Chapitre VIII

Macrobenthos and meiobenthos

Rapport de synthèse

présenté par

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(based on the work of Jan GOVAERE for macrobenthos, of P. LIPPENS, A. VANDERHEYDEN and L. DE CONINCK for meiobenthic nematodes, of E. SCHOCKAERT for Turbellaria, and of technical assistants Mrs J. BALLEGEER-VERMEULEN, Mrs R. VANDEN BERGHE-DE BOEVER, Miss A. VAN BOST and Miss D. VANDENBROECK)

1.- General considerations

It is difficult to overestimate the role of benthos and sediments in the marine ecosystem.

The sea-floor is depositary of the whole production (primary production, partially transformed into secondary, respectively into tertiary and further production) of the whole of the surmounting water column, in as far as these productions were not transformed into energy and escaped avian and human predation. It forms an immense reservoir of food for all sorts of living organisms.

The mineral and organic sediments actively accumulate a whole series of pollutants (heavy metals, pesticides, organic sewage from human agglomerations) which permanently influence the benthic flora, in so far as it receives enough light-energy to subsist, and the benthic fauna.

That fauna finds its raw materials in the benthic flora and in the organic matter, settling down from the water column or introduced by rivers and sewage effluents. Bacteria, protozoa, microscopic and macroscopic invertebrates of all sorts, and vertebrates convert the organic sediments into living matter again and concentrate it, through the food-chain, into products which are or could be of importance for human economy. That, at any rate, is what happens in shallow seas, of which the North sea is a typical example.

Up-to-date views [Ryther (1969)] concerning fish production in the marine environment have shown that the world seas can be divided into three well defined regions : (1) the shallow coastal waters, within the 200 m depth contour, representing about 10 % of all seas; (2) the open sea, beyond the 200 m depth level, about 90 % of the oceans, or three fourths of the earth's surface; (3) some restricted areas where, due to prevailing offshore winds and the strong boundary currents, surface waters are continually or periodically replaced by nutrient rich deeper water. Such coastal upwelling areas exist off Chili, Peru, California, south-west and north-west Africa, in the Arabian sea and in other localized situations; all together they represent one tenth of 1 % of the world oceans. These upwelling regions produce about half the world's fish supply, the other half being produced in shallow coastal seas. The open oceanic seas produce a very small fraction of the world's fish stock : they almost can be considered as biological deserts, at least in respect to fish production. Their primary production, partially transformed into higher production levels is continuously settling down, forming deep-sea sediments which are very slowly broken down into mineral and simple organic compounds which are not restored to the upper water levels, resulting in a slow but gradual dwindling of the limiting P , N and C concentrations; only in the very restricted upwelling areas are they made available again for primary production.

In shallow seas, on the contrary, the organic sediments are continuously broken down, and their building materials restored to the water column. The agents, responsible for that turnover are mainly the benthonic organisms.

1.1.- Benthonic Biomass and Productivity

Numbers of individuals and wet weight of macrobenthic and meiobenthic fauna allow comparisons between these two types of benthonic organisms.

To the macrobenthos are considered to belong all organisms retained by a 1 mm mesh sieving screen; all organisms passing through a 1 mm mesh but retained on a 74 µ mesh screen, or finer, are regarded as meiobenthos [Wigley and McIntyre (1964)].

Polychaeta, Crustacea, Mollusca and Echinodermata form the main macrobenthic, Nematoda, Copepoda and at times larval stages of macrobenthic organisms form the main meiobenthic groups.

Numbers of macrobenthic organisms in healthy shallow waters vary between a few hundreds and a few thousands per m^2, those of meiobenthos between 100,000 and 1,000,000 per m^2.

Wet weight, in g/m^2, varies between more or less 10 and 100 g/m^2 for macrobenthos (excluding all organisms heavier than 5 g each) and between 0,5 and 5 g/m^2 for meiobenthos, the weight ratio between macro- and meiobenthos varying more or less between 10 and 100 . Numbers as well as wet weight ratios can depart from such figures, becoming higher or lower, according to circumstances.

1.2.- Biomass of meiobenthos

Meiobenthos always represents only a small fraction of benthos biomass, because macrobenthic animals make up 90 to 99 % of total biomass, often 96 to 99 % . At first sight, it looks as if meiobenthos could be neglected in studies on the productivity and the biological activity of benthonic organisms.

But productivity has to include the time factor, *e.g.* mean life span and number of generations, and intensity of metabolism (rate of turnover of individual biomass, plus production of proteins which are given off to the sediments).

There are very few data on life span and on interval between successive generations in meiobenthic species. Temperature, available food and specific characteristics play a very important role in this respect. In nematodes life span and generation interval can greatly differ : from a few days, in rapidly multiplying species, to 2 years. Some species, in summer, need only 2 to 3 weeks from one generation to the next, sometimes with high numbers of descendants. But at a temperature 10 °C lower, a species needs double and triple that time.

Taking specific differences into account, it seems to be a safe assumption that meiobenthos (nematodes, copepodes and other small invertebrate groups) presents in the mean 3 generations a year, against 1 for macrobenthos.

