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BERMUDA PLATFORM.

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Zoology

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SHALLOW WATER MEIOBENTHOS OF THE
BERMUDA PLATFORM

by
Bruce Charles Coull

A Dissertation
Presented to the Graduate Committee
of Lehigh University
in Candidacy for the Degree of
Doctor of Philosophy
in
Biology

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1968

Approved and recommended for acceptance as a dissertation in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Sept 13, 1968
(date)

Sidney S. Herman
Professor in Charge

Accepted, Sept 13, 1968
(date)

Special committee directing the doctoral work of Mr. Bruce Charles Coull.

Sidney S. Herman
Chairman

Saul B. Perlman

James M. Park

Sydney S. Perlman

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"For they shall suck of the
abundance of the seas, and
of treasures hid in sand."

DEUTERONOMY 33: 19

SHALLOW WATER MEIOBENTHOS OF THE
BERMUDA PLATFORM

by

Bruce Charles Coull

ABSTRACT

The distribution and abundance of subtidal meiobenthos were studied monthly from June 1967 to May 1968 at six stations on the Bermuda platform: two in Castle Harbor, two in Baileys Bay and two in Harrington Sound. Total number of individuals ranged from 0-133.3 x 10⁴/m² and dry weight biomass from 0-259.3 mg/m². Free-living nematodes constituted 72.6% of the total numbers and 71.8% of the biomass and were the most abundant organisms at all but one station. Harpacticoid copepods were second in overall abundance and were the most abundant organism at one station. Polychaetes, ostracods, kinorhynchans and priapulids were also common.

Distinct seasonal patterns were observed. Total population values were highest in late spring, lowest in the winter. Nematodes often reached maximum values in the winter and were correlated with minimum temperatures. Copepod abundance was related to reproductive cycles and changing sediment conditions. Copepods were abundant in the medium to coarse grained sands, nematodes in the finer sediments. Meiofauna was greatly reduced in the lower layers of sediment; this reduction was attributed to decreased interstitial water and oxygen content.

Field and laboratory results indicated specific grain size

preferences of the Harpacticoida. Epigrowth feeding nematodes were dominant in sandy sediments, deposit feeders in the muds. Epigrowth dominance was probably related to carbon rich aggregated particles coating the sediments.

Three distinct harpacticoid "parallel level bottom communities" were defined: (1) the Leptastacus macronyx (T. Scott) - Praeleptomesochra africana (Kunz) community in the submerged "beach sands," (2) the Stenhelia (D.) n. sp. - Cletodes dissimilis (Willey) community in the carbonate muds, and (3) the Phyllopodopsyllus hermani mihi community in the medium to coarse grained sands.

Diversity analyses of the harpacticoid communities indicated highly evolved, stable assemblages in those areas of low physical stress and less stable, variable assemblages in areas of high physical stress.

Detailed study of harpacticoid copepods yielded sixty-six species, five of which were new species. The most ubiquitous was Phyllopodopsyllus hermani mihi. Twenty-nine species were new to Bermuda and significant changes in the zoogeographical ranges were noted for several species.

I. INTRODUCTION

A. General

All ecological surveys are concerned with two major problems: (1) how do the organisms adjust to their various individual environments, what conditions of their environment can they appreciate, how are the associations organized in light of the environment and (2) how much does the association produce and what is its trophic significance in the complex food web?

A marine ecology investigation is concerned with environmental factors, and organismic associations, which are quite different from those on land or even in fresh water. The benthos, such an association, best exemplifies organism-environment interdependency. Whereas the pelagic association adjusts primarily to water quality (nutrients, temperature, etc.), benthic adjustments to the environment are dependent on a number of additional factors such as pelagic associations and sediments.

This dissertation deals with the first problem presented: the environmental adjustments and association organization of the omnipresent, abundant, productive and often neglected portion of the benthic association, the intermediate sized forms collectively known as the meiobenthos.

The present knowledge of meiobenthos is sparse. All the literature available deals with the fauna in silicate (quartz) sediments; nothing is known about their abundance, distribution or environmental dependency in carbonate sediments. The present investigation in the

95-100% carbonate sediments of Bermuda, was undertaken in an attempt to correct this situation and permit comparisons between carbonate-non-carbonate areas.

"Meiobenthos" was first coined by Mare (1942) to describe those benthic metazoans of intermediate size: animals smaller than those traditionally called "macrobenthos," but larger than the "microbenthos" i.e., bacteria and protozoa. McIntyre (1964) asserts that there is no clear-cut distinction between the meio-macrobenthos; the former simply refers to those metazoans, which, because of their small size can be most adequately sampled by techniques different from those of the larger animals. The meiofauna is by no means a homogeneous group and is not, like the psammon (interstitial fauna), restricted to a particular habitat. McIntyre (1961, 1964), Maus (1966) and Thorson (1966) further break the meiofauna down into two groups: (1) the temporary meiobenthos, those which spend only their larval stages as part of the meiobenthos (usually larvae of the macrofauna), and (2) the permanent meiobenthos, those which are always part of this group. The present survey deals primarily with the permanent forms.

Despite the fluidness of the definition, it is generally accepted that meiofauna refers to those animals which pass through a 0.5 mm sieve and are retained on a sieve with mesh widths smaller than 0.1 mm: in the present investigation, 0.0625 mm. Other investigators have used sieves of 0.1 mm (Mare 1942), 0.160 mm (Wieser 1960), 0.076 mm (McIntyre 1964) and 0.074 mm (Tietjen 1966). The larger mesh sizes most likely allowed some of the smaller forms to

escape. The 0.0625 mm sieve appeared most suitable for collection of these smaller forms.

Moore (1931) and Krogh and Spärck (1936) give population estimates from the Clyde Sea and Copenhagen Harbor muds respectively, while Mare's (1942) investigation dealt also with mud, in the English Channel. Bougis (1946, 1950) reported on population values at 30 m off Cape Abeille in the Mediterranean; Smidt (1951) studied both sand and mud bottoms in the Danish Wadensea; Thiel (1966), deep sea population in the Indian Ocean; and B. Muns (1967), population values of meiofauna, macrofauna and bottom living fish in Danish Estuaries. Most of these authors simply present numbers or biomass of the organisms in the major taxa, but Wieser (1960) (in both sand and mud in Buzzard's Bay, Massachusetts) and Tietjen (1966) (in two New England estuaries) identified the nematodes to species and discussed their ecology. McIntyre (1964) discussed the population values in two Scottish Lochs and Wells (1965) identified the copepods from these same stations. The present study discusses the population densities, biomass and the ecological relationships of all taxa; and in particular the species distributions of the Harpacticoida and Nematoda.

