in January) and 1-10 specimens in 11 stations (3 in September, 4 in May and 4 in January). The species is completely absent in the last 5 stations of all the collections, first two stations of September and January and the first station of May. The average values of total population for a station are found to be maximum between stations 3 and 9.

Temporally total population is found to be maximum (487 specimens) during May and minimum (389 specimens) during September. The relative abundance of total population varies from 1.1% (station 1 of May) to 11.9% (station 16 of May).

4.2.5.1. c. Ecological consideration

Manivannan (1989) after a detailed ecological study of this species stated that the living population is very abundant during April (summer) while the number of living specimens is found to be uniformly less during
the other three seasons, where *T. inflata* goes to a near state of hibernation. He has also given the optimum conditions for the abundance of living population of this species, which are as follows:

- **Temperature**: $31.8^\circ\text{C} - 33.5^\circ\text{C}$
- **Dissolved Oxygen**: $> 6.1 \text{ ml/l}$
- **Salinity**: $33.7\text{‰} - 34.9\text{‰}$
- **Substrate**: Siltysand
- **Calcium carbonate**: $> 29\%$
- **Organic matter**: $< 0.52\%$

The distribution of *T. inflata* in Coleroon estuary was studied by Srinivasan (1997) and revealed that the high temperature, dissolved oxygen content, and salinity of the bottom water favour higher reproduction. It is found that the population of this species to be minimum during October owing to fresh water flow in the river estuary which results due to the monsoonal rains and depression that are prevalent in the area during October–November months.

*T. inflata* is one of the abundant and well represented arenaceous species of the area and occurs as living in 46 samples. Spatially, the living population is found to be higher between stations 3 and 9. The living population is completely absent in the first two and the last six stations of all the collections, except second station in May. Lesser salinity values of the last six stations are the reason for the absence of living forms, while the sandy substrate is the main cause for the absence of living forms in the first two stations. Temporally, the living population is higher during May, is closely followed during January, and lowers in September.
In the present study area, the stations with relatively higher living population (=> 15 specimens) along with their respective sediment type are as follows:

<table>
<thead>
<tr>
<th>Month</th>
<th>Stations</th>
<th>Sediment Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>5 &amp; 6</td>
<td>silty clay sand</td>
</tr>
<tr>
<td>May</td>
<td>4, 5, 6 &amp; 7</td>
<td>silty clay sand</td>
</tr>
<tr>
<td>January</td>
<td>5 &amp; 6</td>
<td>silty clay sand</td>
</tr>
</tbody>
</table>

This clearly shows that the silty clay sand substrate provides favourable environment for the thriving of this species.

In the present study, *T. inflata* does not show any periodicity and it is believed that reproduction occurs at frequent intervals throughout the year, slightly higher during May.

On considering the temporal and spatial distribution of the species it is inferred that the optimum conditions for higher population is as follows:

- Temperature : > 29.5 °C
- Dissolved Oxygen : > 4.5 ml/l
- Salinity : > 29.5 ‰
- Substrate : silty clay sand
- Calcium carbonate : > 13.0 %
- Organic matter : 1.45 – 2.8 %

The accommodative substrate for the thriving of *T. inflata* is found to be silty clay sand. Though various parameters are having their influence on the population distribution, the main controlling factor for the population abundance in the study area for this species is salinity followed by substrate.
4.2.5.2. *Quinqueloculina seminulum* (Linne)

4.2.5.2. a. Living population

This species occurs in living condition in 55 out of the total 69 samples collected and studied. The occurrences of living and total population of *Q. seminulum* (Linne) in actual number of specimens and in percent of the living population are given in tables 4.9 a-b. Its distribution in the Vellar river estuary is shown in Figs. 4.1 a-c and 4.3.

The population size for a station ranges from 1 (station 19 of May & January) to 27 (stations 5 of May) specimens. The population consists of more than 20 specimens in 3 stations (station 5 of September, May and January); 16 to 20 specimens in 11 stations (2 in September, 6 in May and 3 in January); 11 to 15 specimens in 11 samples (5 in September, 2 in May and 4 in January); 6 to 10 specimens in 16 samples (5 in September, 6 in May and 5 in January) and <= 5 specimens in 14 samples (4 in September, 4 in May and 6 in January). In the remaining 14 stations (6 in September, 4 in May and 4 in January) living forms are absent.

Spatially, the mean values for the stations found to be maximum between stations 3 and 9. Seasonally, the total population size found to be maximum (221 specimens) during May, and is minimum (182 specimens) during September. The relative abundance of living population ranges from 4.4 % (station 4 & 6 of May) to 28.6 % (station 17 of September).

