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ON THE ZOOGEOGRAPHY OF THE INTERSTITIAL MEIOFAUNA OF THE ANDAMAN AND NICOBAR ISLANDS, INDIAN OCEAN

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(With 3 Text-figures and 2 Tables)

INTRODUCTION

Our knowledge of the interstitial meiofauna inhabiting the intertidal sands of temperate and tropical coastal waters has been considerably enriched due to the valuable contributions made by many workers since the inception of the studies nearly half a century ago. Extensive researches were carried out on the European coasts and a few other areas, leading to many an interesting discovery on various aspects of the fauna. On the other-hand, nothing is known until quite recently about the interstitial life and the ecological conditions prevailing in other parts of the world. This is particularly true with the Indo-Pacific region, where much exploration and discovery of the fauna still remain to be accomplished in several areas. Thus, any investigation of the Indian ocean, which is known to constitute an important biological link uniting the Atlantic and Pacific waters and bordered by many unexplored regions well isolated by vast stretches of the ocean, will doubtless contribute to a better understanding of the geographical distribution of these animals. Some limited explorations have, however, been carried out in the Indian Ocean on the coasts of Red Sea, South Africa, Mozambique, Madagascar, Maldives, Kerguelen, India, Malaysia and Australia.

Nothing is known of the interstitial meiofauna of the Andaman and Nicobar Islands until the three recent faunistic surveys undertaken by the Zoological Survey of India in the years 1969, 1973 and 1974. During these surveys, the author had an opportunity to make collections of the fauna on some of these islands and study the material. The data presented here includes the author's published and unpublished work. These qualitative collections made at random indicated the presence of a rich variety of fauna of diverse groups that are characteristic of beaches in other parts of the world.

It is premature to attempt a full article on zoogeography when the interstitial meiofauna of the Andaman and Nicobar Islands and other coasts of the Indian Ocean is incompletely known, making a zoogeographical comparison difficult. Yet, a preliminary attempt is made here with the information hitherto available.

Topography and Collecting Localities

The Andaman and Nicobar Islands comprise an arcuate chain of 348 islands of various sizes spread in a distance of about 1120 km and located between Lower Burma and Upper Sumatra of Indonesia in the Bay of Bengal. They are summits of the submarine range of hills that connects Arakan Yomas of Burma with Achin head in Sumatra. The Andaman group with 324 islands forms the northern part of the chain, while the Nicobar group with 24 islands the southern. The total land area of these islands is about 8,293 sq kms. The islands have a mass of hills enclosing valleys and a large part of the territory is covered with dense evergreen tropical forests. The vegetation is mostly Burmese and Malay type. The climate is typically tropical, with heavy gales and rainfall. The soil varies from sand to clay. Some of the shores support rich growth of mangrove vegetation and coral reefs of the fringing type.

The collection of fauna was made at the following 24 stations on the archipelago (Text-figs. 1—2). The stations are serially numbered. The major part of the collections were made from the Andaman group of islands.

North Andaman.—(1) Stewart Island, (2) Sound Island, (3) Aves Island, (4) Mayabander.

Middle Andaman.—(5) Rangat Bay, (6) Long Island.

South Andaman.—(7) Peal Island, (8) Havelock Island, (9) Neil Island, (10) Ross Island, (12) Aberdeen Bay, (12) Wandur, (13) Rangachang, (14) Chiriatapu.

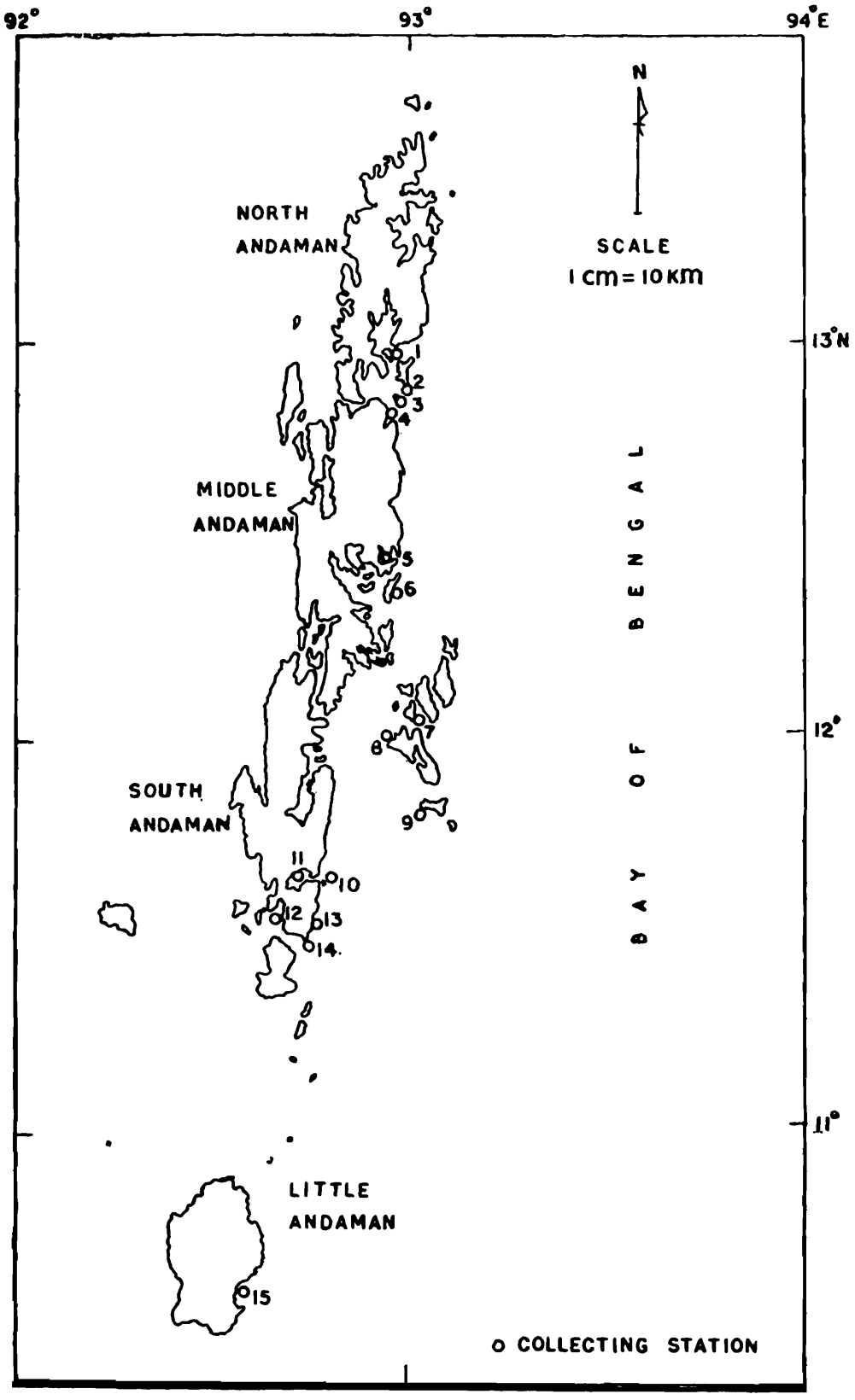
Little Andaman.—(15) Hut Bay.