Moreover intensity of metabolism is inversely correlated with size. In small organisms, turnover of individual biomass (rapidity of renewal of tissues and cell-components during individual life) is several times more rapid than in bigger ones. Also the rate of energy expenditure is to be taken into account. It seems justified to assume that metabolism in meiobenthos is 5 times more intense than in macrobenthos.

Besides, biomass of meiobenthos is generally estimated on the ground of numbers of nematodes and Harpacticid copepodes; groups which only can be studied in the living state, such as ciliates, microflagellates, *Rhabdocoele turbellaria* and Gastrotrichs are not taken into account. Nor is made allowance for bacteria, which must play an important role in the breaking down of dead or excreted proteins and other organic matter. Which means that the usual meiobenthic biomass should on these last grounds again be multiplied by a factor 2 or 3 . Altogether meiobenthos biomass is therefore to be multiplied by $3 \times 5 \times \left\{ {2 \atop 3} \right\} = \left\{ {30 \atop 45} \right\}$, which brings it to a productivity level comparable to that of macrobenthos. The more so as a considerable part of meiofauna falls a victim to the omnivore deposit-feeders.

But much study in the field as well as in the laboratory will be needed before it will be possible to replace assumptions by well ascertained facts in problems concerning life in marine sediments.

1.3.- Existing knowledge of the benthonic communities

There is no common measure in the existing knowledge of lige in the offshore zone, as compared with that in the intertidal zone. Nor is there a common measure in our knowledge of the microscopic components of benthonic biocoenoses as compared with that of the macroscopic components.

While there is a growing amount of factual knowledge about intertidal and inshore biology, there is only very little known about offshore sea floor biology. That little which is known, pertains almost exclusively to macrobenthonic organisms. There is very little, sporadic information about microscopic life : meiobenthos and microbenthos still belong to almost unknown worlds.

Where the benthic fauna vas studied, mainly in its macroscopic components, it was shown that different sorts of sediments (silt, fine sand, coarse sand, gravel) harbour different sorts of animals. Thus one is confronted, in similar habitats, with animal communities which on the one hand all over the world, in widely separated areas, are constituted of the same or very nearly related species, whereas on the other hand in different habitats, lying very near to each other, one finds very different communities.

Whilst one has already some information about the nature of the macrobenthic communities in relation to the nature of the sediments, about meiobenthos that information is just in its beginnings. Moreover, one has almost no data on the influence of seasons, of temperature and other variable parameters on the constitution of the biocoenosis.

The similarity of the fauna of similar habitats poses the problem of the spreading of organisms over the sea floor. While active spreading in some species is possible and even probable, in most of them the spreading is a passive one. This can happen either during planktonic larval stages, or, as is probably the case in most meiobenthic species, whose specific gravity is approaching that of seawater, by drifting with currents near the sea bottom, when some macrobenthic animal stirs a cloudlet of superficial sediment or when heavy storms bring large sections of the sea floor in suspension. In such ways small organisms are disseminated all over the sea floor; oxygen concentration, food, salinity, grain size, predators and other parameters will determine which species will multiply and which ones will stand no chance in new habitats.

1.4.- Sampling techniques

Samples should be representative of the biotopes to be investigated. They should be taken in such a way as to contain the different species living in the biotope in numbers corresponding to their occurrence *in situ*, in order to make possible an evaluation of biomass and of species diversity.

Biomass becomes a measure of productivity only if its turnover (renewal) is taken into account. Turnover of biomass being dependent on all parameters influencing primary productivity, especially on light and temperature, sampling should have some regular periodicity, at least in some grid-points representative of the main biotopes : silt, silty fine sand, fine sand, coarse sand.

Rapidity of turnover varies with size of organisms. Duration of life-cycle also gives some indication of rapidity of turnover. Big animals with long life-cycle show slow turnover, small animals with short life-cycle generally show rapid turnover of biomass.

The study of macrobenthos and meiobenthos requires different sampling techniques. Using a 0.1 m^2 van Veen-grab, Stripp (1969) needed 12 samples (1.2 m^2) in order to find representatives of all macrobenthic species present in a silty sea floor, 7 samples gave 90 % ; 5 samples 80 % and 2 samples 60 % of all species; in the latter case all important species are however represented in the sample.