Wigley and McIntyre (1964) investigated macrofaunal-meiofaunal relationships off the New England coast and presented meio-macrofaunal number-biomass ratios as well as the ecology of the two major taxa. K. Muns (1967) and Thorson (1967) restrict their discussion of meiofaunal components to the "temporary" forms, although Thorson does discuss the feasibility of naming the benthic community on the

basis of the meiofauna.

Rarely have the organism-sediment interrelationships of the meiofauna been specified and when they have, only nematodes have been considered (Wieser 1960; Tietjen 1966; Hopper and Meyers 1967). These relationships are specified for both the nematodes and harpacticoids in the present study.

Community elucidation has long been a useful tool for the environmental scientist. Except for Wieser's (1960) description of two distinct meiofaunal communities in Buzzard's Bay and Por's (1964) indication of harpacticoid copepod communities in the Mediterranean off Israel, the meiofaunal benthic associations have been neglected. This thesis establishes three distinct carbonate communities. A new approach, fitting the meiofaunal communities to a Stress-Time Model on the basis of species diversification and niche segregation after Sanders (1967) is presented.

Estuarine studies by Tietjen (1966) and B. Muns (1967) have delineated seasonal patterns and species succession within some groups of the meiofauna, but the other surveys were of such short duration no seasonal pattern could be discerned. Seasonal patterns of abundance and species distributions of Bermudian meiofauna and the suspected causal factors are discussed herein.

Moore (1931), Krogh and Spärck (1936), Mare (1942), Bougis (1946, 1950), Smidt (1951), McIntyre (1961), Wieser and Kanwisher (1961), Tietjen (1966) and B. Muns (1967) have shown that most meiofaunal organisms are confined to the upper 2 cm of sediment, with the majority of the nematodes confined to the upper 4 cm and

reaching a lower limit of 6 to 8 cm. In the present study the vertical distribution of the Bermudian fauna is examined and compared with the other areas. Possible reasons for the vertical limitations are presented.

Lang (1948), Por (1964, 1965), Vervoort (1964) and Wells (1967) list the zoogeographical ranges of the known harpacticoid copepods. Several new distributions and additions to the known ranges are added in this thesis.

Renaud-Debyser (1955, 1963) in the Bahamas, Kline (1968) in Miami, and Renaud-Mornant and Serene (1967) in Malasia have studied these intermediate sized organisms in a carbonate environment but their investigations have dealt with the beach psammon and not the subtidal fauna. All found reduced numbers of organisms in the carbonates when the values were compared to those of silicate sands.

There has recently been increased interest in the systematics of various meiofaunal groups, with portions of the work being done in carbonate areas. Chappuis and Delamare Deboutteville (1956) have described the copepods and isopods of Bahamian beaches. Hopper (1961a, 1961b, 1963) has listed many of the nematodes common in the Gulf of Mexico, Hopper and Meyers (1967a, 1967b) of Biscayne Bay, Florida, and Wieser and Hopper (1967) those common to the east coast of Florida. Seyer (1966) has reported on the "fond coralline" copepods at Banyuls-sur-Mer, France; Por (1964), on those in the Levantine and Pontic areas of the Mediterranean; and Higgins (1964), on kinorhynchids off North Carolina. Many of the species prevalent in these were also found in Bermuda.

In summary, the specific objectives of the investigation may be detailed as follows:

1. To demonstrate the existence of a significant meiobenthos population within the carbonate sediments of the Bermuda platform.
2. To determine the taxa encompassed by the meiofauna, their population densities and their biomass.
3. To compare the Bermudian populations with those of other areas.
4. To determine the nature of the vertical distribution of meiofauna in the sediments.
5. To delineate those environmental factors affecting the populations and to specify the organism sediment interrelationships of the Nematoda and Harpacticoida.
6. To determine whether population fluctuations and species succession occurred on a seasonal basis.
7. To establish the community relationships of the carbonate meiobenthos, define the community in terms of its diversity, and fit the resultant diversity values to a Stress-Time Model.
8. To compare the zoogeographical ranges of the harpacticoids and expand the distribution records of particular species.

B. Other Studies In The Area

As mentioned previously, all other true meiobenthic studies have been conducted in a predominantly silicate environment. Two macrofaunal studies have been conducted on or near the Bermuda platform (Chave et al. 1962 and Sanders et al. 1967). Barnhart (1963) has studied the distribution of sediments and foraminifera across

the platform. Some early studies, primarily systematic, of various macrofauna on the Bermuda platform include Webster (1884); Verrill (1900, 1901, 1908); Richardson (1901); Hoagland (1919); and Treadwell (1936, 1941).

Willey (1930, 1931, 1935) published an account of the harpacticoid copepods from Bermuda and Yeatman (1962, 1963) included some Bermuda harpacticoids in his work. Neither investigator collected benthic samples, although some of the forms in the present study were collected by both.

C. Harpacticoid Copepod Systematics

The harpacticoid copepods have been studied in detail during the present survey. Within this extremely diverse group, certain species are benthic, certain species are pelagic, some are epiphytic, some are epizoic, and some species are known to inhabit two or more of these niches. Since these organisms have played such an important part in the present survey, a short review of the systematic literature is listed on page 20 (Methods and Materials).

The literature is replete with reports on the systematics of the Harpacticoida. Lang's (1948) two volume monograph is a necessity for any systematic work on the organisms as it collates the majority of the literature up to that point. After 1948, the literature is scattered in several languages. A complete review of the literature is not within the scope of the present work. However, those investigations found useful in the present survey are listed in the Methods and Materials.

Representatives of the species collected during the present

survey have been deposited at the Division of Crustacea, United States National Museum, Washington, D.C.