Car Nicobar.—(16) Sawai Bay, (17) East Point, (18) West Point.

Kamorta.—(19) Nancowry Harbour, (20) Chotina Bay, (21) Champin Island, (22) Katchal Island.

Great Nicobar.—(23) Campbell Bay, (24) Bonnington Bay.

The collection of fauna was generally made at 3 to 5 places depending on the extent of exposure between the low and the high tide levels of the intertidal zone ; but mostly taken near the half-tide level, where bulk of the fauna normally distributed. With the help of a shovel, sand samples were dug out at various depths in the intertidal zone from top to a depth 50 cm below surface and transported to field laboratory in open polythene jars. Each sample of 100 ml was placed in a beaker containing 6% magnesium chloride solution, 10-15 minutes allowed for anaesthetization of fauna and then the



Text—fig. 1. Map of the Andaman Islands, showing collecting stations 1-15.

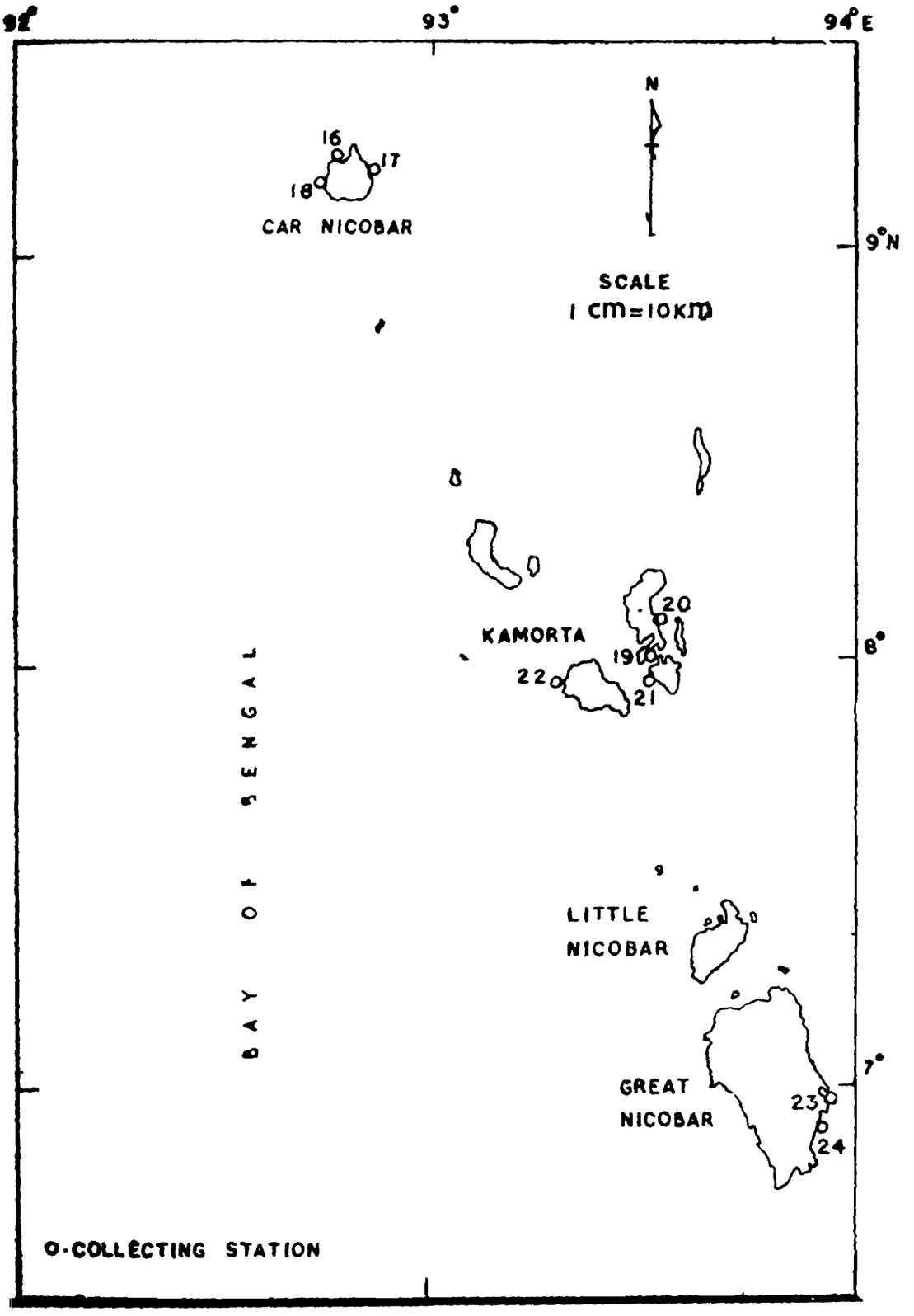
sediment vigorously stirred. After a momentary settling of the coarse sediment, the supernatent water was quickly decanted through a seive with apertures of 65 μm. The stirring and decanting processes were repeated thrice, when bulk of the fauna got removed from the sediment. Animals thus released on the seive were washed off into a vial with a jet of filtered sea water. The diverse groups of fauna present in each sample were examined under a binocular microscope, sorted out and counted. The soft fauna was studied in fresh condition or fixed in Bouin's fluid and preserved in 70% alcohol ; while the hard fauna was preserved in 5% neutral formalin containing 2% glycerine, for subsequent analysis.