In the present macrobenthos investigations of the southern Bight, Govaere regularly takes 5 (to 7) 0.1 m^2 van Veen-samples, probably obtaining the 80 % species level. As between each successive sampling, the ship is slightly drifting off, the samples are taken in nearby but different places, making up for patchiness in the distribution of the different species. In meiobenthos, patchiness is yet more pronounced. By taking a core in each of the 5 van Veen-samples, and mixing the 5 subsamples, one should have a good chance to have a sample representative of the local meiofauna, *if a van Veen-grab gives a reliable meiobenthos sample.*

Doubts have recently been raised about the reliability of meiobenthos sampling. Almost all sampling gear (van Veen-grab, and others, Schipek, mud-snapper, gravity corers McIntyre (1971)), when lowered from the ship towards the sea floor, is preceeded by a shock-wave which dislodges the superficial flocculent material which harbours a good part of the meiofauna. Even corer-tubes of about 2 to 4 cm diameter, however carefully inserted by a diver, could not collect the totality of the superficial sediment layer. Only by using considerably larger corer-tubes, of 10 cm diameter, could this evil be overcome. Comparing the results of 2.2 cm gravity-corer-sampling, with those of carefully subsampled 10 cm corers handled by divers, McIntyre found that gravity-corer-sampling loses 35 % of nematodes and nearly 80 % of copepodes (nematodes and copepodes making up about 90 % of the meiofauna). Of turbellarians, gastrotrichs and kinorhynchs, only about 60 % are recovered by gravity corers as compared with diver-handled wide corers.

It is possible that losses of part of the meiofauna are more important in silty sediments than in sandy ones as the shock-wave more rapidly chases away the superficial loose materials.

Following these findings, it will be necessary to compare diver-handled wide-corer-samples with the usual van Veen samples, in order to have a possibility to correct the earlier results obtained by van Veen sampling.

2.- Preliminary results

These results are given in the following figures.

References

McINTYRE (A.D.), (1971). Deficiency of Gravity Corers for Sampling Meiobenthos and Sediments, *Nature*, *231*, n° 5300, p. 260.

RYTHER (J.H.), (1969). Photosynthesis and Fish Production in the Sea, *Science*, *166*, 72-76.

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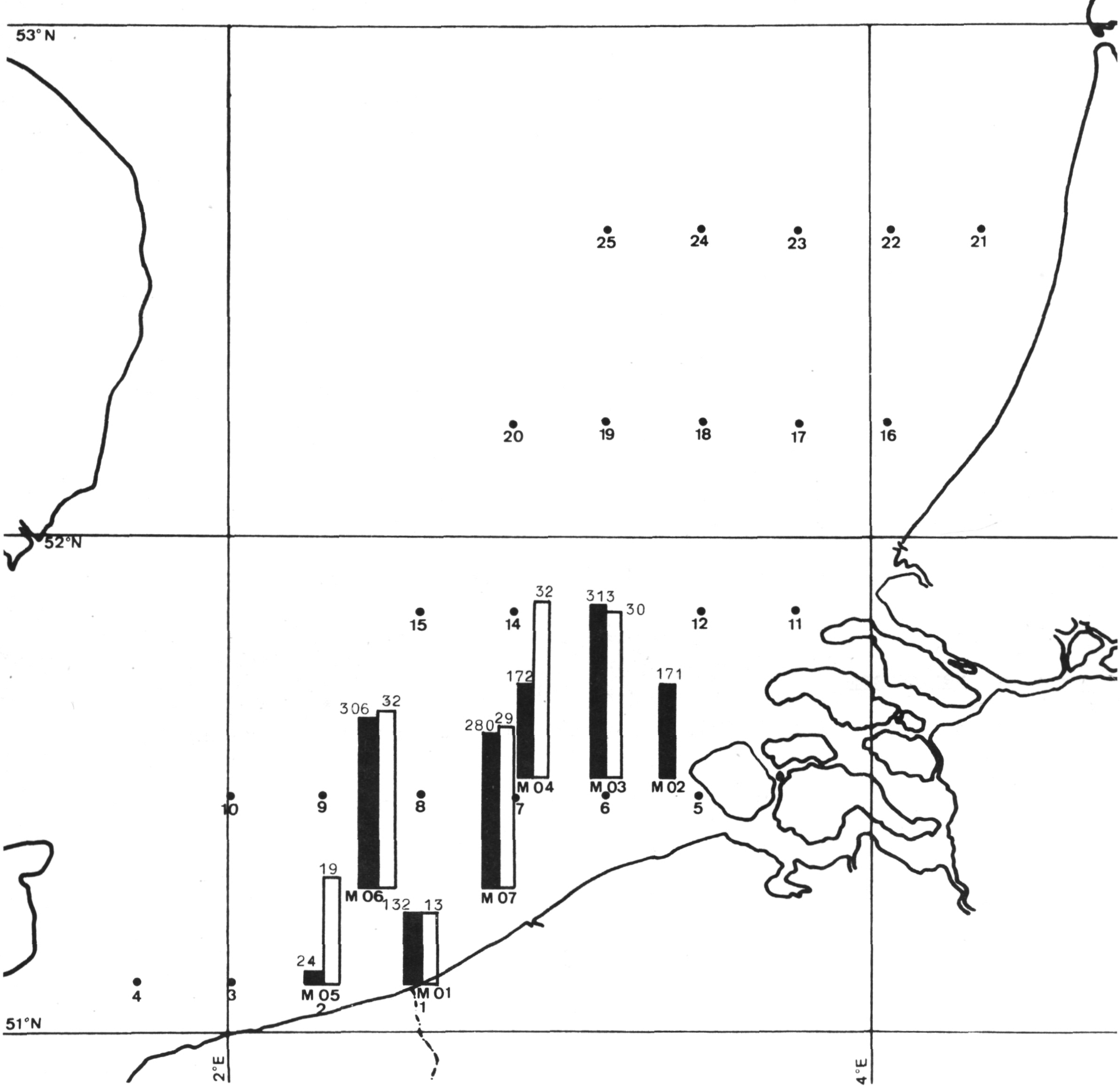
WIGLEY (R.L.) et McINTYRE (A.D.), (1964). Some quantitative comparisons of offshore meiobenthos and macrobenthos south of Martha's Vineyard, *Limnol. Oceanogr.*, *9 (4)*, 485-493.



