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ECOLOGY AND OCCURRENCE OF *PUGILINA (HEMIFUSUS) COCHLIDIUM* AND *PUGILINA ERECTA (GASTROPODA:* MELONGENIDAE) FROM THONDI COAST , PALK STRAIT IN TAMIL NADU.

ECOLOGÍA Y OCURRENCIA DE *PUGILINA* (*HEMIFUSUS*) *COCHLIDIUM* Y *PUGILINA ERECTA* (GASTROPODA: MELONGENIDAE) DE LA COSTA THONDI, ESTRECHO PALK EN TAMIL NADU.

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ABSTRACT

The environment is a selective force of an organism and its population. Knowledge of the environmental parameters of study area is thus an essential prerequisite to understand the composition of animal's inhabitants and their distribution. In the present study the Ecology and Occurrence of two species of *Pugilina (Hemifusus) cochlidium* and *Pugilina erecta* along the coast of Thondi are influenced by the environmental factors with less significance. As these animals are bottom living, they were not much affected by changes in the environmental factors. In the present study the maximum temperature was recorded during summer season and the minimum during monsoon. The changes in the temperature have been proved to have meager influence in the distribution of these two species as the temperature variation was not sufficient enough to affect their distribution.

Keywords: *Pugilina (Hemifusus) cochlidium*, *Pugilina erecta,* temperature, monsoon, distribution.

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RESUMEN

El medio ambiente es una fuerza selectiva de un organismo y su población. El conocimiento de los parámetros ambientales del área de estudio es, por lo tanto, un requisito previo esencial para comprender la composición de los habitantes de los animales y su distribución. En el presente estudio, la Ecología y la ocurrencia de dos especies de Pugilina (Hemifusus) cochlidium y Pugilina erecta a lo largo de la costa de Thondi están influenciadas por los factores ambientales con menos importancia. Como estos animales viven en el fondo, no se vieron muy afectados por los cambios en los factores ambientales. En el presente estudio, la temperatura máxima se registró durante la temporada de verano y la mínima durante el monzón. Se ha demostrado que los cambios en la temperatura tienen poca influencia en la distribución de estas dos especies, ya que la variación de temperatura no fue suficiente para afectar su distribución.

Palabras clave: *Pugilina* (*Hemifusus*) *cochlidium*, *Pugilina erecta*, temperatura, monzón, distribución.

INTRODUCTION

Environmental conditions also play an important role in promoting the occurrence and abundance of commercially exploitable marine resources (Ivelev, 1966). Hydrographical parameters such as rainfall, temperature, salinity and dissolved oxygen determine the distribution and survival of the animals in estuaries, mangroves and in other environments. They directly or indirectly affect the life activities of each and every organism in various levels of their life. The organisms and their habitat adaptations are imperative for their survival. The environment is a selective force of an organism and its population. Knowledge of the environmental parameters of study area is thus an essential prerequisite to understand the composition of animal's inhabitants and their distribution, dispersal and relative zonal abundance within the vast and interior areas of the coastal waters. The physico-chemical parameters are involved in determining the distribution of living components of an ecosystem.

Alvarez-Borrego et al (1984) have studied the temperature and salinity in Esterode punta banda. Ramanathan (1987) has studied the salinity distribution in Khawr. Robert et al*.,* (1987) have observed the hydro biological parameter in Arcachen

basin. In Indian waters, studies are limited to very few observations has been made on the distribution and ecology of the molluscan fauna by Harkantra (1975) and Narasimham (1988). In India following works with regard to the hydrobiological aspects and valuable studies have been reported were Singbal, (1973); Nair & Ganapathi (1983); Rao & Valasraj (1984) and Patare (1998). De Sousa et al., (1981). Extensive studies have been made pertaining to the spatio-temporal distribution and behaviour of nitrate-nitrogen, phosphate-phosphorous and silicate-silicon in many estuaries of India (Reddy et al., 1983; Gowda and Panigrahy, 1992; Das et al., 1997).