Throughout the dissertation a new copepod, Phyllopodopsyllus hermani, is often mentioned. A description of P. hermani is in press and is expected to be published shortly (Coull, Crustaceana, in the press).

Lang's (1948) phylogeny is followed throughout the dissertation.

II. THE INVESTIGATION

A. Area of Study (Figure I)

Six stations in three localities (Castle Harbor, Baileys Bay and Harrington Sound) were sampled monthly. These stations were part of the original quarterly sampling program and were selected because each had at least one interesting feature, exemplified a different environment and was easily accessible.

Each shallow station was marked with a white "Clorox" bottle buoy attached to a length of pipe (57 cm) which was driven into the sediment. During the period of sampling, the buoys broke loose, but the pipes remained and the exact station could be located accurately with a cursory swim employing a face mask and snorkel. Using three very sharp shore ranges, the deep stations could be ascertained to within 50 feet.

1. Castle Harbor

The harbor is characterized by an irregular bottom profile and an open sea connection to the south-east. Castle, Rusby, Charles, Southampton and Non-Such Islands partially bar the seaward entrance to the harbor, with Castle Roads and Non-Such Scaur the main passages into the harbor. The north-west portion of the harbor, though bounded by the Longbird Bridge and Causeway, opens into Ferry Reach. One-third to one-half of the harbor was dredged in the early 1940's, but the two selected stations were away from this dredged area.

a. Castle Harbor Shallow (CHS) (3 m)

CHS was located at the south-south-east corner of the harbor,

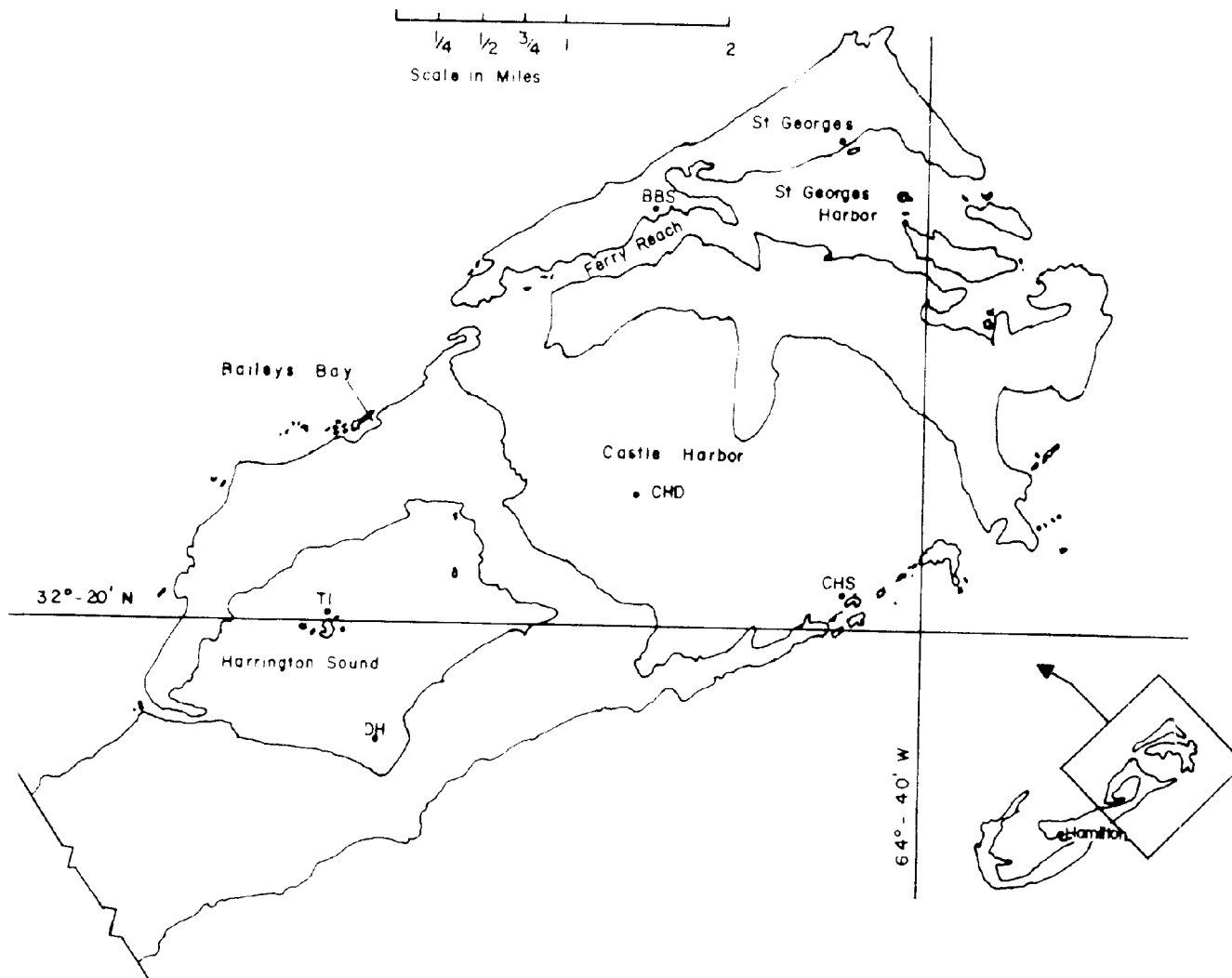


Figure 1. Map of Bermuda showing the locations of the meiofaunal stations.

16 m north-west of the precipitous cliffs of Castle Island. The sediment is a wave-rippled, winnowed, well-sorted, densely packed, fine sand (median grain size ranged from 190-240 μ). The station is an area of continual tidal current activity.

b. Castle Harbor Deep (CHD) (13 m)

CHD was situated approximately in the center of Castle Harbor, 1500 m north-east of the Castle Harbor Hotel. The sediment is a poorly sorted silty-sand interspersed with Halimeda spp. fragments, Occulina diffusa fragments and broken molluscan shells. The mud-water interface was difficult to detect, as a flocculent layer was apparent. There was no stirring of the bottom (even in the highest winds) and the environment remained relatively constant throughout the year.