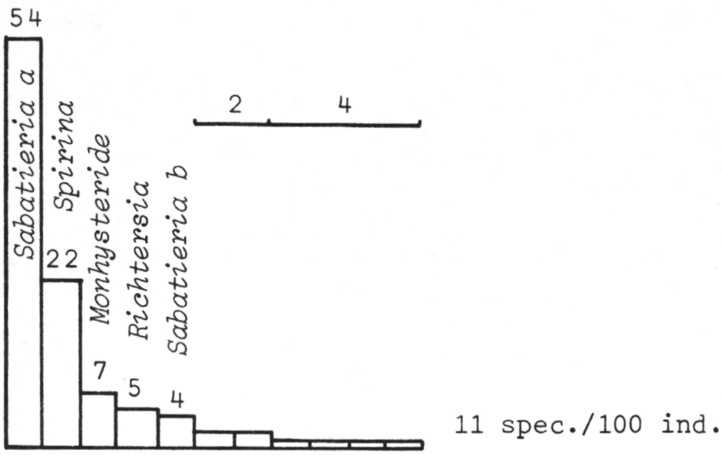
n = $x \times 10^3/m^2$

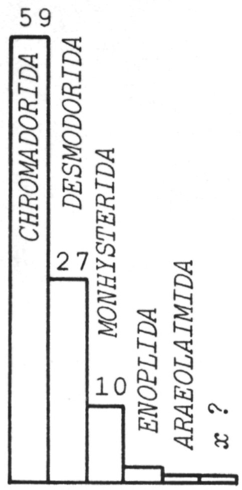
n = n species/100 indiv.

NEMATODA

M 01 23-01-71 A

Mudsnapper





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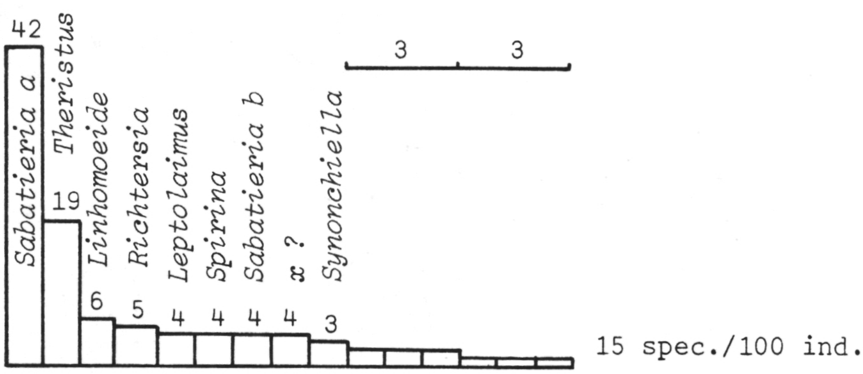

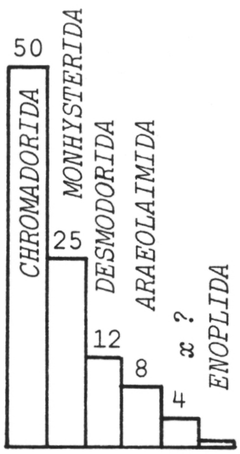

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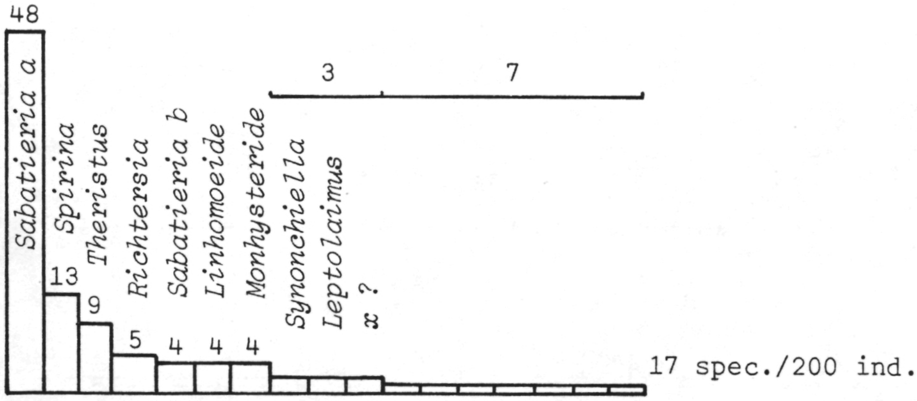