Habitat and Distribution of Fauna

The archipelago offers a rich variety of habitats for the colonization of fauna. Thus, the biogeographic importance of these islands lies mainly in providing isolated biotopes, favouring evolution of a variety of species. In many of the islands investigated, the coast is mostly rocky and sandy or muddy. In some areas the sandy beaches are extensive, while in other places they are restricted to patches between cliffs. Many of the beaches studied are exposed to surf action, while some are sheltered. The sands are mostly fine and medium, silicious or coralline, and grain shape varied from spherical to angular. Temperature and salinity of interstitial water in the habitat varied between 26°C to 30°C and 29‰ to 34‰, respectively. The intertidal sands are sufficiently rich in organic detritus.

The fauna was collected from coarse sandy substrates to soft sediments. The general pattern of distribution of the diverse groups of fauna at different intertidal and vertical levels of these sandy beaches more or less conforms with the conditions reported in other parts of the world. Widely distributed species occurred in different kinds of substratum. Sheltered beaches with adequate coarse particle size generally harboured rich populations of the fauna, probably due to the less disturbed habitat that permits an uninhibited proliferation of the fauna. Beaches with very fine or muddy sand yielded poor collections. Thus, the majority of species showed preferences to habitat selection and are not susceptible to abiotic conditions of the environment. Bulk of the fauna occurred near half-tide level 10-40 cm below surface, depending on the distance from low water level.

The density and diversity of the fauna varied from island to island and locality to locality. Thus, a considerable percentage of the species are stenotopic with restricted distribution, while the others appeared to have a wider distribution on these islands. Quantitatively, the density of the fauna is comparatively low and a maximum of only 600-800 specimens could be collected in 100 cm^3 sand (Rao. 1970a). Almost all the typical groups of the interstitial meiofauna, excepting Mystacocarida and Bryozoa, were collected in these sandy beaches.



Text—fig. 2. Map of the Nicobar Islands, showing collecting stations 16-24.

Quantitatively, the copepods formed a dominant element of the total meiofauna (Fig. 3A). Annelids and nematodes were generally second in overall abundance. The Ciliata, Turbellaria, Gnathostmulida, Gastrotricha, Isopoda and Amphipoda, are moderately represented. All the other groups of animals occured in very small numbers.

List of Species

The list of interstitial meiofauna species of the diverse groups hitherto identified from these islands, together with their known geographical distribution, is given in Table 1. The distribution shown for few of these species is not complete due to non-availabity of the concerned literature. The collecting localities, abundance and collection data of these individual species will be given while publishing the detailed reports of the concerned groups. The fauna is largely composed of species of well known genera having more or less a global distribution. Recent investigations on different parts of the world have indicated a wide geographical distribution of many interstitial species and the present study further adds to the ranges of several species. Thus, these zoogeographical ranges will be extended as more and more areas

Table—1. The known geographical distribution of interstitial meiofauna species of the Andaman and Nicobar Islands on other coasts of the world. *Species which are uncertain endemics.+denotes record of the species. Africa includes Madagascar.

Alphabetical list of species	India	Africa	Europe	America	Other parts
CILIATA					
* *Aspidisca* sp.					
Coleps tesselatus Kahl	+		+	+	
* *Coleps* spp. (2)					
Condylostoma patens (O. F. Muller)	+		+	+	
Diophrys appendiculata (Ehrenberg)	+		+	+	Japan
* *Diophrys* sp.					
Epiclintes ambiguus (O. F. Muller)	+		+	+	Japan
Euplotes vannus O. F. Muller	+		+	+	
* *Euplotes* sp.					
Geleia fossata Kahl	+		+	+	
Lacrymaria olar O. F. Muller	+		+	+	Japan
Metopus vestitus Kahl	+		+	+	Japan
Oxytricha marina Kahl	+		+		Japan

Alphabetical list of species	India	Africa	Europe	America	Other parts
Pleuronema coronatum Kent	+		+	+	Japan
• *Prorodon* sp.					
• *Remanella* sp.					
• *Trachelocerca* sp.					
Tracheloraphis phoenicopterus(Cohn)	+		+	+	
• *Tracheloraphis* sp.					
Urotricha globosa Schewiakoff	+				New Zealand
CNIDARIA					
• *Anthohydra psammobionta* Salvini-Plawen and Rao					
• *Halammohydra andamanensis* Rao					
• *Halammohydra chauhani* Rao					
• *Halammohydra* sp.					
TURBELLARIA					
- *Acanthomacrostomum gerlachi* Ax	+				Māldives
• *Breslauilla* sp.					
Cheliplana vestibularis Beauchamp	+		+		
• *Cicerina* sp.					
• *Coelogynopora* spp. (3)					
• *Convoluta* spp. (2)					
• *Diascorhynchus* sp.					
Gyratrix hermaphroditus Ehrenberg	+	+	+	+	Galapagos, Greenland, Japan.
• *Macrostomum* spp. (2)					
• *Minona* sp.					
Monocelis lineata (O. F. Muller)	+		+		
• *Nematoplana* sp.					
• *Otoplana* spp. (3)					
• *Plagiostomum* spp. (2)					
• *Polycystis* sp.					
• *Promesostoma* spp. (2)					
• *Proxenetes* sp.					
• *Rogneda* sp.					
• *Schizochilus* sp.					
• *Utegla* sp.					