4.2.5.2. b. Total Population

This species occurs in 63 out of the total 69 samples collected and studied as living and / or dead. The total population size ranges from 2 (station 20 & 21 of September) to 75 (station 5 of May) specimens. It
consists of more than 40 specimens in 16 samples (4 in September, 7 in May and 5 in January); 26 - 40 specimens in 14 samples (6 in September, 4 in May and 4 in January); 11 - 25 specimens in 16 samples (5 in September, 5 in May and 6 in January); and =< 10 specimens 17 samples (6 in September, 5 in May and 6 in January). No specimens of this species, either as living or dead, have been noticed in the last two stations of all the collections. Spatial distribution of this species reveals that it is more populated in stations 3 to 9. Temporally, the population is found to be maximum during May (627 specimens) and minimum in September (547 specimens). The relative abundance of total population ranges from 4.0 % (station 4 of September) to 50.0 % (station 21 of May and January).

4.2.5.2. c. Ecological consideration

Boltovskoy (1964) has observed that Q. seminulum lives for only one year, the period of reproductive activity is for five months (November to March) with a peak in December. The population of this species is found to be the maximum during January.

Murray (1968) stated that Q. seminulum is not physically adapted to withstand hypo saline conditions and also believed that it may be true with the most, if not all. Todd and Low (1961) reported this species from the open Sen beaches of Martha’s Vineyard Island, U.S.A., within the temperature range of 19° C to 23° C and salinity range of 31.1 to 32.1 ‰.

The foraminiferal distribution in the Palk Bay, off Rameswaram was studied by Kumar et al., (1996) and Kumar and Manivannan (2001b) and have observed living population to be maximum in April and minimum in October. They concluded that the spatial distribution of the species was controlled by calcium carbonate content of the substrate and the
accommodative substrate for this species is silty sand. The optimum conditions for its abundance in their study area were found to be: temperature: 31.5ºC to 32.6ºC, Salinity: < 35 ‰, Dissolved oxygen: > 6 ml/l and organic matter: > 0.47%.

According to Srinivasan (1997), the maximum living population size of this species in Coleroon river estuary, Tamil nadu was found in April and minimum in January. The optimum conditions for its abundance are temperature: >32º C, salinity: > 31 ppt, dissolved oxygen: > 4.9 ml/l and organic matter: > 2%. This species was found to occur more in the siltyclaysand type of substrate followed by siltysand.

Sivakumar (2002) and Gangaimani (2009) after their ecological study of foraminifera from the shelf sediments, off Chennai and off Tuticorin respectively, concluded that the seasonal and temporal distribution of this species revealed that the environmental condition that prevailed during summer season is favourable for the abundance and higher reproduction in both the areas. They have found that the population of the species increases with increasing temperature, salinity, and CaCO₃ content of the substrate. The optimum conditions for its abundance in their study area were found to be temperature: 32º C, salinity: > 35 ppt, dissolved oxygen: > 5.5 ml/l and organic matter: 1- 2.5%, and silty clay sand substrate.

Kumar and Manivannan (2001a) in their study of foraminifera from Cauvery estuary, South East Coast of India have found the population of this species to be the maximum in March and the favorable substrate as silty clay sand and silty sand. The congenial conditions for its abundance are found to be: temperature - 31ºC to 31.2ºC and salinity - 30.4% to 32.0%.
In the present study area *Q. seminulum* is one of the abundant and well represented arenaceous species and it occurs as living in 55 samples. Spatially, the living population is found to be higher between stations 3 and 9. It is also observed that the living population is completely absent in the last six stations of September and last four stations of May and January because of the lesser salinity values prevailed in these stations. Temporally, the living population is maximum during May, closely followed during January, and is minimum in September.

In the study area, the stations with relatively higher living population (= >16 specimens) along with their respective sediment type are as follows:

<table>
<thead>
<tr>
<th>Month</th>
<th>Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>5, 6 &amp; 7 (silty clay sand)</td>
</tr>
<tr>
<td>May</td>
<td>3 (silty sand); 4 - 9 (silty clay sand)</td>
</tr>
<tr>
<td>January</td>
<td>4 (silty sand); 5 - 7 (silty clay sand)</td>
</tr>
</tbody>
</table>

Thus, in the present area, the most accommodative substrate for this species is silty clay sand.