Narayanaswamy and Sarma (1982) have studied the physical characteristics of the coastal waters between Navapur and umbharat. The hydrography of the inshore waters of Karwar was has been observed by Annigeri (1986). Dharmaraj et al., (1986) have studied the hydrographical feature of Vizhinjam inshore waters. Rivonker and Verlancar (1990) have made observations on the physico-chemical characteristics of fishing grounds of Mangalore coast. Jagadeesan (1986) has studied the environmental inventory of the marine zone of Coleroon estuary and inshore waters of Pazhayaru. Gemma Evangeline (1975) has studied the hydrobiology of the estuaries and backwaters of Ramanathapuram district, Tamil Nadu. Rama Raju et al., (1989) have studied the hydrography of wedge back pre-monsoon and monsoon seasons. Arunabha et al. (1990) have observed the seasonal variations of some hydrographical parameters in a tidal creek opening into the Bay of Bengal. Karl Banse (1990) has made oceanographic observations of the east coast of India. Relatively more information is available on the plankton and hydrography of the Gulf of Mannar (Chacko and Malu Pilay1957; Chacko and Rajendran 1959; Chidambaram et al.,1951; Arunabha et al. (1990); and Marichamy and Pon.Siraimeetan. 1979).

Albertson, (1980) studied the long term effects of high temperatures and low salinities on specimens of *Melongena corona* and *Nassarius vibex*. Dinetz, (1982) studied the intraspecific variation and size distribution of the crown conch, *Melongena corona.* Woodbury, (1986) studied the role of growth, predation, and habitat selection in the population distribution of the crown conch, *Melongena corona.* Pon Siraimeetan et al., (1987) studied the habitat ecology and food of *lambis lambis* and *hemifusus cochlidium.* Bowling, (1994) studied the habitat and size of the florida crown conch *Melongena corona*. Walker, (1998) studied a population study of *Melongena corona*. Chapman, (2000) describes a comparative study on differences among species and patches of habitat on the movements of three species

of intertidal gastropods. Kaplowitz, (2001) studied the uncovering the economic benefits of *Chivita* (*Melongena melongena* & *Melongena corona bispinosa*. Trussell, (2002) studied the gradient variation in the growth of an intertidal snail in response to water velocity. Power et al., (2002b) studied the Population biology of melongenid whelks in the intertidal zone.

In terms of molluscan ecology, the limits of marine water habitat may be the best defined area on the basis of faunal assemblages, communities that live in water with certain temperature for an adequate period for reproduction or maturation. Ecological factors such as salinity, pH, dissolved oxygen, temperature and rainfall may affect the breeding cycle and growth of all organisms. Hence, it is imperative to know the interrelationships between the organisms and the environmental parameters in order to evaluate the suitability and function of ecosystem. Previously no attempt has been made in the study of ecology of *Pugilina (Hemifusus) cochlidium* and *Pugilina erecta* in Thondi coast, Palk bay and hence the present investigation was carried out on Physico-Chemical parameters at Thondi coastal waters of Palk bay.

MATERIALS AND METHODS

Samplings: The water samples were collected from the study area for a period of one year from January 2018 to December 2018, 12 months duration, divided, for convenience, into post-monsoon (January – March), summer (April – June), pre-monsoon (July – September) and monsoon (October – December) seasons. The monthly rainfall data were collected from the metrological observatory unit at Thondi. Monthly water samples were collected in Thondi area from January 2018 to December 2018, Samplings were made on every full moon during high tide. In the present investigation surface water samples were collected by using clean plastic containers. Samples of sediment were collected every month using a Vanveen grab. The samples were collected and packed in polythene bags and stored in a freezer adjusted to about -20^0 C. For estimation of the nutrients in the sediment samples, the frozen samples were thawed and dried at specified temperatures, before the samples can be used for analysis nutrients. The amount of nutrients present in the samples was expressed as µg/g.

Estimation of Physico-Chemical Parameters: Determination of surface water temperature: The temperature the surface water was recorded and the mean temperature was recorded by using the standard Celsius thermometer. Estimation

of salinity: The Classical Mohr Titration method (Strickland and Parsons, 1972), was adopted to estimate salinity of water samples collected from the stations. Initially, Chlorinity was estimated. Using Knudsen's equation salinity was established. Measurement of pH: An Elico LI 120 model pH meter was Pre calibrated with standard buffer solutions of pH 4.0, 7.0 and 9.2. Water samples were collected from the study area is used to measure pH. Estimation of dissolved oxygen: Winkler's method (Strickland and Parsons, 1972), was adopted to estimate the dissolved oxygen content in the water samples collected from the station. The water samples were fixed in the station and titrations were done by adopting routine procedures in the laboratory, and the readings were recorded. Turbidity The method is based on a comparison of the light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension. It is expressed as NTU (Nephelometric Turbidity Unit). Total Suspended solids: Suspended solids are the retained material and a standard glass fiber filter disc in agooch crucible after filtration of well mixed sample. The residue is dried at 103°C-105°C and weighed. Transparency: The limit of visibility is measured using Secchi disc.