Alphabetical list of species	India	Africa	Europe	America	Other parts
Vejdovskya pellucida (M. Schultze)	+		+		
GNATHOSTOMULIDA					
* *Austrognathia* sp.					
* *Gnathostomula* spp. (2)					
* *Haplognathia* sp.					
NEMATODA					
Anticoma acuminata (Ebrth)	+		+	+	Red Sea, Maldives
Anticoma arctica Steiner	+		+	+	Red Sea, Maldives
* *Araeolaimus* sp.					
* *Bathyepsilonema* sp.					
* *Bathylaimus* sp.					
Camacolaimus prytherchi Chitwood	+			+	Maldives Bermuda
* *Ceramonema* sp.					
Chromadora vulgaris Bastian	+		+	+	
Chromaspirina indica Gerlach					Maldives
Desmodora brevicollis (Cobb)		+			Maldives, Jamaica
Desmodora megalosoma Steiner	+	+		+	Maldives
* *Desmodora* spp. (2)					
Dolicholaimus benepapillosus (Schulz)	+		+	+	
Draconema cephalatum Cobb	+		+	+	Red Sea, Maldives
Enoploides harpax Wieser	+			+	
* *Enoploides* sp.					
Eubostrichus exilis (Cobb)	+			+	Red Sea, Maldives
* *Gammanema* sp.					
Halalaimus supercirrhatus Gerlach	+			+	Maldives
* *Halalaimus* spp. (2)					
Halichoanolaimus robustus (Bastian)	+		+	+	Maldives
* *Halipletus* sp.					
Latronema orcinum Gerlach	+		+	+	Red Sea, Maldives
* *Mesacanthion* sp.					
Metachromadora clavata Gerlach	+			+	Red Sea, Maldives

Alphabetical list of species	India	Africa	Europe	America	Other parts
• *Microlaimus* sp.					
Monhystera parva (Bastian)	+		+	+	Red Sea,
Monoposthia costata (Bastian)	+		+	+	Maldives
• *Nannolaimus* sp.					
Oncholaimus brachycercus de Man	+		+	+	
Platycoma africanum (Gerlach)	+	+			Red Sea, Maldives
Procamacolaimus tubifer Gerlach	+	+			Red Sea, Maldives
Rhynchonema cinctum Cobb	+			+	Red Sea
Sabatieria jubata (Cobb)	+			+	
• *Sabatieria* sp.					
• *Spaerolaimus* sp.					
Steineria pilosa (Cobb)	+		+	+	
• *Steineria* sp.					
Synonchium obtusum Cobb	+	+	+	+	Red Sea, Maldives
Syringolaimus striaticauda de Man	+		+	+	Red Sea
• *Theristus* spp. (2)					
• *Tricoma* sp.					
• *Viscosia* sp.					
GASTROTRICHA					
Acanthodasys aculeatus Remane	+		+	+	Maldives
Aspidophorus marinus Remane	+		+	+	Maldives
• *Cephalodasys* sp.					
Chaetonotus atrox Wilke	+		+		
• *Chaetonotus* spp. (3)					
Dactylopodola indica (Rao and Ganapati)	+				
• *Dinodasys* sp.					
• *Macrodasys* spp. (3)					
• *Paradasys* sp.					
Paraturbanella boadeni Rao and Ganapati	+				
• *Paraturbanella* spp. (5)					
• *Planodasys* sp.					
• *Pseudostomella malayica* Renaud-Mornant					Malaysia

Alphabetical list of species	India	Africa	Europe	America	Other parts
* *Pseudostomella* spp. (2).					
Tetranchyroderma indica Rao and Ganapati	+				
* *Tetranchyroderma* spp. (6)					
Thaumastoderma heideri Remane	+		+		Maldives
* *Turbanella* spp. (2)					
Urodasys viviparus Wilke	+		+	+	Maldives, Bermuda
* *Urodasys* sp.					
Xenotrichula velox Remane	+		+		
* *Xenotrichula* spp. (2)					
KINORHYNCHA					
Cateria gerlachi Higgins	+				
* *Echinoderes andamanensis* Higgins and Rao					
Echinoderes ehlersi Zelinka		+			
* *Pycnophyes* sp.					
NEMERTINA					
* *Cephalothrix* sp.					
* *Ototyphlonemertes* spp. (3)					
* *Sacconemertes* sp.					
ROTIFERA					
* *Encentrum* spp. (2)					
* *Proales* sp.					
ARCHIANNELIDA					
Dinophilus gyrociliatus Schmidt	+		+	+	Japan
* *Dinophilus* sp.					
Diurodrilus benazzii Gerlach	+		+		
* *Diurodrilus* sp.					
Nerilla antennata Schmidt	+	+	+	+	
* *Nerilla* sp.					
* *Nerillidium* sp.					
Polygordius madrasensis Aiyar and Alikunhi	+	+			
* *Polygordius* spp. (3)					
Protodrilus indicus Aiyar and Alikunhi	+				Malaysia New Caledonia
Protodrilus pierantonii Aiyar and Alikunhi	+				Galapagos