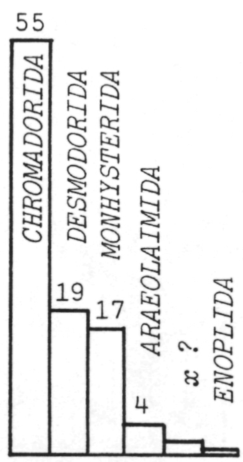

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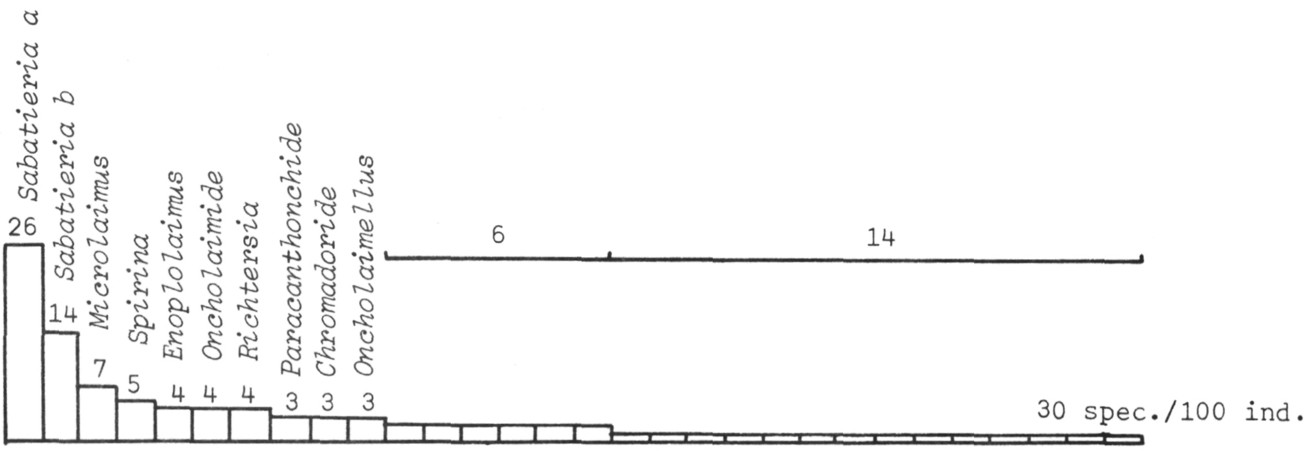

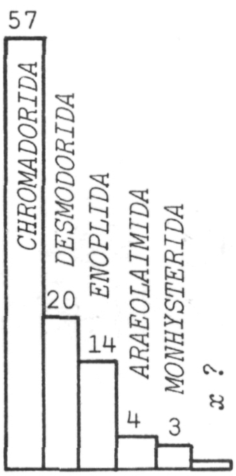

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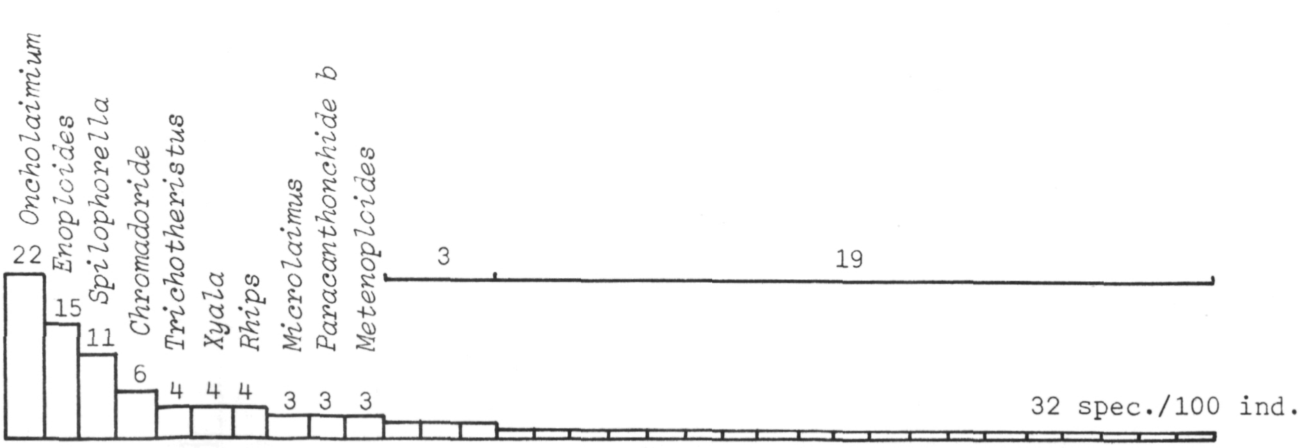