Population Studies: In the present study the *Pugilina* (*Hemifusus*) *cochlidium* and *Pugilina erecta* are marine benthic gastropods found to distributed at the depth of 10-15 fathoms. Their nature of habitat posed great difficulties in sampling for population studies. The animal was collected by operating the trawler (10 - 19 nautical mile/hour) for hours, using the trawl net of mesh size (1.0cm). The collected population was examined to record the number of males and females.
Statistical analyses: The data generated during the one year period of study were subjected to statistical analysis, to extract inferences and to be able to interpret the relationships between variables. Statistical Package for Social Scientists (SPSS) 10.0.1 version, which is a comprehensive statistical package, was employed. Correlations between all the parameters were worked out.

RESULTS AND DISCUSSION

Coastal ecosystems, especially in the tropical regions, have been known for their richness in biological productivity. The physico-chemical characteristics of an aquatic ecosystem undergo changes due to the action of tides, inflow of domestic and industrial effluents and during rainfall consequently, the biological characteristics are also likely to change. The physico-chemical parameters such as temperature,

salinity, dissolved oxygen, pH and nutrients showed seasonal variations (Tables 3 & Fig 1).

Rainfall: In the present study the minimum (0.2mm) rainfall was recorded during May and the maximum (390.5mm) rainfall was recorded during November. In the study area the rainfall was mainly influenced due to northeast monsoon. The bulk of rainfall was obtained during the northeast monsoon and the pattern of rainfall influenced the physico-chemical and biological characteristics of the study area. Rainfall results in the inflow of fresh water from rivers and estuaries. Seasonal variations brought about by monsoon cycles and tidal rhythms have been known to be responsible for natural variations in the physical, chemical and biological characteristics of the coastal ecosystem (Keesing & Irvine, 2005). In addition, anthropogenic inputs have altered the character of the coast adversely and resulted in biodiversity hot-spots.

Table 1. Correlation analysis of Environmental parameters in studied site.

	Temp. (°C)	Salinity (‰)	pH	DO mg/l	Turbidity (NTU)	TSS (mg/l)	Transparency (m)
Temp. (°C)	1						
Salinity (‰)	0.8120	1					
pH	-0.2331	-0.1820	1				
DO mg/l	0.0828	0.0209	-0.2849	1			
Turbidity (NTU)	-0.3703	-0.4629	0.2289	-0.1334	1		
TSS (mg/l)	-0.6170	-0.7732	0.2157	-0.1191	0.8288	1	
Transparency (m)	0.0180	0.3442	0.2613	0.1927	-0.2933	-0.5391	1

Water temperature (Table 1) varies in accordance with ambient air temperature. In Thondi maximum temperature was recorded 34.2 ºC during summer and the minimum of 29.3ºC during monsoon. The maximum temperature of 34.2°C was due

to the high solar radiation. The maximum and minimum values of surface temperature were attributed with peak solar radiation and the temperature of water essentially influenced by the atmosphere. The range of water temperature in the present study is comparable with the earlier records in this area. Alvarez Borrego & Alvarez Borrego (1982) have suggested the temperature variations as a function of bathymetry, solar radiation, tidal currents, incidence of upwelling waters and atmospheric variations. Marichamy et al., (1985) have reported that both air temperature and surface water temperature steadily increased from winter (September-October) to summer (April-May). The appreciable reduction in temperature during November to January may be due to the effect of rainfall and influx of rain water as evidenced by the lowering of salinity and incidence of the cold cyclonic climate and minimum solar radiation due to heavy clouds covering during these rainy days.