2. Baileys Bay

Located on Bermuda's north shore, the bay is bordered on the south by the north shore and on the north by Bay Island. Grass beds of Thalassia testudinum (König) are interspersed throughout the bay and serve as traps for suspended sediment. Tidal flow passing through the bay bypassed the grass beds and flowed only over the exposed sediment.

a. Baileys Bay Coarse (BBC) (3-4 m)

BBC was situated approximately 100 m south of the south-west tip of Bay Island, in the center of the bay. The station is 10 m from the nearest Thalassia bed and is a site of tidal movement. The sediment is a coarse sand (Wentworth 1922) with Halimeda spp. fragments and considerable amounts of broken shell. The sediment

is stratified: the coarse material restricted to the upper two centimeters, the finer material below. The condition, however, did not persist throughout the year. With the onset of winter, the sediment environment was altered (See Results).

b. Baileys Bay Fine (BBF) (2 m)

BBF was located approximately 50 m south of the south-west tip of Bay Island, 50 m north of BBC on the edge of a Thalassia bed. The sediment is medium sand (mgs, 500µ), with little or no vertical stratification. Roots of Thalassia were evident at a sediment depth of 5 cm. This environment also was not stable: often (especially in winter), the grass bed was not in evidence and the station marker was surrounded by sand (See Results).

3. Harrington Sound

Harrington Sound is an almost enclosed, semi-tropical lagoon. It maintains near-normal oceanic temperature and salinity despite its restrictiveness. The main tidal exchange with the outside waters takes place through a narrow opening at the south-west corner, Flatts Inlet.

Neumann (1965) divided the Sound into three ecological zones: (1) the Shallow Sandy Zone (0-10 m), (2) the Ocaulina Zone (10-19 m) and (3) the Subthermocline Zone (19-to the deepest part of the Sound, approx. 27 m). The zonation is distinct and is characterized by different faunal assemblages. (See Neumann for a description of the area.)

a. Trunk Island (TI) (5 m)

TI was situated 20 m north of the north-east tip of Trunk Island.

The sediment is a relatively well-sorted medium sand (mgs, 485 μ), consisting of well worn fragments of calcareous algae, molluscs, forams and land derived cemented clasts.

b. Devils Hole (DH) (27 m)

DH was located at the south-east corner of Harrington Sound in the deepest portion of the Sound. The sediment is a coarse silt consisting primarily of fecal pellets of Certhium sp. and Ostrea frons (Williams 1966) and the pseudo-feces of various other molluscs. As with Castle Harbor Deep, the mud water interface was difficult to detect as a flocculent layer was apparent.

During the summer months, a temporary thermocline was established between 18-21 m and dissolved oxygen decreased to 0 ml/L at 25 m. The thermocline was established during May, most prevalent in September and turned over in October. No vertical stratification was present from October to May.

B. Methods and Materials

1. Field

Samples were collected monthly (June 1967-May 1968) at the six stations (Figure 1). The stations were occupied using the Bermuda Biological Station launch Abudefduf (26'). Samples at Castle Harbor Deep and Devils Hole (deeper stations) were taken as hand cores using SCUBA equipment. At the shallow stations (Castle Harbor Shallow, Baileys Bay Coarse, Baileys Bay Fine, and Trunk Island) hand cores were obtained with the use of face mask and snorkel.

The sampling was accomplished by pushing a short (15-20 cm) plastic core liner (inner diameter 3.5 cm) into the sediment to a

depth of 10 cm. With the plastic liner in the sediment, a rubber stopper was pushed into the top of the core tube. The core tube was then quickly removed from the sediment and a #7 recessed top rubber stopper employed to close the other end. The plastic liner (with both ends corked) was transported through the water to the launch. The cores for organism counts were immediately extruded; a stick molded to fit the recess in the bottom cork was used to push the sediment upward and cut off at the two, five and seven cm levels (retaining the following sediment segments: 0-2, 2-5, 5-7, >7 cm). Each segment was placed in a polyethylene pint jar (wide mouth "Mason" type) with enough sea water to cover the sediment. Four replicate cores, for organism analyses, were collected in this manner. Periodically, extra cores were collected for grain size analyses, water content measurements and chemical analyses of the sediments. Further additional cores were taken in June 1967 for statistical analyses to determine the monthly sampling program.

Samples for overlying water column dissolved oxygen were collected by hand, except at Devils Hole, where a Nansen bottle was used. Samples were taken monthly at the surface and bottom at Castle Harbor Shallow, Baileys Bay and Trunk Island; at the surface, 6.5 m and the bottom at Castle Harbor Deep; and at the surface, 7 m, 14 m, 21 m, 24 m, at Devils Hole.

Surface temperatures were recorded with a bucket thermometer. At Devils Hole a Bathythermograph was used to record temperature throughout the water column.

An attempt to discern the exchange, flow and current direction

of the bottom water in Baileys Bay was undertaken in September. Weighted polyethylene bags containing fluorescein dye were dropped throughout the bay and the dispersion of the dye recorded and photographed.

2. Laboratory

a. Enumeration of the Meiiofauna

In the laboratory each pint mason jar was filled with H.A. Millepore (0.45 μ) filtered sea water and a few granules of Rose Bengal were added. Rose Bengal is a vital stain recommended by Walton (1952) to distinguish living and dead foraminifera and Mason and Yevich (1967) to facilitate sorting benthic samples. The samples were then stored in a refrigerator for a minimum of 24 hours to allow penetration of the stain. The animals remained alive for 4-6 days in the jars; the samples were all sorted well within this time limit. After removal from the refrigerator, the samples were shaken vigorously and the supernatant poured through two sieves with mesh widths of 500 μ and 62.5 μ . This procedure was repeated five times and the residue left in the Mason jar, as well as the fine fraction that passed through the 62.5 μ sieve, were periodically examined for meiiofauna. Preliminary checks to ascertain the number of animals remaining in the residue and passing through the fine sieve had shown that very thorough shaking tears loose all the animals and puts them into the supernatant. The percentage of animals passing the fine sieve was generally insignificant and consisted solely of juvenile nematodes. The organisms left on the sieve were washed into finger bowls, the excess water siphoned off (using

0.064 mm plankton mesh over the end of the siphon) and transferred to a plastic tray by eye dropper. The samples were then counted and separated into major taxa with the use of a dissecting microscope.