Seasonal and temporal distribution of this species reveals that the population increases with increasing temperature and dissolved oxygen content of bottom water, and CaCO₃ content of the substrate and hence population is found to be higher during May.

On considering the temporal and spatial distribution of the species it is inferred that the optimum conditions for higher population are as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>&gt; 29.5°C</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>&gt; 4.5 ml/l</td>
</tr>
<tr>
<td>Parameter</td>
<td>Value</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Salinity</td>
<td>&gt; 29.5 ‰</td>
</tr>
<tr>
<td>Substrate</td>
<td>silty clay sand</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>&gt; 13.0 %</td>
</tr>
<tr>
<td>Organic matter</td>
<td>1.45 – 2.8 %</td>
</tr>
</tbody>
</table>

Though various parameters are having their influence on the population distribution, the main controlling factor for the population abundance in the study area for this species is salinity followed by the nature of the substrate.

4.2.5.3. Nonionoides boueanum (d’ Orbigny)

4.2.5.3. a. Living Population

This is one of the abundant species of the study area and the living population of this species is found in 55 samples out of 69 samples collected and studied. The living and total population of *N. boueanum* in actual number of specimens and in percent of the living and total population are given in tables 4.10 a-b. Its distribution in the Vellar river estuary is shown in figs. 4.1 a-c and 4.4.

The population size for a station ranges from 1 (station 19 of May & January) to 22 (stations 5 of May) specimens. The population consists of more than 20 specimens in 2 stations (station 5 of May and January); 16 to 20 specimens in 6 stations (1 in September, 3 in May and 2 in January); 11 to 15 specimens in 14 samples (5 each in September and January, 4 in May); 6 to 10 specimens in 16 samples (5 in September, 7 in May and 4 in January) and <= 5 specimens in 19 samples (6 in September, 5 in May and 8 in January). Living forms are completely
absent in rest of the other 14 stations (6 in September, 4 each in May and January). Like other abundant species of the study area, the population of this species is very less in stations 13 -19. Spatially, the higher population is concentrated in stations between the stations 3 - 9 in all seasons.

Temporally, the living population of this species is found to be maximum in May (183 specimens) and minimum in September (139 specimens).

The relative abundance of the living population of this species ranges from 3.8% (station 4 of January, 5 of September, and 6 of May and October) to 25.0 % (station 18 of May & January and 19 of January).

4.2.5.3. b. Total population

This species occurs in 60 out of 69 samples either as living or dead. Among the stations, the total population of this species is found to be more than 40 specimens in 11 samples (3 in September, 4 each in May and January); 26-40 specimens in 17 samples (6 each in September and May and 5 in January); 11-25 specimens in 19 samples (6 each in September and May and 7 in January), while =< 10 specimens in 13 samples (5 in September, 4 each in May and January).

Seasonally, the total population of this species varies from 533 specimens (May) to 444 specimens (September). As in the case of living population, the total population of this species is also uniformly distributed except where the substrate is either sandy or with lesser salinity values. The relative abundance of this species ranges from 3.6 % (station 7, September)
to 27.3 % (station 20, January). The higher relative percentage is found to be maximum during January.

4.2.5.3. c. Ecological consideration

In his study of foraminiferal ecology from the Coleroon estuary, Srinivasan (1997) has found that the living population size of this species is found to be maximum in April and minimum in October. The spatial distribution of this species is mainly controlled by salinity of the bottom water. Temporally, the population of this species is positively correlated with temperature, dissolved oxygen, salinity of the bottom water and calcium carbonate content of the sediments.

Sivakumar (2002) in his study of foraminifera off Chennai, South East Coast India has observed the living population of this species to be maximum in May and minimum in January. Further he has observed that the type of substrate and percentage of CaCO$_3$ to be the controlling factors for the spatial variation. Also, temporally, the population of this species is found to be positively correlated with temperature, dissolved oxygen, salinity of the bottom water and calcium carbonate content of the sediments.

Gangaimani (2009) in his study of foraminifera, off Tuticorin, South East Coast of India, has observed that the living population of this species is found to be maximum in April and minimum in October. He has found that in that area the optimum conditions for the thriving of this species to be temperature: $32^o$ C, salinity: >35 ppt, dissolved oxygen: >5.5 ml/l and
calcium carbonate: >19.5% and silty clay sand, and silty sand substrate.

In the study area, the silty sand substrate, percentage of calcium carbonate of the sediments and salinity values of the bottom water are the main controlling factors for the spatial variations of this species.