Salinity (Table 1) varied over a narrow range of 30.2 -34.3 ‰. In the study area, salinity recorded the minimum (30.2 ‰) and maximum (34.3 ‰) during monsoon and summer months. High salinity were recorded during summer seasons and low salinity obtained during monsoon seasons. Variations in salinity were observed to be due to rainfall and flow of freshwater into the sea during changing tides. The low salinity associated with the anthropogenic freshwater inputs (Saunders et al., 2007) and the low salinity in the study area is probably due to the huge volume of fresh water, but also an indication that within a saline system the input of considerable freshwater could be considered as a pollutant (Saunders et al., 2007). Such characteristics are common in Indian estuaries where nutrient levels are controlled by anthropogenic discharges (De-Sousa 1999). Grasshoff, (1976) has revealed that salinity variation is mainly influenced by anthropogenic fresh water influx rather than prevailing regime.

pH (Table 1) Variations in pH were very meager during the study period. The minimum pH (8.0) was recorded during post monsoon and maximum pH (8.2) during summer seasons. pH values showed seasonal variations during the study period. In the present study, pH showed minimum during monsoon and maximum during summer. Generally, higher pH values may be attributed to sea water mixing and redox variations in sediment and water column while lower pH values are observed during monsoon may due to influx of freshwater, and tide action (Panigrahy et al., 1999). The high pH in Thondi coastal waters mainly influenced by high and low photosynthetic activities, that contributes to an elevation of the level of pH. The

significant difference of pH is attributed to low and high primary productivity zones, respectively. The relationship of high pH and high primary productivity has been defined as the phenomenon of stagnant aquatic environments and saline reservoirs in India (Nayak et al., 2004; Mustafa 2005).

Dissolved oxygen (Table 1) In Thondi the minimum value of DO 3.96 mg/l was recorded during monsoon and maximum value of DO 4.68 mg/l during post monsoon. The high oxygen content especially during north east monsoon could be attributed to low temperature and low salinity values which might help to enhance the level of dissolved oxygen content in water. Rochford (1951) has stated that greater solubility of oxygen in water takes place when temperature and salinity are low. A similar observation has been reported by Ramamoorthi (1953) in madras coastal waters. Ganapati and sarma (1958) at Vishakapatnam have observed a direct relationship between oxygen and temperature. Satpathy (1996) has reported that maximum dissolved oxygen value was observed during monsoon period co-incides with the seasonal salinity minimum. Similar observation was also noted in the present study. Correlation analysis between salinity and dissolved oxygen showed significant negative correlations by Satpathy (1996).

The significant positive correlations of water temperature with dissolved oxygen, during summer in contrast with the significant negative correlations of the water temperature with dissolved oxygen during monsoon. This clearly defines the critical role of temperature controlling the water chemistry that increases and decreases dissolved oxygen levels in monsoon and summer seasons, respectively. This is exemplified by conditions during summer when small bubbles are present in the sea associated with organic matter, grow in the presence of high oxygen saturations (Ramsey 1962). Much work has been done in recent years to explore the relationship between economic development and environmental quality (Hale et al., 1998; Hale & Guardia, 2001; Hale et al., 2001). Dissolved oxygen content in the study area varied from 3.96mg/l to 4.68mg/l. However higher values were recorded during monsoon 5.89/mg/l which is in agreement with Kamala (1983). In the present study, it has been observed that fluctuation in dissolved oxygen content was not a limiting factor in the distribution of animals.

Turbidity (Table 1) In the study area, turbidity varied between 16 – 49 (NTU). The minimum value of 16 (NTU) was recorded during post monsoon and the maximum value of 49(NTU) was recorded during monsoon. TSS (Table 1). In the study area,

TSS varied from 45.82 – 75.01(mg/l). The minimum value of 45.82 (mg/l) was recorded during post monsoon and the maximum value of 75.01(mg/l) was recorded during monsoon. Transparency (Table 1). In the study area, transparency of water varied from 1.12 – 1.51 (m). The minimum transparency was recorded 1.12m during monsoon and the maximum value of 1.51 was recorded during summer. In the present study statistical analysis of environmental parameters in Thondi revealed both Positive and negative Correlation (Table 1). The strong positive correlation was observed in between TSS and Turbidity. Weak positive correlation was observed in between DO and Salinity and the weak negative correlation was observed between DO and TSS. The moderate negative correlation was observed between pH and Temperature.

