

## MEIOFAUNA STUDIES

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The term meiofauna was first used by Mare (1942) to describe benthic metazoans of intermediate size. Traditionally meiobenthos refers to those animals which pass through a 0.5 mm size mesh and are retained on a sieve with mesh width of 0.045 mm. The size category is however, not fixed by any rigid definition but is simply an indication of the way investigators have found it convenient to sample a particular size group. Some meiofauna are interstitial, others are burrowing while still others have epibenthic or phytal existence. The remarkable adaptation of meiofauna to many kinds of habitats is reflected in the numerous morphological and ecophysiological features (Boeden and See, 1985). Some of the most common adaptations in meiofauna are the following:

1. Thin shape body or leaf like form for moving through interstices and around individual sand grains.
2. Possession of tactile sensoria, photoreceptors and statocysts concerned with sensing, photonegative response and orientation.
3. Extensive ciliation for locomotion.
4. Reduction in appendages to allow passage through the interstices.
5. Possession of adhesive tube.
6. Presence of integumental cuticular structure to protect against mechanical damage.

Due to regressive evolution of body size certain organs disappear in meiofauna. These include circulatory structure, nephredia and eyes. The respiratory structures lack in smallest meiofauna and both respiratory and excretory requirements are assessed by epidermal epithelium.

### KIND OF MEIOFAUNA

Meiofauna can be divided conveniently into (1) temporary meiobenthos usually the larvae of macrofauna and other groups which have benthic juvenile stages) (2) permanent meiobenthos which includes Nematoda, Harpacticoida, Gastrotricha, Turbellaria, Kinirhyncha, Tardigrada and some specialised members of Archiannelida, Oligochaeta, Halacarida and Ostracoda (McIntyre, 1969). The smallest representative of numerous invertebrate phyla are to be found in meiofauna.

## COLLECTION AND PROCESSING OF SAMPLES

Techniques of macrobenthos sampling will, in principle also be suitable for meiobenthos, but due to much higher numerical density of meiofauna, smaller samples are usually adequate. This can be obtained by subsampling from a larger volume of samples collected subtidally. Coring generally preferred in the intertidal areas or in shallow waters where SCUBA divers can work. The cores used varies in surface areas from 1 to 10 cm square, depending on the density of the fauna. It is acceptable to take subsamples from a grab haul in deep water work.

Extraction of meiofauna from the sediment may be a major operation. This could be done both in the living conditions and with preserved samples. From sandy sediments, satisfactory quantitative extraction may be achieved by repeated shaking and decanting through an appropriate sieve. Elutriation is a more sophisticated version of the decanting procedure. Muddy sample decantation or elutriation is ruled out and it may be convenient to divide samples containing fine material using appropriate sieves.

When dealing with preserved material decantation is still possible for sand and sieving for mud, but staining of the whole sample to aid in detecting the animals is desirable. However, the floatation techniques employed for extraction work best with preserved material. Different liquids have been used - sugar solution, zinc chloride, sodium chloride, magnesium sulphate, depending on the type of animals to be removed and the sediment composition. Hulings and Gray (1971) have given complete methodology for the study of meiofauna.

## POPULATION DENSITY OF MEIOFAUNA

Studies on meiobenthos have proliferated rapidly over the past two decades and this has produced an expanding volume of literature. Today meiofauna is an important field of research in marine biology. Data available in the literature shows that meiofaunal densities varies from few to thousands per 10 cm square in the sandy, muddy or seagrass habitat. Details for the range of total population are given in Table 1 and 2.