In the present area, the stations with relatively higher living population (>= 15 specimens) along with their respective sediment type are as follows:

<table>
<thead>
<tr>
<th>Month</th>
<th>Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>5 (silty clay sand)</td>
</tr>
<tr>
<td>May</td>
<td>4, 5, 6 &amp; 7 (silty clay sand)</td>
</tr>
<tr>
<td>January</td>
<td>5 (silty clay sand)</td>
</tr>
</tbody>
</table>

Thus, in the present area, the most accommodative substrate for the abundance of population is silty clay sand.

Temporally, the population of this species in the study area is found to be positively correlated with temperature, dissolved oxygen of the bottom water, calcium carbonate content of the sediments and depth.

Considering the temporal as well as the spatial distribution of this species, it is inferred that the congenial environment for the thriving of this species in the present area are as follows:

- Temperature : > 30°C
- Depth : > 3.5 m
- Dissolved oxygen : > 4.4 ml/l
- Salinity : > 30‰
- CaCO₃ : > 14 %
- Organic matter : 1.9 – 2.80 %

In general, the population of this species multiplies during May
(summer) and spatially population of this species is found to be more in stations between 4 and 7, as noticed with most of the other widespread and abundant species of the area.

4.2.5.4. Ammonia beccarii (Linne)

4.2.5.4. a. Living Population

In the study area A. beccarii was found in living condition 60 out of the 69 samples collected. The living population in a station varies from 1 to 28 specimens per unit volume of sediment (100 ml of wet sediment).

The living and total population of A. beccarii in actual number of specimens and in percent of the living and total population are given in table 4.11 a-b. The distribution of this fauna in the study area is shown in figs. 4.1 a-c and 4.5.

The living population consists of more than 20 specimens in 8 samples (one in September, 4 in May and 3 in January); 16-20 specimens in 11 samples (4 each in September and January, 3 in May); 11-15 specimens in 9 samples (4 in September, 3 in May and 2 in January); 6-10 specimens in 14 samples (5 each in September and May and 4 in January) and =< 5 specimens in 18 samples (5 in September, 6 in May and 7 in January). Higher population of this species is noticed between stations 4 and 7.

Temporally, the living population of this species is found to be maximum in May (244 specimens) and minimum in September (197 specimens). The relative abundance of the living population of this species ranges from 4.9 % (station 5 of May and January) to 100 % (station 19 of September, 20 of May & January and 21 of May).
4.2.5.4. b. Total population

This species is found in living and/or in dead condition in 66 out of 69 samples. Among the stations, the total population of this species is found to range from 1 to 81, the maximum being at station 5 of May. In the study are more than 40 specimens of this species is found in 22 samples (7 each in September and January, 8 in May), 26 - 40 specimens in 13 samples (4 each in September and January, 5 in May), 11 - 25 specimens in 10 samples (4 each in September and January, 2 in May) and less than 10 specimens in rest of the samples. The analyses of spatial distribution of this fauna reveal that the concentration of this species is more between stations 4 and 7 in all the collections.

Temporally, the total population size varies from 717 specimens (May) to 625 specimens (January). The relative abundance of total population of this species is found to be minimum of (4.9 %) in station 3 of September to 100 % in all the collections.

4.2.5.4. c. Ecological consideration

This species occurs as living in 60 out of 69 samples. The living population is higher during May and is lower during September. Spatially, the abundance of population is concentrated between station 4 and station 7 in all the collections. The living forms are absent in the last 4 stations in September, 2 stations in May and 3 stations in January, mainly due to the lower salinity values that prevail in these stations.

Phleger and Lankford (1957) found that the reproduction of Streblus beccarii (Linne) occurs at frequent intervals and is not related with any season. Boltovskoy (1964) stated that A. beccarii (Linne) does not show any
periodicity and it is believed that reproduction occurs at frequent intervals throughout the year.

Venkata Rao and Subba Rao (1976) observed that *A. beccarii* is tolerant of extreme changes in ecological conditions in Chipurupalle stream. They have given the optimum conditions for the abundance of this species are as follows:

- **Salinity**: 32 - 33 ‰
- **Temperature**: 29.5 \(^\circ\)C - 34.0 \(^\circ\)C
- **Dissolved Oxygen**: 1.53 - 5.44 ml/l
- **Organic matter**: 0.82 - 1.59%
- **Substrate**: Silty clay or sandy clay

Kumar et al., (1996) and Kumar and Manivannan (2001b) after correlating this species with substrate characters and bottom water characters respectively, of the Palk Bay off Rameswaram observed that the living population size is maximum during July. Spatially the distribution of the species was found to be erratic. The limiting factor in controlling the living population was found to be silty sand type of substrate.