Alphabetical list of species	India	Africa	Europe	America	Other parts
• *Protodrilus* spp. (5)					
Saccocirrus krusadensis Alikunhi	+		+		Japan ?
Saccocirrus major Pierantoni			+		Japan
Saccocirrus minor Aiyar and Alikunhi	+				Malaysia
Saccocirrus orientalis Alikunhi	+	+			
• *Saccocirrus* sp.					
• *Trilobodrilus* sp.					
POLYCHAETA					
Branchiosyllis exilis (Gravier)	+	+		+	Red Sea. Maldives Galapagos
Brania oculata (Hartmann-Schroder)	+	+	+	+	Red Sea, Galapagos
Brania subterranea (Hartmann-Schroder)	+	+	+	+	Galapagos
• *Brania* sp.					
• *Ceratonereis* sp.					
Ehlersia cornuta (Rathke)	+	+	+		Red Sea, Malaysia
• *Ehlersia* sp.					
Eusyllis homocirrata Hartmann-Schroder	+	+		+	Galapagos
• *Exogone* spp. (3)					
Goniadides aciculata Hartmann-Schroder	+				Red Sea
• *Goniadides* spp. (2)					
Hesionides arenaria Friedrich	+	+	+	+	Red Sea, Malaysia, Polynesia, Japan, Galapagos.
Hesionides gohari Hartmann-Schroder	+	+	+	+	Red Sea
Hesionides indooceanica Westheide and Rao	+				
• *Hesionides* spp. (2)					
Hesionura elongata (Southern)	+		+	+	
Microphthalmus urofimbriatus Alikunhi	+	+			Red Sea
Ophryotrocha labronica Greca and Bacci ?	+		+		Japan, Galapagos ?
Parasphaerosyllis indica Monro	+	+		+	Samoa, Galapagos, Red Sea

Alphabetical list of species	India	Africa	Europe	America	Other parts
Petitia amphophalma Siewing	+	+	+	+	Red Sea
Pisione complexa Alikunhi	+				
Pisione oerstedii Grube	+	+	+	+	Galapagos
* *Pisione* sp.					
Pisionidens indica (Aiyar and Alikunhi)	+	+		+	Red Sea, Malaysia
Plakosyllis brevipes Hartmann-Schroder	+		+		Red Sea New Caledonia
Sphaerosyllis bengalensis Rao and Ganapati	+				
* *Sphaerosyllis* spp. (2)					
Syllis gracilis Grube	+	+	+	+	
* *Trypanosyllis* sp.					
Typosyllis variegata (Grube)	+	+	+	+	Red Sea, Maldives
* *Typosyllis* spp. (2)					
OLIGOCHAETA					
Aeolosoma maritimum Westheide and Bunke ?	+		+		Galapagos
* *Enchytraeoides* sp.					
Fridericia bulbosa (Rosa)	+		+	+	
* *Marionina* spp. (2)					
Phallodrilus monospermathecus (Knollner)	+		+	+	
OSTRACODA					
* *Cythereis* sp.					
Cytheridea papillosa Bosquet	+		+	+	
* *Cytheridea* sp.					
Microcythere subterranea Hartmann	+		+		
Microloxoconcha compressa Hartmann	+		+		
* *Polycope* spp. (2)					
* *Xestoleberis* sp.					
COPEPODA					
Ameira parvula (Claus)	+	+	+	+	
* *Ameira* spp. (2)					
Amphiascoides neglectus (Normann and T. Scott)			+		
* *Amphiascus* sp.					

Alphabetical list of species	India	Africa	Europe	America	Other parts
Apodopsyllus camptus Wells	+				
Apodopsyllus depressus (Krishnaswamy)	+				
Arenopontia indica Rao	+				
Arenopontia subterranea Kunz	+	+	+	+	
Arenopontia longiremis Chappuis ?	+	+			Bahamas
Arenosetella germanica Kunz	+	+	+	+	
• *Arenosetella* spp. (2)					
• *Balucopsylla* sp.					
• *Brianola* spp. (2)					
• *Canuellina* spp. (3)					
Ectinosoma dentatum Steuer	+	+	+	+	Caroline Is. Bermuda
Ectinosoma melaniceps Boeck	+	+	+	+	Red Sea
• *Ectinosoma* sp.					
• *Eoschizopera reducta* Wells and Rao					
Harpacticus gracilis Claus	+	+	+	+	Red Sea, Maldives
Hastigerella leptoderma Klie ?			+		
Hastigerella setosus (Rao and Ganapati)	+				
• *Hastigerella* spp. (2)					
Karllangia arenicala Noodt ?					Red Sea
Klieonychocamptoides remanei Noodt	+	+			Teneriffa
Kliopsyllus holasticus (Klie)			+		
Kliopsyllus psammophilus (Noodt)	+				Red Sea, Malaysia
• *Kliospsyllus spiniger* Wells, Kunz and Rao					
Kliopsyllus wilsoni (Krishnaswamy)	+				
• *Kliopsyllus* sp.					
Laophonte cornuta Philippi	+	+		+	Red Sea, Maldives, Bermuda
• *Laophontina* sp.					
Leptastacus constrictus Lang				+	Malaysia
• *Leptopsyllus* sp.					
• *Longipedia* sp.					
Lourinia armata (Claus)			+		
• *Melima* sp.					

Alphabetical list of species	India	Africa	Europe	America	Orther parts
Nitocra affinis rijekana Petkovski	+	+	+		
Nitocra spinipes Boeck ?	+	+	+	+	Red Sea
* *Nitocra* sp.					
Noodtiella intermedia Wells	+	+			
* *Noodtiella* sp.					
Oniscopsis pauliani Chappuis		+			
Paralaophonte spinicauda Vervourt					Caroline Is.
Paraleptomesochra africana (Kunz)		+		+	Bermuda
Paraleptomesochra minima Wells	+	+			
* *Paramesochra* spp. (2)					
Parastenhelia hornelli Thompson and A. Scott	+	+	+		Red Sea
Phyllopodopsyllus longipalpatus (Chappuis)			+		
* *Phyllopodopsyllus* spp. (2)					
* *Phyloleptomesochra* sp.					
* *Psammameira* sp.					
Psammastacus spinicaudatus Rao and Ganapati	+				
Psammopsyllus operculatus Nicholls	+	+		+	Australia
* *Sarsameira* sp.					
* *Schizopera* sp.					
Sicameira langi Rao	+				
* *Stenocopia* sp.					
Sunaristes tranteri Hamond					Australia
* *Sunaristes* sp.					
* *Tetragoniceps* sp.					
Tisbe furcata (Baird)	+	+	+	+	Red Sea, Maldives, Bermuda
* *Willeyella* sp.					
ISOPODA					
* *Angeliera cosettae* Coineau and Rao					
* *Angeliera* sp.					
* *Microcerberus andamanensis* Coineau and Rao					
AMPHIPODA					
* *Bogidiella sootai* Coineau and Rao					
* *Ingolfiella kapuri* Coineau and Rao					