## THE INTERTIDAL ZONE

Extensive studies have been made in the intertidal zone of exposed or semiexposed tidless or tidal beaches. On these beaches the total meiofaunal density shows great deal of variation ranging from 11 to 1529/10 cm square in the tidless area of Scandinavia having heterogenous sediment composition (Table 1). In the tidal region different values are reported by different authors on different sediment deposit. In the tropics very high values of upto 3815/10 cm square are reported in the fine sand on the south east coast of India. The meiofaunal density in the mud flat areas are much higher (up to 11820/10 cm square). In the salt marsh areas of the west coast of India meiofaunal density up to 9096/10 cm square are reported. The differences in the estimated densities could, apart from prevailing environmental conditions, be due to variation in the techniques used by different authors.

## THE SUBTIDAL ZONE

Data on quantitative studies of meiobenthos from subtidal zones of the world oceans are available. The range of population estimates are summarised in Table 2. There is general tendency of the fauna to decrease with increasing depth. The values are higher in the estuaries, seagrasses and continental shelf areas and poor in the continental slope and abyssal zone. It appears that the population density for meiofauna occurring in the continental slope, rise and abyssal region are about one order of magnitude lower than in shallow waters ( $\approx 200$  m) although there is some variation in the meiofaunal density reported from shallow marine bottoms (Tietjen, 1971).

## DISTRIBUTION

Horizontal Distribution: Meiofaunal organisms are very patchily distributed horizontally within the sediment (Coull and Bell, 1979). The pattern of distribution often follows the negative binomial (clumps) distribution. The reasons for this are not fully understood but several ideas have been put forth. It has been suggested that patchiness may be the result of attraction of meiofauna to an organic point source such as dead and decaying organic matter. It is believed that food of the most of the meiobenthic animals are patchily distributed and certain food sources so localized, can determine the horizontal distribution of meiofauna. Biogenic structures and selective predation could cause patchiness.

Vertical Distribution: Meiofauna have shown a declining tendency in number of organisms with increasing depth in the sediments (McIntyre, 1969; Tietjen, 1969; Cantelmo, 1978; Ansari, 1989). In soft sediments the fauna appears to be confined mainly to the upper few centimeters of the sediments and over 60% fauna are observed in the top 1 to 2 cm depth. However in sandy beaches significant number of meiofauna particularly nematodes are reported in the 50 to 60 cm depth layer (Malan and McLachlan, 1985). In tidless beaches meiobenthic animals have been found down to the level of the water table, as deep as 52 cm below the surface. Four possible causes for this vertical zonation are cited (Tietjen, 1969). (1) Vertical pH changes (2) Vertical Eh changes (3) Vertical decrease in interstitial water (4) Vertical differences in food content. Vertical migration of meiofauna are also related to tidal movement.

## SEASONAL CHANGES

Observations throughout a full year or over several years are not common but when they have been made, seasonal peaks have usually been noted. Coull & Bell (1979) observed significant monthly and yearly natural fluctuations of marine meiofauna on a long term basis. Natural fluctuations in the population density of meiofauna have also been reported from other areas (Ansari, 1989). It is therefore suggested that short term sampling does not adequately characterize the meiofauna dynamics of a region, habitats or sediment type. Short term sampling is of course better than no sampling and may be useful to answer specific questions.

## MEIOFAUNA AND BENTHIC PRODUCTIVITY

The quantification and energetic role played by meiofauna remains a far and exclusive goal. Meiofaunal standing crops in sand are often an order of magnitude lower than in mud. Gerlech (1971) suggested that meiofauna are responsible for about 5 times the total benthic metabolism of the macrofauna. However, due to its much more rapid turn over the secondary production of meiofauna equal or exceed that of macrofauna. Thus in extremely shallow waters (estuaries, mudflats) the macro/meiofauna standing crop biomass ratio approximate 1. In a tropical estuary Ansari (1989) reported a macro/meiofaunal biomass ratio of approximately 1 which signifies the meiofaunal role in the energetics of the system.

## TROPHIC RELATION

There has been much debate on the ultimate fate of the meiobenthic production and utilization. Three pathways have been suggested (Coull and Bell, 1979).