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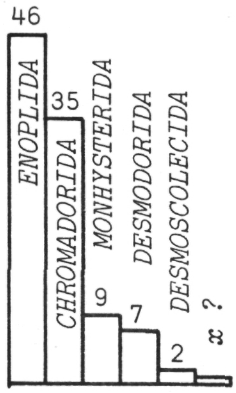
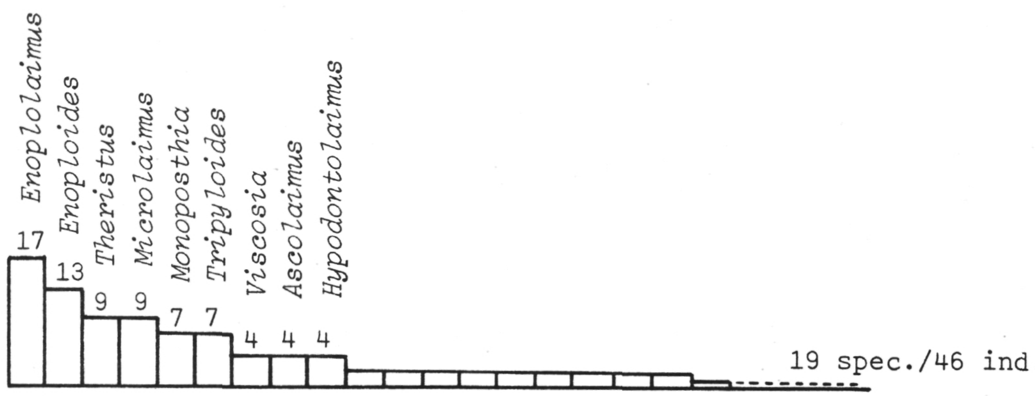
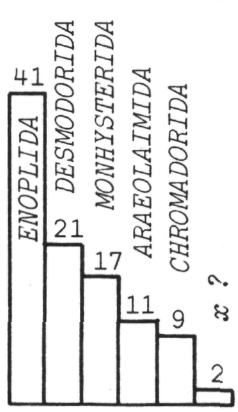


M 05   02-02-71   Mudsnapper





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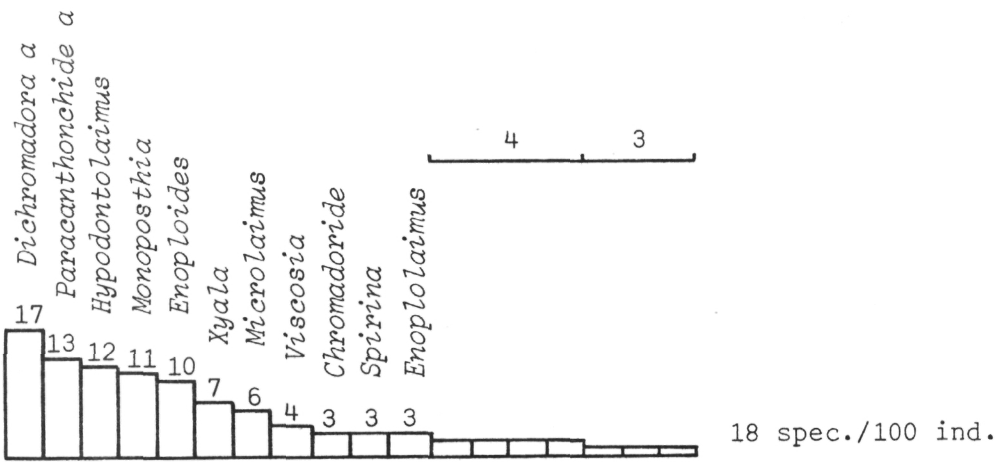

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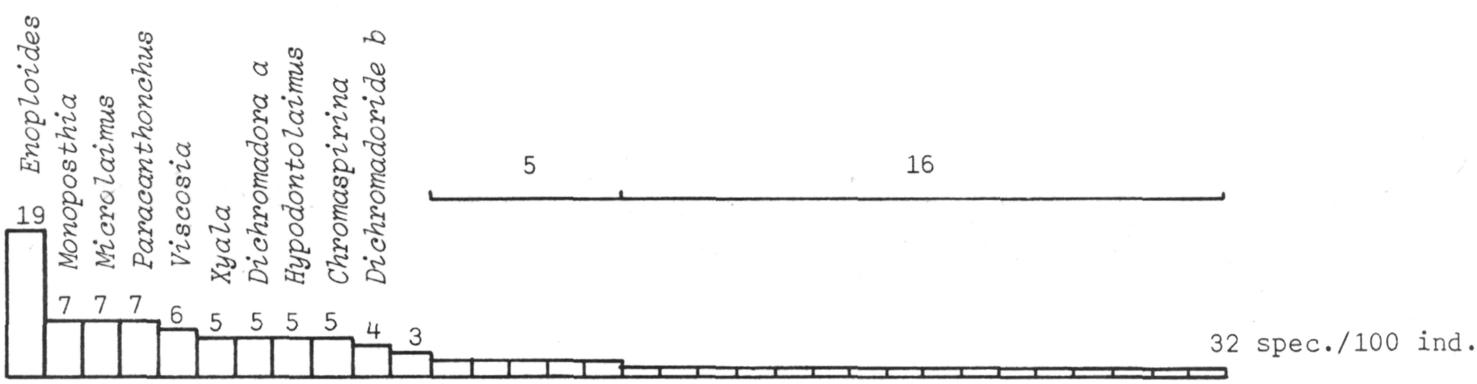