Alphabetical list of species	India	Africa	Europe	America	Other parts
• *Ingolfiella* sp.					
TARDIGRADA					
Batillipes mirus Richters	+		+	+	Malaysia
• *Batillipes* sp.					
Parastygarctus higginsi Renaud-Debyser		+			Malaysia
Stygarctus bradypus Schulz	+		+	+	Bahamas
ACARINA					
• *Actacarus* sp.					
• *Copidognathus* spp. (3)					
Halacarus anomalus Trouessart	+		+	+	
• *Halacarus* sp.					
COLLEMBOLA					
• *Isotoma* sp.					
MOLLUSCA					
Caecum glabrum (Montagu)	+		+		
• *Microhedyle* spp. (2)					
• *Pseudovermis soleatus* Salvini-Plawen and Rao					
Pseudovermis indicus Salvini-Plawen and Rao	+				
• *Pseudovermis* sp.					
ECHINODERMATA					
• *Trochodota havelockensis* Rao					
• *Leptosynapta* sp.					
TUNICATA					
• *Heterostigma* (?) sp.					

of the world are investigated. Hitherto, a total of 324 species comprising about 60 per cent of the fauna collected were identified and the actual number of species inhabiting these islands would be much higher. The majority of species listed here are those already reported from other parts of the world, while some new genera and a large number of new species mostly cited here at the generic level, are yet to be described. Thus, the list also excludes large material of unidentified species, particularly of the groups Ciliata, Turbellaria, Gnathostomulida, Nematoda, Nemertina, Polychaeta, Oligochaeta and Copepoda. As several areas of these islands are still virgin fields, any

intensive explorations in the future are likely to reveal the existence of many more known and unknown species. Due to the uneven distribution of meiofauna in the interstitial habitat, unless and until an intensive search is made all along any particular area, no negative report of the occurrence of a meiofauna species can be established with certainty.

Zoogeography and Evolution

As already indicated, any attemept to rationalise the zoogeography of the interstitial meiofauna of these islands suffers from lack of adequate information from many parts of the world and particularly from the adjoining countries of the east. A summary of the zoogeographical relationships of the Andaman fauna based on the data shown in Table 1, is given in the Table 2. A perusal of the Table 2 shows that out of the total 324 species listed, 50 (or 15.4 per cent) appear

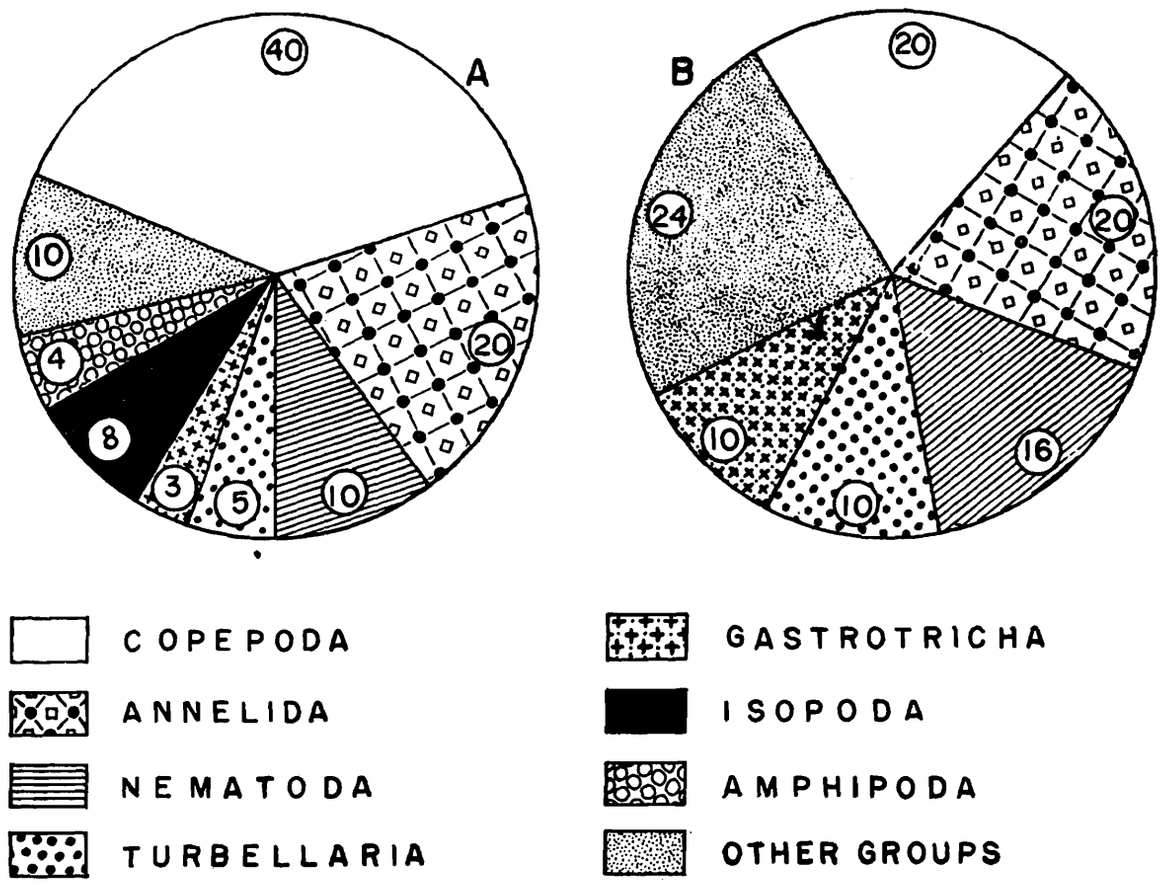
Table—2. A summary of the zoogeographical relationships of the interstitial meiofauna of the Andaman and Nicobar Islands.