All organisms collected were counted. Every harpacticoid copepod was picked out of the sample, put into a vial containing 4% buffered formalin, and identified to species at a later date. Approximately every third nematode was separated out and put into formalin. The separated nematodes were then split into two equal parts. One-half of the nematodes were grouped on the basis of their buccal apparatus after Wieser (1953) and one-half shipped to Dr. Bruce E. Hopper for species identification. Wieser (1953) had divided the free living marine nematodes into four groups, according to the structure of their oral cavity, each morphological division being assumed to represent different types of feeding mechanisms. The divisions are as follows:

Group 1A - small, unarmed buccal cavity, selective deposit feeders.

Group 1B - large, unarmed buccal cavity, non-selective deposit feeders.

Group 2A - small, armed mouth cavity, epistrate feeders.

Group 2B - large, armed buccal cavity, omnivore-predators.

Whenever possible, taxa were sent to specialists for identification. The harpacticoid copepods were identified with the use of a binocular compound microscope. Each harpacticoid species was mounted in Hoyer's Mounting Medium and permanent slides and vials

with each species were retained. Representatives of the species collected have been deposited at the United States National Museum.

Number of organisms per m^2 was established by calculating the area of the 3.5 cm inner diameter core liner; dividing the area into 1 square meter ($10,000 \text{ cm}^2$); and multiplying this factor (1039) by the number of organisms counted, i.e.:

$$A = \pi r^2$$

$$A = 3.14 \times (1.75)^2 = 9.621 \text{ cm}^2$$

$$\frac{10,000}{9.621} = 1039$$

$$1039 \times \#org. = \#org./m^2$$

Jones (1962), criticizing this method, asserts that extrapolating one small sample to represent the fauna in one square meter presupposes all areas within the square meter are exactly the same as the sampled portion. The effect of possible patchy distribution was minimized in the present survey as the values from the four replicate cores were averaged and plotted with the standard deviation.

b. Weight Determinations

Dry weights of the major meiofauna taxa were determined by drying a known number of organisms at 50°C to constant weight. The specimens were weighed on a Mettler Microbalance (M5) and the total weight divided by the number of individuals to establish the dry weight per individual. The results were in general agreement with Wieser (1960), McIntyre (1964) and Tietjen (1966). Wet weights were determined using the 25% dry weight/wet weight ratio discussed by Wieser (1960) and Tietjen (1966). The value for each organism was multiplied by the number of organisms per m^2 to give the dry and wet

weights per m^2 . The average individual dry weights of the meiofauna taxa were: copepods, 0.00123 mg; nematodes, 0.00212 mg; ostracods, 0.011 mg; polychaetes, 0.0062 mg; halacarids, 0.0014 mg; kinorhynchs, 0.0027 mg; turbellarians, 0.0020 mg; lamellibranch larvae, 0.00576 mg; and amphipods, 0.00520 mg.

c. Harpacticoid Systematics

Besides Lang's (1948) synopsis of the pre-1948 literature, the following references were employed during the systematic portion of the survey: Klie (1949, 1950); Kunz (1949, 1951, 1954, 1962, 1963); Chappuis (1953, 1957); Bozic (1955); Noodt (1955a, 1955b, 1955c, 1957, 1963, 1964); Roe (1955); Chappuis and Delamare Deboutteville (1956); Delamare Deboutteville (1960); Wells (1961, 1963, 1965, 1967); Yeatman (1962, 1963); Griga (1963); Soyer (1963, 1964, 1966); Bodin (1964); Por (1964a, 1964b, 1964c, 1965); Vervoort (1964); Gonzalez and Bowman (1965); Lang (1965); Wells and Clark (1965); Dussart (1966); Wilson (1966); and Geddes (1968).

Willey's (1930, 1931, 1935) original papers on the Bermuda harpacticoids also proved to be of great value.

d. Chemical Analyses

(1). Sedimentary Organic Matter

The sediment was dried at 80 °C, ground with a mortar and pestle, and stored in a dessicator. The method used for determination of organic matter was a modification of the potassium dichromate-sulfuric acid wet oxidation method outlined by Maciolek (1962). The wet oxidation method has been criticized by Wangersky and Chave (personal communication) who assert that the major objection to wet oxidation is that the refractory portion is not oxidized; therefore

total sedimentary organic carbon is not measured.

To measure total natural organic matter, Morgans (1956) has suggested multiplying the value obtained by wet oxidation by 1.3 since wet oxidation is assumed to oxidize only 75% of the natural organics. However, Sanders et al. (1965) have noted that the refractory portion is not a readily available food source for the benthos; it is only the labile portion which the organisms can use. Since the refractory portion is not a readily available food source, and the wet oxidation does not oxidize the refractory portion, the values obtained in the present study were not multiplied by Morgans' (1956) factor of 1.3 to obtain total organics.

The carbonates were dissolved with dilute H_2SO_4 and the chlorides complexed with Ag_2SO_4 (Quinn and Salomon 1964). The dilute acid carbonate dissolution served to partially hydrolyze the labile organic fraction and the remainder of the technique follows that of Maciolek (1962). There are no approximations for the refractory portion or total organics, i.e., the non-refractory (labile) plus the refractory.

(2). Sedimentary Phosphorus

Total phosphorus was determined spectrophotometrically using the method of Murphy and Riley (1958), following digestion of the sample (100 mg) for 2 hours with 1.4 ml of concentrated H_2SO_4 .

(3). Sedimentary Nitrogen

Total nitrogen in 100 mg samples of dried pulverized sediment was determined using a Coleman Model 29 nitrogen analyser. The analyser employs the micro-Dumas technique.