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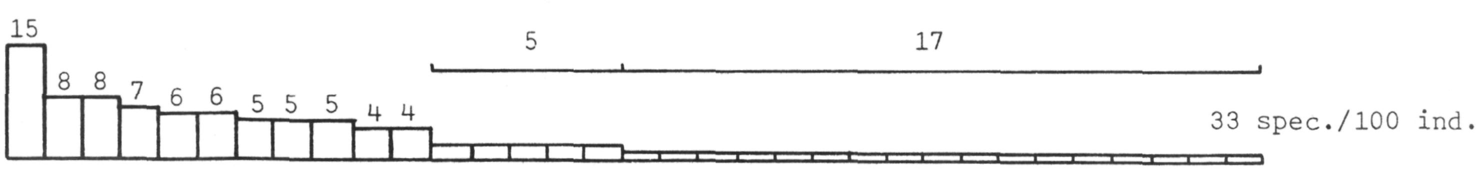
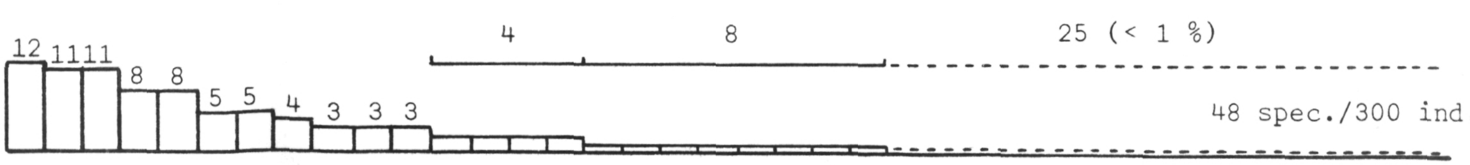


M 06 04-02-71 A + B + C Mudsnapper



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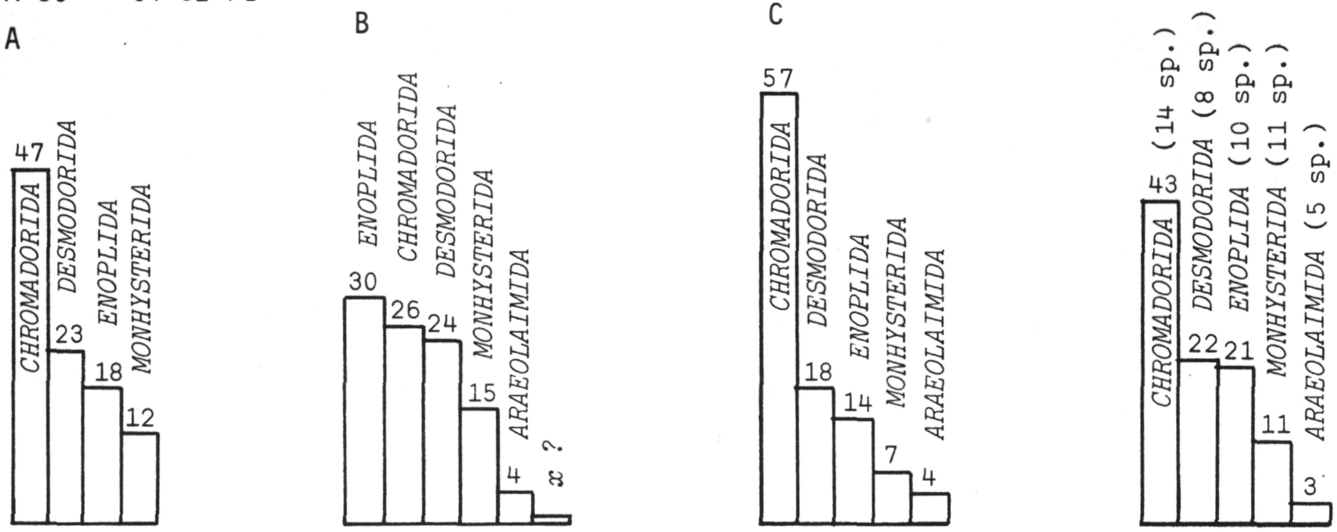
A + B + C



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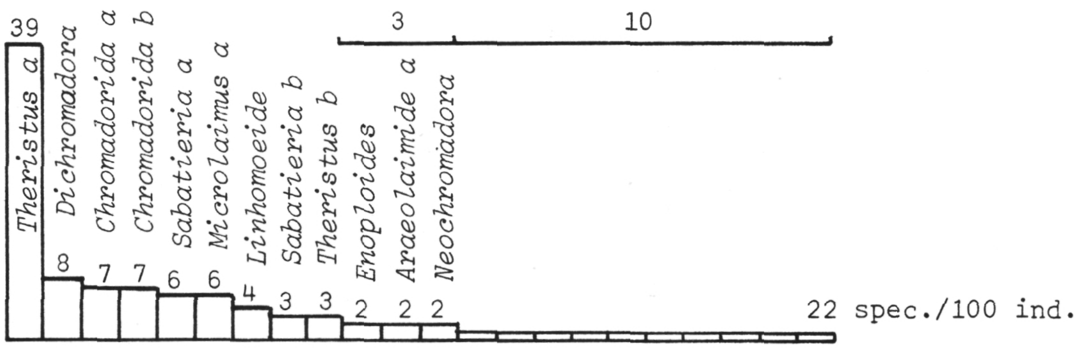