Srinivasan (1997) in his study of the foraminifera of Coleroon estuary South East Coast of India has found that the living population size is found to be maximum in July and minimum in October. In the area he has observed that silty sand, followed by clay sand, to be the favorable substrates for the thriving of this species. The optimum conditions for the thriving of this species in the area were found to be temperature: 31 \(^\circ\)C - 32\(^\circ\)C, salinity: >32.2 ppt – 33.6 ppt, dissolved oxygen: >3.8 ml/l - 5.2 ml/l and calcium carbonate: >10%.
Sivakumar (2002) concluded that the higher living population of this species is noticed during May, which is closely followed during September and lower during January. In his study he has also observed that this species is tolerant to wide range of environmental parameters and to the monsoon effects.

Gangaimani (2009) from his study of foraminifera off Tuticorin, SE Coast of India has found that the population of this species to be higher in April, closely followed during July and lower during October. The favourable substrate for higher population of this species in the area is found to be silty sand and silty clay sand substrate. He has found that the optimum conditions for the thriving of this species are temperature: 32°C, salinity: >32.5 ppt, dissolved oxygen: > 5.5 ml/l and organic matter: > 0.9 - 1.2%.

In the study area, the stations with relatively higher population (>20 specimens) of this species along with their respective sediment type are as follows:

<table>
<thead>
<tr>
<th>Month</th>
<th>Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>4, 5, 6, 7 &amp; 8 (silty clay sand)</td>
</tr>
<tr>
<td>May</td>
<td>3 (silty sand); 4, 5, 6, 7, 8 &amp; 9 (silty clay sand)</td>
</tr>
<tr>
<td>January</td>
<td>3, 4 (silty sand); 5, 6, 7, 8 &amp; 9 (silty clay sand)</td>
</tr>
</tbody>
</table>

Thus, in the present area, the most accommodative substrate for this species is silty clay sand substrate.

In the present study, the reproduction of *A. beccarii* (Linne) seems to occur at frequent intervals and is not influenced by change in environmental conditions prevailed during different seasons. But the spatial distribution of the species reveals that it prefers higher salinity of the bottom water and higher calcium carbonate content and organic matter.
content of the substrate for higher reproduction and population.

The optimum conditions for the thriving of this species in the present area are as follows:

- **Temperature**: $> 30^\circ C$
- **Depth**: $> 3.5$ m
- **Dissolved oxygen**: $> 4.4$ ml/l
- **Salinity**: $> 30$ %
- **CaCO$_3$**: $> 14$ %
- **Organic matter**: $1.9 – 2.80$ %

In general, the main controlling factors for higher reproduction of this species are the salinity of the bottom water and calcium content of the substrate along with silty clay sand substrate.

### 4.2.5.5. *Ammonia tepida* (Cushman)

#### 4.2.5.5. a. Living Population

*A. tepida* was found in living condition in 56 out of the 69 samples collected. The living population in a station varies from 1 (station 17, May and January) to 22 specimens (stations 5, May).

The living and total population of *A. tepida* in actual number of specimens and in percent of the living and total population in the study area are given in table 4.12 a-b. The distribution of this fauna in the study area is shown in figs. 4.1 a-c and 4.6.

The living population consists of $>20$ specimens in 1 sample (May); 16-20 specimens in 9 samples (one in September, 4 each in May and January); 11-15 specimens in 11 samples (5 in September, 3 each in May
and January); 6-10 specimens in 14 samples (4 each in September and January, 6 in May) and ≤ 5 specimens in 21 samples (7 in September, 6 in May and 8 in January). The living forms were absent in 13 samples (last 5 stations of September and 4 stations each during May and January.

Spatially, the average population size of each station for the three collections ranges from 1 (stations 17, 18 & 19) to 20 (station 5). The higher population is concentrated between stations 3 and 8 as noticed in other abundant species of the study area.

Temporally, the living population of this species is found to maximum in May (180 specimens) and minimum in September (147 specimens). The relative abundance of the living population of this species ranges from 3.9% in station 3 of September and 5 of May and January to 33.3% maximum in station 18 of September.