Population Density: *Pugilina* (*Hemifusus*) *cochlidium* and *Pugilina erecta* Sex ratio: Of the 1387, individuals of *Pugilina* (*Hemifusus*) *cochlidium* examined, 547 were males and 840 females. In *Pugilina erecta ,* out of 1165 individuals examined, 439 were males and 726 females (Tables 2 and 3). Statistical analysis showed a significant difference in two species between males and females in the sex ratio. The male and female ratio in *Pugilina* (*Hemifusus*) *cochlidium* and in *Pugilina erecta* was 3:1. These were preponderance of females over males. This was also found to be the case when considered month wise. Tables show the number of percentage, sex ratio and chi-square values of these two species. The sex ratio of male and female in both the species fluctuating in monthly samplings and also in different size groups. Chi-square analysis showed that the sex ratio deviated significantly from the expected 1:1 ratio in two species.

The number of animals collected by trawl operation from January 2018 to December 2018 was recorded and is given in Tables 1 and 2. Number of males and females was also enumerated. The total number of *Pugilina* (*Hemifusus*) *cochlidium* collected during the entire study period was 1387 and it comprised of 547 males and 840 females, whereas in *Pugilina erecta the* total number was 1165 and it comprised of 439 males and 726 females. The minimum numbers in Pugilina (Hemifusus) cochlidium 77 were recorded during Dec and it comprised 34 males and 43 females whereas in *Pugilina erecta* it was recorded as 59 during December and it comprised 26 males and 33 females. The maximum number 154 of *Pugilina (Hemifusus) cochlidium* recorded during May and it comprised 58 males and 96 females and *Pugilina erecta* was recorded 126 during in May which comprised 47 males and 79 females. During the study period in *Pugilina* (*Hemifusus*) *cochlidium* males occurred

in the minimum number (34) and females (43) in December while the maximum number of males was found in May (58) and maximum number of females (96) in May. In *Pugilina erecta* the minimum number of males (26) and in females (33) was recorded during December while maximum number of males (47) and in females (79) was found in May.

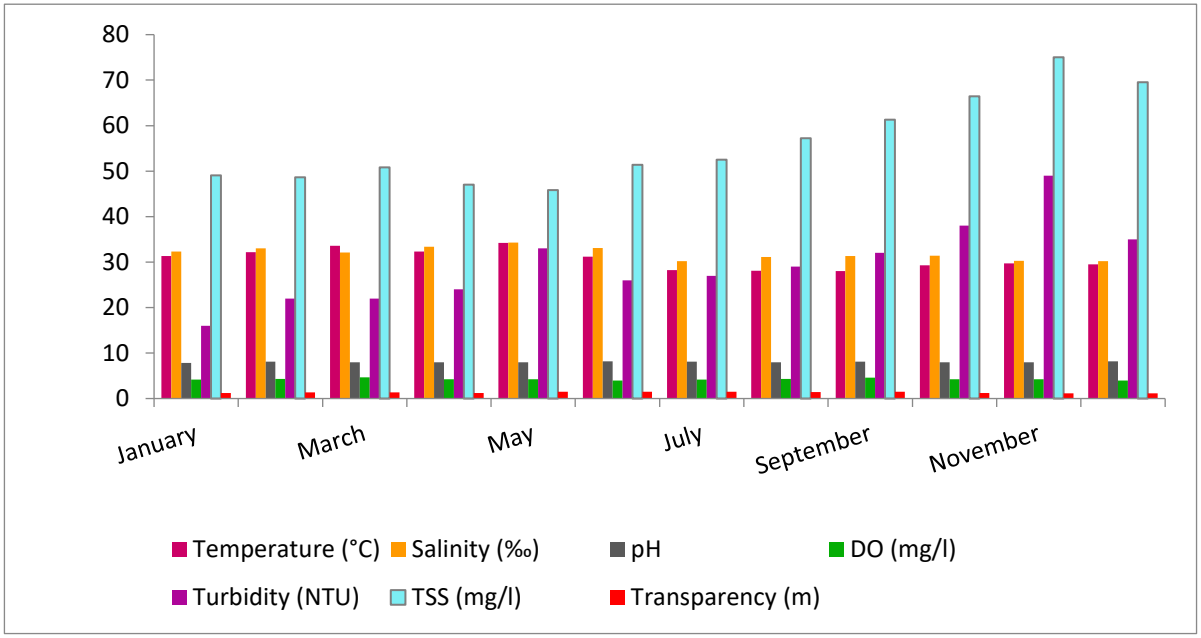

Fig.1. Variations in the Physical properties of seawater from Thondi during Jan -Dec 2018

Table 2. *Pugilina (Hemifusus) cochlidium* population parameters measured in the present study.