1. To macro fauna
2. To higher trophs
3. To nutrient regeneration

It has been demonstrated experimentally by Reise (1979) that abundance of meiofauna is regulated by macrofauna. Some of the meiobenthic organisms are preyed upon by meiobenthic predators. There is also possibility of epibenthic meiofauna constituting an important food for predatory fishes. The importance of meiofauna as food for larval and juvenile fishes is well documented. Meiofauna have also been found in the gut of macrofauna (Tietjen, 1969). However, most important role of meiofauna in marine sediments seems to assist in the recycling of nutrients at lower trophic levels and to enhance the mineralization of organic matter. Experimental studies to suggest the exact role of meiobenthic metazoans will be a fruitful avenue of meiofaunal research. We still do not know what and how much the meiofauna consume.

## FACTORS INFLUENCING DISTRIBUTION OF MEIOFAUNA

Most of the studies on meiofauna have suggested that control of meiofaunal population is by the physical properties (Coull, 1969; Tietjen, 1969; Contelmo, 1978). Ansari (1989) suggested that biological interactions play a much significant role in organizing meiofaunal community structure. The main factor controlling distribution on the beach are probably temperature, salinity and the grain size. Associated with these factors are the availability of water (interstitial) and Eh which normally affects the vertical distribution of meiofauna. On subtidal grounds the major factors are the same as those indicated above but as the water deepens the range of variation becomes less until the very stable conditions of the abyssal plain are reached. Here the vertical distribution of the fauna is essentially similar to

that in the intertidal zone (McIntyre, 1969) and availability of food becomes an important factor.

Apart from its direct involvement in the trophic relation of marine environment, sediment meiofauna is of interest for pollution studies. It has been suggested that meiofauna could be better indicators of environmental stress than macrofauna due to their small size, shorter generation time and a life style almost always limited to the benthos (Ansari et al, 1984; Frithsen et al, 1985). Of late, meiobenthos are being used in the assessment of marine environmental stability and quality and more recently meiobenthologists have been using data for hypothesis generation and predictive modelling (Coull, 1986).

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Table 1. Partial list of density of intertidal meiofauna recorded by various workers. Values are range of total number/10 cm

Location	Deposit	Total meiofauna	Reference
Stockhol , Sweden	sand	11-1529	Jansson, 1968
Wadden Sea, Denmark	sand	50-768	Smidt, 1951
Porto Novo, India	sand	968-1960	McIntyre, 1968
Bristol Channel, U.K.	mud	90-11820	Rees, 1940
Vellar estuary, India	mud	420-3815	McIntyre, 1968
Andaman Sea, India	sand	2270-6116	Ansari&Ingole, 1983
Salt Marsh, Georgia USA	mud	460-16300	Teal&Wieser, 1966
Estuarine beach, India	sand	18-3734	Harkantra, 1984
River beach, S. Africa	sand	445-4031	McLachlan, 1977
Sandy beach, Kenya	sand	1013-6327	Ansari <u>et al</u> , 1984
Salt marsh, India	mud	282-9096	Ingole <u>et al</u> , 1987

Table 2. Partial list of the density of subtidal meiofauna recorded by various workers. Values are range total number/10 cm

Location	Depth (m)	Total meiofauna	Reference
Buzzard Bay, USA	18	276-1861	Wieser, 1960
Loch Nevis, Scotland	101	541-2224	McIntyre, 1964
Off North Carolina, USA	50-2500	40-1174	Tietjen, 1971
Off East Africa	1045-5030	15-170	Theil, 1966
Bermuda Coast, USA	2-13	123-1333	Coull, 1970
South west coast, India	4-12	78-1445	Damodaran, 1973
Andaman Sea, India	100-500	68-340	Ansari & Parulekar, 1981
Bay of Bengal, India	100-1000	122-1630	Ansari <u>et al</u> , 1977
West Coast, India	20-107	250-2925	Ansari <u>et al</u> , 1980
Off Southern New England	40-179	127-988	Wigley & McIntyre, 1964