Group	Total number of species	Cosmopolitan species	Eurytopic or widely distributed species	Species known from Indian Ocean only	Uncertain endemics
Ciliata	21	8	4	—	9
Cnidaria	4	—	—	—	4
Turbellaria	29	1	3	1	24
Gnathostomulida	4	—	—	—	4
Nematoda	46	13	9	3	21
Gastrotricha	38	4	2	4	28
Kinorhyncha	4	—	—	2	2
Nemertina	5	—	—	—	5
Rotifera	3	—	—	—	3
Archiannelida	24	2	4	4	14
Polychaeta	36	12	3	5	16
Oligochaeta	6	—	3	—	3
Ostracoda	8	—	3	—	5
Copepoda	70	8	15	12	35
Isopoda	3	—	—	—	3
Amphipoda	3	—	—	—	3
Tardigrada	4	2	—	1	1
Collembola	1	—	—	—	1
Acarina	6	—	1	—	5
Mollusca	6	—	1	1	4
Echinodermata	2	—	—	—	2
Tunicata	1	—	—	—	1
Total	324	50	48	33	193

to be cosmopolites, 48 (or 14.1 per cent) eurytopics, 33 (or 10.2 per cent) Indian Ocean forms and 193 (or 59.6 per cent) uncertain endemics. Thus, the cosmopolites and eurytopics are adequately represented on these islands ; but in the absence of the evidence of their true interbreeding, it is now difficult to say whether these two categories are sibling species. The species exclusively known from Indian Ocean are not yet many and zoogeographically, the present distributional pattern of the fauna does not indicate any specific grouping of species characteristic for the shores in this region. However, the element of endemic fauna appears to be sufficiently strong in these islands, although the endemic genera are fewer in number than the species. It is possible that further investigation would reveal more endemic genera and species for these islands. It is also possible that a number of species which are now regarded endemic for these islands may reveal their existence in other regions of the Indian Ocean. Thus, these zoogeographical ranges are likely to continue to change as more and more areas in this region are investigted, the now supposed endemics joining the ranks of eurytopics. However, the probable endemism of fauna for these islands appears to be nearly similar to the rates reported for the fauna in other parts of the world, with the exception of some young oceanic archipelagoes, such as the Galapagos Islands in the South Pacific (Ax and Schmidt, 1973).

The composition and abundance of genera and species of these islands are more or less in agreement with the other regions of the world hitherto explored. In all the major groups of the fauna encountered, quantitative abundance of few dominant species is observed. Thus, about 20 per cent of the total species encountered comprised about 75 per cent of the total number of meiofauna individuals, while bulk of the remaining species occurred in small numbers. Some species are so poorly represented that they are rarely encountered in the collections made on these islands. Many interstitial meiofauna groups with a considerable number of genera and species are known to have also a wide geographical distribution. Thus, qualitatively the groups Ciliata, Turbellaria, Gnathostomulida, Nematoda, Gastrotricha, Archiannelida, Polychaeta and Copepoda, are best represented on these islands with many a variety of taxa, while the remaining groups have only moderate to poor representatives (Fig. 3B). Further, many tolerant species of the groups Ciliata, Nematoda, Archiannelida, Polychaeta, Oligochaeta, Copepoda and Tardigrada, appear to have a cosmopolitan or eurytopic distribution, while the other groups have a restricted geographical distribution with limited number of eurytopic species in their cadres (Table 2).

Apart from the endemic element, it is difficult to distinguish between many of these cold temperate and warm tropical species, due to their distribution in almost all these regions. At present, the affinities of the Andaman fauna with the fauna of other regions of the Indian Ocean are not quite clear and with further intensive exploration, many strong faunal links are likely to appear between



Text—fig. 3. Circle diagrams illustrating the percentage composition of the diverse groups of interstitial meiofauna (excepting Ciliata) of the Andaman and Nicobar Islands. A—Quantitative distribution, B—Qualitative distribution.

different land masses of the area. Hitherto, many species described and reported from different areas of the Indian Ocean, such as Red Sea (Nicholls, 1944 ; Gerlach, 1958b, 1959, 1964a, 1967 ; Hartmann-Schroder, 1960 ; Noodt, 1964), South Africa (Zelinka, 1913 ; Day, 1967 ; Barrisford, 1969 ; Hartmann-Schroder, 1974 ; Jouin, 1975), Mozambique (Wells, 1967), Madagascar (Chappuis, 1952, 1954 ; Gerlach, 1953, 1958a ; Renaud-Debyser, 1965), Maldives (Sewell, 1940, Gerlach, 1961, 1962, 1963, 1964b ; Ax, 1971), Ceylon (Fauvel, 1953 ; Noodt, 1971), India (Aiyar and Alikunhi, 1940, 1944 ; Alikunhi, 1946, 1947, 1948a, b; Fauvel, 1953 ; Krishnaswamy, 1957 ; Timm, 1961; Ganapati and Rao, 1967; Rao, 1967, 1969, 1970b, 1971, 1972a; Rao and Ganapati, 1966, 1967, 1968a, b, c, 1969a, b ; Higgins, 1968 ; Wells, 1971 ; Salvini-Plawen and Rao, 1973 ; Hartmann, 1974 ; Westheide and Rao, 1977), Malaysia (Ranaud-Mornant, 1967 ; Renaud-Mornant and Serene, 1967) and Australia (Nicholls, 1945 ; Hamond, 1973), occurred on these islands (Table I). Thus, at present about 15 species (4.6 per cent of the total) are known exclusively common to both

India and Andamans, while the remaining western regions indicate far less commonness. These islands being located in the middle of the Oriental Region, detailed explorations are likely to reveal some clear affinities with the fauna of India, Burma and Indonesia. Due to geographical proximity, it is quite possible that the Andaman fauna is more closely related to the fauna of the countries east of it, which remain unexplored with the exception of Malaysia. It is seen that many (9) of the few (10) species reported from Malaysia (Renaud —Mornant and Serene, *op. cit.*) occurred on these islands. Thus, there is a close degree of similarity between these two regions and any further collecting will doubtless reveal still closer relationship. As many of the coasts in the Indian Ocean are now very incompletely investigated, it is not yet opportune to offer an extended discussion on the zoogeography of the fauna of these islands.