(4). Dissolved Oxygen

The modified Winkler technique outlined in Strickland and Parsons (1965) was used in the determination of dissolved oxygen.

e. Sediment Parameters

(1). Grain Size Distribution

For grain size measurements the core was sectioned at the 2 cm level and the grain size distribution was determined for both fractions, i.e., 0-2 cm and >2 cm. The sediment was sieved through a nest of seven U.S. Standard Sieves, each separated by one ϕ unit. The sieves used had mesh openings of 4 mm, 2 mm, 1 mm, 0.5 mm, 0.25 mm, 0.125 mm, and 0.0625 mm. The silt-clay fraction that passed through the 0.0625 mm sieve was collected in a bucket of known volume. The fractions collected on the sieves as well as a 100 ml aliquot of the silt-clay fraction were then put into 250 ml tared beakers, dried at 80 °C and weighed. The silt-clay weight was then extrapolated to the total volume of the bucket. All of the grain size analyses were determined by wet sieving the sediment in fresh water, thus avoiding the aggregation that often accompanies drying of carbonate sediments.

(2). Eh, pH

Both Eh and pH were measured with a Beckman Zeromatic pH meter. Readings were made at seasonal intervals in the upper two centimeters of the cores.

(3). Interstitial Water

Water content was determined on split core fractions, i.e., 0-2 cm and >2 cm. Wet sediment was weighed in a tared 250 ml beaker,

dried at 80 °C to constant weight and reweighed. Wet weight minus dry weight was interpreted as the weight of the interstitial water.

f. Variations Between Samples

An estimate of the variations within samples (replicate cores at the same station) was obtained by taking eight cores at each station during June 1967. Variation was estimated using the coefficient of variation, C (Snedecor 1956). This statistic, which is a ratio of the sample standard deviation to the sample mean, is expressed as a percent; the lower the C value, the lower the variation between replicate cores.

Only the total population was tested using this statistic and the values obtained for the eight replicate June cores were: CHS 19.8%, CHD 6.2%, BBC 11.4%, BBF 19.4% and TI 8.8%.

Although eight cores were taken in June 1967, the number of replicate cores actually taken for organism analyses during the year's study was four, except for January, March, April and May 1968 when two replicates were taken.

All the harpacticoid copepods were picked out of all the samples from one monthly station and put into the same vial. The percentage per species was used to estimate succession and dominance. This technique tends to even out the variation between replicates (when identifying the harpacticoids to species) as all of the individuals were used for species identification and ecologic consideration.

g. Diversity Analysis

Diversity within the harpacticoid populations was measured using the rarification methodology of Sanders (1967). Sanders has compared

this methodology to a number of diversity indices and has concluded that the rarification technique is the most applicable as it is not dependent upon sample size.

The idea behind the methodology is to keep the percent composition of the component species constant but reduce the sample size in order to determine the number of species and number of individuals which would have been present had smaller samples been taken. The explanation of the methodology is taken directly from Sanders (1967) (p. 6-7).

"The species are ranked by abundance, and the percent composition of each species and the cumulative percent are plotted. In a hypothetical example there are 1000 individuals and 40 species. As an example, the number of species at the 25 individual level will be determined. The percent composition is the same as in the original sample, but the number of individuals is reduced to 25. Since 25 specimens in this reduced sample represent 100% of the individuals present, then each individual specimen forms 4% of the sample. In the original sample, seven species each comprise 4 or more percent, and in total they compose 76% of the sample by number. Therefore, each of these seven species will be present in the reduced sample. This leaves a residue of 24% of the original sample comprising the remaining 33 species. Because none of these species form more than 4% of the original sample, those species of this group that will appear in the reduced sample cannot be represented by more than one individual. Since one specimen comprised 4% of the reduced sample, therefore:

$$\frac{24\%}{4\%} = 6 \text{ species}$$

$$7 + 6 = 13 \text{ species present per 25 individuals.}"$$

This methodology is applied several times at different total population values. The resultant number of species per specified number of individuals is then plotted. The resultant curvilinear line is due to the fact that individuals are added at a constant rate, but the progressively rarer species are added at a continuously

decreasing rate. The end point of the curve gives the actual number of species and individuals present in the sample, and the curves themselves give the interpolated number of species at different population levels. The method can only be used to interpolate, not extrapolate.

The closer the curves approach the ordinate, the greater the diversity, i.e., a large number of species per small number of individuals. The closer the curvilinear line(s) approaches the abscissa, the lower the diversity, e.g., a line parallel with the abscissa would indicate the lowest possible diversity, only one species present no matter how many individuals.

h. Experimental

Experiments to determine the grain size preferences of the meiofauna taxa were attempted in March (Experiment I) and April (Experiment II). An aquarium ($10\frac{1}{2} \times 6\frac{1}{2} \times 8\frac{1}{2}$ in.) was used. Sand collected from Ferry Reach (a non-study station) was wet sieved with filtered sea water through 1.0 mm, 0.5 mm, 0.25 mm, and 0.125 mm sieves (Experiment I) and through 2.0 mm, 1.0 mm, and 0.5 mm sieves (Experiment II). The aquarium was divided into two equal parts, using a plywood divider and certain sieved sands were placed on either side of the divider. During Experiment I, sand >0.5 mm and <1.0 mm was placed on one side of the divider, and sand <0.5 mm and >0.250 mm on the other. The sand used in Experiment II was >1.0 mm and <2.0 mm and >0.5 mm and <1.0 mm. In both experiments, 4 cm of the sieved sand were placed on either side of the divider.

After the sand had been placed in the aquarium, sea water was

gently added to both sides to fill the aquarium. The divider was removed and an air-stone placed in the center of the tank. There was some overlapping of the sediment types in the center of the tank. The aquarium was then placed in a plastic "dish pan" filled with sea water.

Meiofaunal components were then sorted out of samples taken from Baileys Bay Coarse, Baileys Bay Fine and Trunk Island, and randomly pipetted into the experimental tank.

Replicate equal volume sub-samples were procured from the center of each respective sand patch, from each side of the aquarium at specific time intervals. The animals collected were counted, separated to a major taxon and the harpacticoids identified to species.

III. RESULTS

A. Environmental Parameters

1. Air Temperature, Wind Direction

Air temperatures in Bermuda during the period 14 June 1967 to 17 May 1968 ranged from a low of 8.9 °C on 27 February 1968 to a high of 31.1 °C on 27 August 1967.

Winds were primarily out of the N, NW and NE during the winter months and out of the S, SW and SE during the summer.