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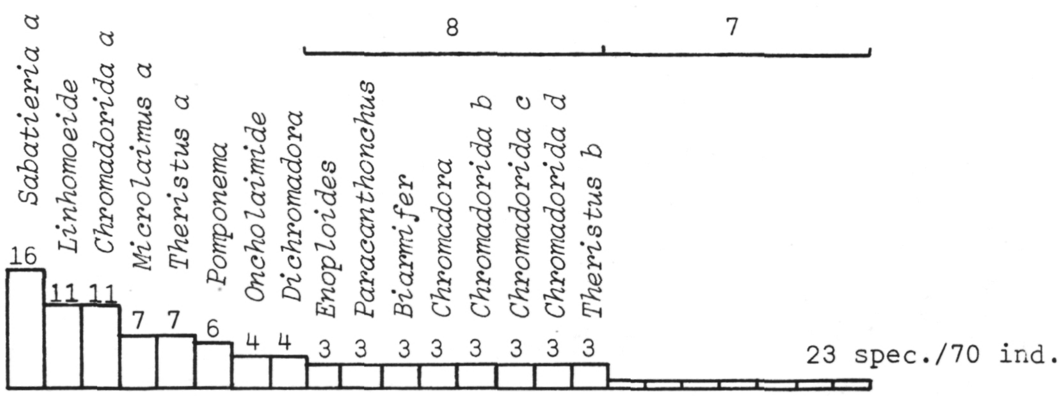

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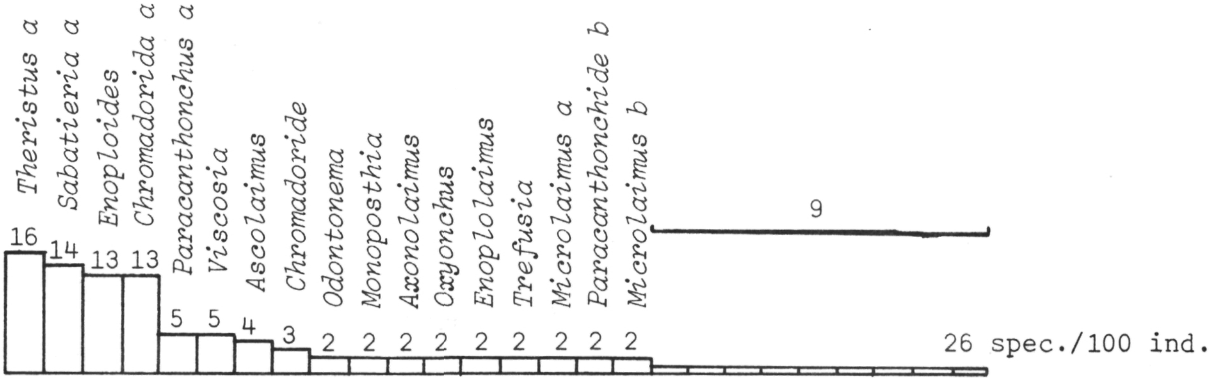
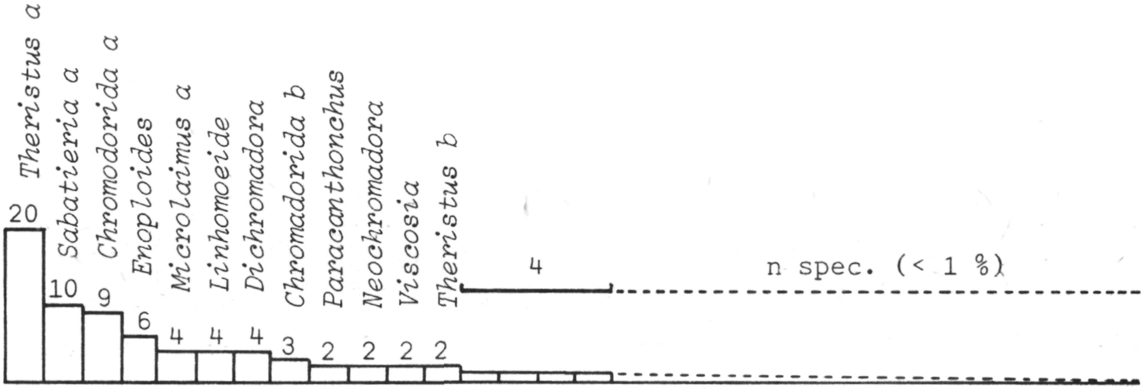


M 07 05-02-71 A + B + C (270 ind.) Mudsnapper



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