The Andaman and Nicobar Islands first arose from the ocean bed in the Mesozoic period about 110 million years ago and have since then undergone several periods of partial submergence and elevation (Roonwal and Bose, 1964). Thus, the archipelago is sufficiently aged and is now known to support very similar taxa of widespread meiofauna species. The absence of larval dispersion and other bio-ecological peculiarities in the sedentary interstitial meiofauna should in fact lead to a high degree of endemism in isolated areas, but the present evidence of a high degree of similarity of taxa reported from different continents supports the historical role played by the continental drift (Rao, 1972b). The considerable degree of endemism in these islands which are separated from the mainland by a vast stretch of the ocean, probably signifies the considerable period of their isolation following the drift. Thus, the modern distributions of the fauna are probably to be explained from an understanding of the former arrangement of the present land masses before the drift occurred. Sterrer (1973) is also of the opinion that the cosmopolitanism and high degree of faunal similarity over vast geographic range might be due to slow speciation after the geological dispersal by continental drift. Thus, the present pattern of distribution indicates that the consequence of the historical drift is perhaps stronger in interstitial meiofauna than in the fauna of many other marine habitats.

Hitherto, active migration and transport along the margins of the continents were considered to be the means of short range dispersal in this sedentary meiofauna. But in a recent article, Gerlach (1977) favourably considered the various possible means of meiofauna dispersal to distant areas by mechanisms such as by airborne animals, rafting on drifting materials, ballast of sailing vessels, pelagic ways of life, dispersal in suspension or eroded sediments during severe storms etc., and concluded that there is no reason to attribute more importance to the geographical patterns of meiofauna than to the distribution of most other marine animals. But, even during the periods of severe storm or turbulence along a particular coast, it is not known to how much offshore distance the eroded sediment with meiofauna can be carried in suspension. Further evidence is probably necessary to

substantiate this means of dispersal. However, these accidental mechanisms can probably play a role as a matter of chance for certain species at random, but cannot possibly be held responsible for the total dispersal of meiofauna species of all the groups to widely separated oceanic areas, resulting in the present pattern of distribution. If the dispersal to distant areas is to depend on such accidental means of transport, the chances of regular gene flow between populations of widely separated areas would be quite limited and the present similarity of this faunal element on a global scale perhaps dose not exist. Further, if the oceans are considered no barrier for dispersal of meiofauna, every endemic species has a chance to migrate anywhere and it will be difficult to explain the present distribution and development of endemics due to isolation. As already indicated, the faunal element considerably differed from island to island in the Andaman Archipelago and certain endemic species appeared quite stenotopic. Thus, when stenotopic endemism is so prominent within a closely knit archipelago, the chances of the accidental means of meiofauna dispersal by drifting to too distant areas seem limited. The high precentage of endemism reported for the Galapagos Archipelago appears to be due to the recent formation of these islands, followed by rapid speciation due to lack of initial competition (Ax, 1977) ; and thus many of the old taxa characteristic of the historical continental plates are probably missing. The morphological similarity of the Galapagos fauna with the European species might be the result of parallel development due to identical environmental conditions. Has the continental meiofauna really crossed a ocean barrier of about 1000 km and reached the Galapagos Islands ? If so, the means of dispersal other than the drifting ways etc., are also probably to be explored.

However, as the composition and external morphology of Andaman meiofauna species almost resemble the known in other parts of the world, any phylogenetic development of the fauna of these islands appears to be limited to the formation of endemic species. Although the region of Indian Ocean is considered as one of great biological interest, unless and until a clear picture of these areas emerges, it is difficult to locate any evolutionary centre for the meiofauna in this region.

SUMMARY

1. A preliminary investigation of the geogrophical distribution of interstitial meiofauna collected from marine beach sands on Andaman and Nicobar Islands, has been attempted. The zoogeographical significance of the study lies in the fact that the work is the first of its kind in the Indo-Pacific region.

2. The density and distribution of meiofaunal groups in the intertidal sands of these islands is indicated. The density and diversity of fauna is nearly similar to other explored areas of the world. Ubiquitous genera have well representeed species on these islands.

3. The list of meiofauna hitherto recorded from these islands has a total of about 324 species in 200 genera. The actual number of species inhabiting the archipelago is much higher and further exploration of these areas will probably prove to have a rich diversity of taxa than now known.

4. The geographical distribution shows that about 50 species in 45 genera represent cosmopolitan taxa, while 48 species in 40 genera are eurytopics. No specific grouping of Indian Ocean element as such is noticed and 33 species in 30 genera are recorded. About 193 species in 132 genera are uncertain endemics. Due to lack of adequate data from different coasts of the Indian Ocean, the exact amount of endemism could not now be estimated.

5. The world wide distribution of many interstitial meiofauna genera and species is now well established. The faunal element is dominated with species and genera showing affinities with the entire warm temperate parts of the world. Detailed explorations are likely to reveal some closer relationships with the fauna of Oriental Region.

6. The means of meiofauna dispersal are discussed in relation to the age of these islands. The presence of a considerable percentage of endemic element indicates that the Andaman fauna has at least a limited phylogenetic development of its own.

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