4.2.5.5. b. Total population

Among the stations, the total population of this species is found to range from 2 to 64 specimens, the maximum being at station 5 of May. In the study area more than 40 specimens of this species is found in 13 samples (4 each in September and January, 5 in May), 26 - 40 specimens in 14 samples (5 each in September and May and 4 in January), 11 - 25 specimens in 18 samples and less than 10 specimens in rest of the samples except last three samples of all the collections and station 20 of January where the specimens are completely absent. Spatial distribution reveals that the fauna, as in living population, is more concentrated between stations 3 and 9 in all the collections.

Temporally, the total population size is maximum (550 specimens) in
May and minimum (474 specimens) in January. The relative abundance of this species is found to be minimum (3.8%) in station 3 of September and May to 23.1% in station 20 of September.

4.2.5.5. c. Ecological consideration

Bradshaw (1961) from his laboratory experiments has observed that the reproduction of *A. tepida* occurs only between 20 °C and 30 °C with optimum conditions being 25 °C - 30 °C and salinity values between 20 ‰ – 40 ‰.

Kumar et al. (1996) in a detailed study of this fauna from the Palk Bay, off Rameswaram has found this species in living condition in almost all the samples and he attributes this to the tolerance of this species to the fluctuations of temperature, salinity, dissolved oxygen, organic matter, etc.,

Srinivasan (1997) after a detailed ecological study of this species from the Coleroon estuary stated that the living population is very abundant during April and is lowest in October. Analysis of temporal distribution of species reveals that the higher temperature, dissolved oxygen content and salinity values favour higher reproduction. He has found that the optimum conditions the thriving of this species are temperature: >31°C, salinity: >32 ppt, dissolved oxygen: >3.8 ml/l and calcium carbonate: >10%, and silty clay sand and silty sand substrate.

Gangaimani (2009) has observed higher living population of this species during April, closely followed during July and lower during October. The congenial substrates for this species are found to be silty sand and silty clay sand and the living as well as total population of this species is found to be directly proportional to the temperature and
dissolved oxygen content of bottom water and calcium content of the substrate.

In the present study area, this species occurs as living in 51 out of the total 69 samples. Relatively higher living population is noticed during April, which is closely followed during January and September. Spatially, the higher population is observed between station 3 and station 9 in all the collections.

In the study area, the stations with relatively higher population (>16 specimens) of this species along with their respective sediment type are as follows,

<table>
<thead>
<tr>
<th>Month</th>
<th>Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>September</td>
<td>5 (silty clay sand)</td>
</tr>
<tr>
<td>May</td>
<td>4, 5, 6 &amp; 7 (silty clay sand)</td>
</tr>
<tr>
<td>January</td>
<td>4 (silty sand); 5, 6 &amp; 7 (silty clay sand)</td>
</tr>
</tbody>
</table>

Thus, in the present area, the congenial substrate for the species is found to be silty clay sand.

In the present study the temporal distribution of living population of *A. tepida* reveals that this species reproduce periodically irrespective of the change in environmental conditions.

But, spatial distribution of *A. tepida* indicates that the species prefers higher calcium carbonate content and organic matter content of the substrate and higher salinity values of bottom water.

The optimum conditions for a higher reproduction of this species in the present area are as follows:

Temperature : > 30° C
Depth : > 3.5 m  
Dissolved oxygen : > 4.4 ml/l  
Salinity : > 30 ‰  
CaCO₃ : > 14 %  
Organic matter : 1.9 – 2.80 %

The congenial conditions for higher reproduction of this species are the salinity of the bottom water and calcium content of the substrate along with silty clay sand substrate.

The study of the distribution and ecology of the abundant foraminifera species reveals the following:

- In the present study, the temporal distribution of living population comparatively higher reproduction and population of foraminiferal fauna reveals that during May (summer) is mainly due to the congenial environmental conditions that prevailed during this period.

- But, spatial distribution of these abundant forms indicates that they prefer higher calcium carbonate content, organic matter content and sediment fines of the substrate and higher salinity values of bottom water.

- In the study area, uncongenial environmental conditions such as sandy substrate (stations 1 & 2) or low salinity have resulted in (stations 18 to 19) lower population and species diversity and hence predominance of abundant species.

- The total absence of living forms in stations between 20 and 23 is mainly due to the very low salinity values.
• The less population encountered during September is due to the greater flow of fresh water in the river estuary brought by the rain caused due to monsoon and depressions in the adjoining Bay.

• The accommodative substrates that favour the population abundance are silty clay sand and followed by silty sand.

In general, living population of the Vellar river estuary is mainly controlled by the salinity of the bottom water, CaCO₃ content of the substrate. The favourable substrate for higher reproduction are silty clay sand and silty sand.