Month	Male (Nos)	Female (Nos)	Male (%)	Female (%)	Ratio	Chi Square Value	'P' Value
Jan	35	60	36.84	63.16	1.71	5.407	0.0201
Feb	42	73	36.52	63.48	1.74	0.826	0.3632
March	50	72	40.98	59.02	1.44	0.051	0.8203
April	49	81	37.69	62.31	1.65	1.037	0.3084
May	59	90	39.60	60.40	1.53	1.242	0.2651
June	55	81	40.44	59.56	1.47	6.020	0.0141
July	49	81	37.69	62.31	1.65	9.592	0.0020
August	43	72	37.39	62.61	1.67	0.794	0.3727
September	39	64	37.86	62.14	1.64	6.150	0.0131
October	46	73	38.66	61.34	1.59	20.71	< 0.0001
November	40	38	51.28	48.72	0.95	1.421	0.2333
December	40	55	42.11	57.89	1.38	2.921	0.0874
Total	547	840	39.44	60.56	1.54	20.12	< 0.0001

Table 3. *Pugilina erecta* population parameters measured in the present study.

Month	Male (Nos)	Female (Nos)	Male (%)	Female (%)	Ratio	Chi Square Value	'P' Value
Jan	26	54	32.50	67.50	1:2.08	0.234	0.6280
Feb	39	65	37.50	62.50	1:1.67	1.864	0.1721
March	43	51	45.74	54.26	1:1.19	0.088	0.7656
April	37	75	33.04	66.96	1:2.03	5.707	0.0169
May	45	59	43.27	56.73	1:1.31	0.640	0.4236
June	39	76	33.91	66.09	1:1.95	16.14	< 0.0001
July	32	67	32.32	67.68	1:2.09	10.38	0.0013
August	38	63	37.62	62.38	1:1.66	1.375	0.2410
September	35	61	36.46	63.54	1:1.74	1.443	0.2296
October	38	62	38.00	62.00	1:1.63	0.637	0.4246
November	35	62	36.08	63.92	1:1.77	0.020	0.8853
December	32	31	50.79	49.21	1:0.97	0.036	0.8492
Total	439	726	37.68	62.32	1:1.65	7.003	0.0081

In the littoral area, seasonal salinity fluctuation was observed. The maximum and minimum salinity were recorded during summer and monsoon respectively. The animals can thrive well in the salinity range of 30.1‰ to 34.5‰. Since the animals are capable of withstanding salinity fluctuation in the above range, the population of two species was not affected in the littoral area. Similar observation has been earlier made by Tagore (1989). In the study area, hydrogen ion concentration ranged between 8.0 to 8.2 and as such hydrogen ion concentration variation was not affected their distribution and abundance of the animal population. Similar observation was also made by Carriker (1955) for muricid gastropods. In general, high values of dissolved oxygen are associated with high values of primary productivity (Krishnamurthy and Vishwanathan, 1968). It is assumed that high concentration of oxygen is met with before and after the outburst of phytoplankton (Subramanyan, 1959). The higher concentration at the surface water may be due to the effect of photosynthetic activities of the phytoplankton and higher solubility of oxygen in low saline water.

With the accumulation of information on the distribution of animal life in oceans, differences in the habitats at different depths became increasingly evident. These differences are shown by the kinds of animals occurring at different levels, by their abundance and by the modification of characteristics such as colour, size, feeding habitats and breeding etc. In the present study the distribution and abundance of two species of *Pugilina* (*Hemifusus*) *cochlidium* and *Pugilina erecta* along the coast of Thondi are influenced by the environmental factors with less significance. As these animals are bottom living, they were not much affected by changes in the environmental factors. In the present study the maximum temperature was recorded during summer season and the minimum during monsoon. The changes in the temperature have been proved to have meager influence in the distribution of these two species as the temperature variation was not sufficient enough to affect their distribution. This is in agreement with the observation have been made by Kurian (1972) and Ajmalkhan et al. (1975).

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