2. Water Temperatures (Figure 2)

The high temperatures listed below are for August 1967, the low temperatures for February 1968 except for those noted otherwise.

a. Castle Harbor Shallow

Surface temperatures ranged from 17.0 °C in January 1968 to 27.5 °C in August. Day to day temperatures fluctuated at this shallow station depending on cloud cover, percent solar radiation and wind. No appreciable difference was noted in surface and bottom temperatures (Figure 2a).

b. Castle Harbor Deep

Surface temperatures ranged from a low of 16.0 °C to a high of 27.0 °C. Day to day fluctuations were slight and the entire water column remained isothermal throughout the year (Figure 2b).

c. Baileys Bay

Surface temperatures ranged from a low of 16.2 °C to a high

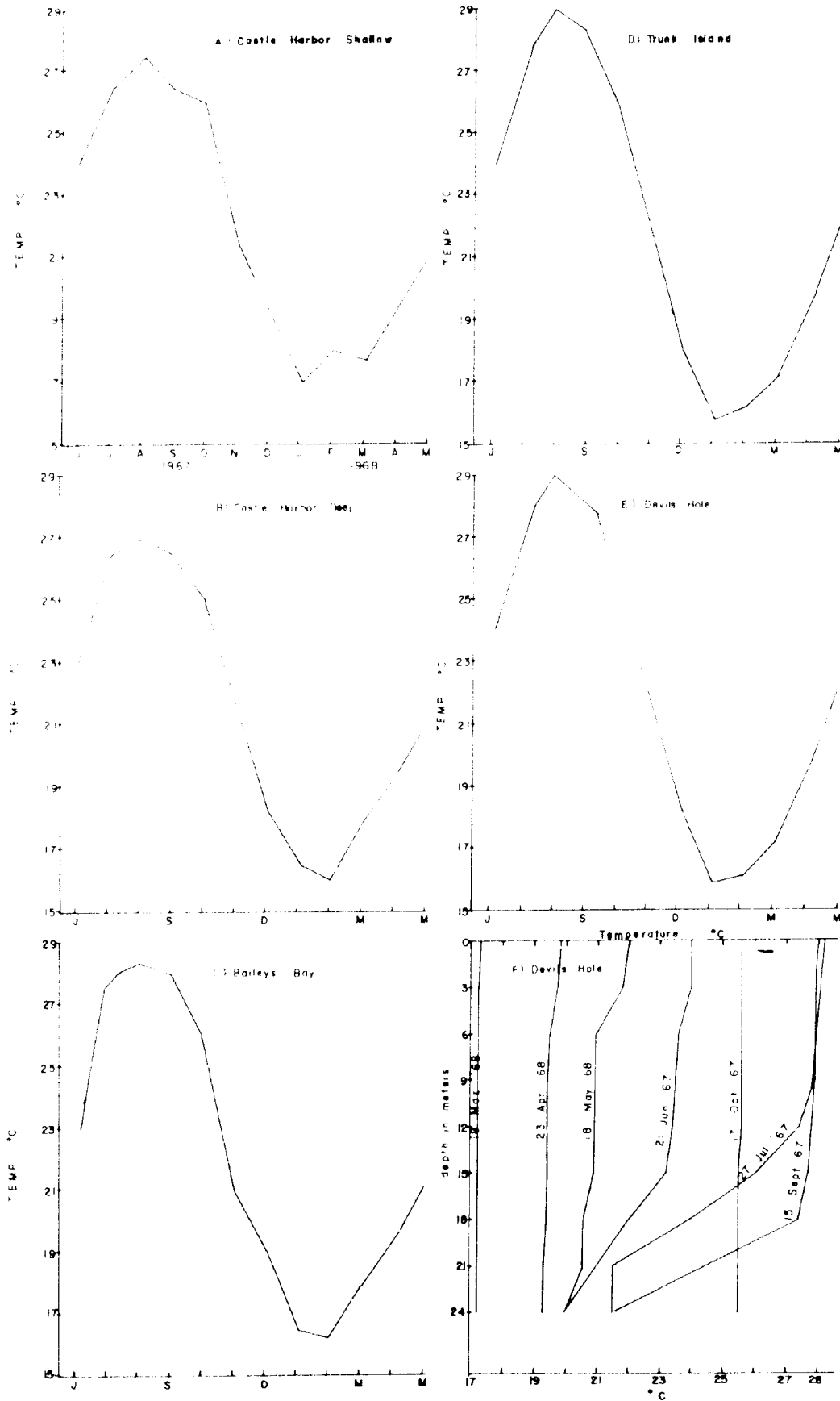


Figure 2. a-e) Seasonal variation of surface temperature at the study stations f) Temperature profiles - Devils Hole.

of 28.3 °C. No appreciable gradient was notable between the surface and bottom (Figure 2c).

d. Trunk Island

Since Trunk Island is in an enclosed body of water, the surface waters tended to warm and cool faster than those of the outside stations. Surface temperature ranged from 15.8 °C to 30 °C. The water column remained isothermal throughout the year (Figure 2d).

e. Devils Hole

Surface temperatures were similar to those at Trunk Island and ranged from 15.8 °C to 29.8 °C (Figure 2e).

During the summer months, commencing in May, a temporary thermocline was established at 15-18 m. As the surface waters warmed the thermocline continued between 15-18 m, but the temperature range increased. In June the temperature drop between 15-18 m was 1.2 °C, in July 2 °C, and in August 5 °C. In late August, early September the thermocline deepened to 18-21 m. The convective overturn occurred some time in early October. During the remainder of the study, the water column was isothermal (Figure 2f).

3. Chemical Analyses

a. Sedimentary Organic Matter

The values for sedimentary organic matter at the study stations are shown in Table 1. Values ranged from a low of no detectable organic carbon at CHS on 17 June 1967 to a high of 17.60 mg C/gm sediment at DH on 17 September 1967.

TABLE 1. QUARTERLY SEDIMENTARY ORGANIC MATTER (mg C/gm sediment)

<u>Date</u>	<u>CHS</u>	<u>CHD</u>	<u>Station</u>		<u>TI</u>	<u>DH</u>
			<u>BBC</u>	<u>BBF</u>		
17 June 1967	*	5.00	2.30	2.30	0.74	14.50
15 Sept. 1967	1.20	6.24	4.40	4.40	1.04	17.60
19 Dec. 1967	0.07	6.05	3.97	2.90	0.59	15.60
18 Mar. 1968	0.07	5.50	2.11	2.81	0.14	13.95

* No detectable organic carbon

b. Sedimentary Phosphorus

Percent total phosphorus for all the stations is shown in Table 2.

TABLE 2. QUARTERLY PERCENT TOTAL SEDIMENTARY PHOSPHORUS

<u>Date</u>	<u>CHS</u>	<u>CHD</u>	<u>Station</u>		<u>TI</u>	<u>DH</u>
			<u>BBC</u>	<u>BBF</u>		
17 June 1967	0.021	0.052	0.008	0.007	0.019	0.094
15 Sept. 1967	0.015	0.030	0.005	0.006	0.018	0.074
19 Dec. 1967	0.016	0.035	0.008	0.008	0.015	0.068
18 Mar. 1968	0.013	0.032	0.008	0.009	0.018	0.056

The phosphorus values ranged from a low of 0.005% at BBC on 15 September 1967 to a high of 0.094% at DH on 17 June 1967.

c. Sedimentary Nitrogen

The total nitrogen values are based on the samples of one month (June 1967) because of equipment failure.

TABLE 3. PERCENT TOTAL SEDIMENTARY NITROGEN

<u>Date</u>	<u>CHS</u>	<u>CHD</u>	<u>Station</u>		<u>TI</u>	<u>DH</u>
			<u>BBC</u>	<u>BBF</u>		
17 June 1967	0.035	0.130	0.048	0.046	0.035	0.200

d. Dissolved Oxygen

(1). Castle Harbor Shallow

Surface oxygen ranged from 3.30 ml/L on 18 December 1967 to

5.54 ml/L on 18 March 1968. Bottom values were always higher than those at the surface and ranged from a low of 4.83 ml/L on 17 August 1967 to a high of 5.62 ml/L on 18 March 1968.

(2). Castle Harbor Deep

Oxygen values generally increased with depth. Surface values ranged from 4.73 ml/L on 20 July 1967 to 5.59 ml/L on 18 March 1968, 6.5 m values from 5.11 ml/L on 17 August 1967 to 6.20 ml/L on 17 February 1968 and bottom values from 5.13 ml/L on 17 August 1967 to 7.13 ml/L on 20 July 1967.

(3). Baileys Bay

Bottom oxygen values ranged from a low of 4.73 ml/L on 17 October 1967 to a high of 5.79 ml/L on 17 February 1968. Surface values ranged from 3.48 ml/L in October to 5.48 ml/L on 18 March 1968 and were generally lower than those at the bottom.

(4). Trunk Island

The high values for both the surface and bottom were recorded in March 1968: 5.99 ml/L for the former, 6.19 ml/L for the latter. The low values were noted in July 1967, 4.69 ml/L for the surface, 4.70 ml/L for the bottom.

(5). Devils Hole

As illustrated in Figure 2f, the water column was not isothermal throughout the entire year. As the thermocline was established in late May - early June, the dissolved oxygen at 24 m decreased and by August, none was detectable. This anaerobic condition remained until the convective overturn of the thermocline in October; the water column then became isothermal and dissolved oxygen was distri-

bated evenly throughout. Table 4 illustrates the effect of the overturn on the distribution of dissolved oxygen.

TABLE 4. DEVILS HOLE - TEMPERATURE AND OXYGEN
15 September 1967 - 17 October 1967

<u>Date</u>	<u>Depth (m)</u>	<u>Temp. °C</u>	<u>O₂, ml/L</u>
17 Sept. 1967	Surface	28.0	4.86
	7	27.9	4.95
	14	27.7	4.89
	21	24.2	3.45
	24	21.5	0.00

17 Oct. 1967	Surface	25.6	4.56
	7	25.6	4.56
	14	25.5	4.47
	21	25.5	4.61
	24	25.5	4.56

4. Sediment Parameters

a. Grain Size Distribution

(1). Castle Harbor Shallow

The sediment, a well sorted, densely packed, rippled, fine sand, was well rounded, uniformly sized and reminiscent of the typical "Pink Beach" sands of Bermuda. Early attempts to establish different stations in troughs and on the crests of the ripples proved futile. There was no difference in the grain size distribution nor in the inhabitant fauna.

Measurements of the distance between and the height of the ripples were obtained at different intervals. The ripple size was dependent on the tidal flow and local climatic conditions. Ripple size varied between 9.3 cm long and 2.4 cm high in February 1968 to 6.3 cm long and 1.6 cm high in November 1967.

The median grain size (mgs) of the upper 2 cm was constant

throughout the year ranging from 0.19 mm in December 1967 to 0.24 mm in June 1968. Median grain size of the >2 fraction was approximately 0.04 mm coarser than that of the 0-2 segment. Percent silt-clay was negligible and ranged from 0.7-12.4% for the 0-2 segment and 1.0-6.4% for the >2 segment. Figure 3 illustrates a typical cumulative distribution curve for this station.

The sorting coefficient, $S_o = \sqrt{Q_1/Q_3}$ (Trask 1932), of the 0-2 cm segment was close to that of Trask's definition of a very well-sorted sediment, ranging from 1.22 to 1.34. The S_o of the >2 cm segment varied from 1.36 to 1.45. Using Inman's (1952) statistic (Phi Median Deviation, $\sigma_\phi = (\phi_{86} - \phi_{14})$), which represents one standard deviation unit on either side of the mean, the values ranged from 0.53 to 0.75 (0-2 cm) and 0.70-0.79 for the >2 segment.

(2). Castle Harbor Deep

This deep station harbors a typically poorly sorted carbonate mud. The mud was interspersed with irregularly sized fragments of Occulina diffusa, calcareous algae (particularly Halimeda sp.), echinoid spines, sponge spicules, foraminiferal tests and broken molluscan shells.

Depending upon the amount of large coral fragments in the sediment, the median grain size ranged from 0.044 mm to 0.138 mm for the 0-2 segment. On one occasion, August 1967, several large Occulina chunks were evident and a median grain size of 0.350 mm was recorded; however, this must be assumed to be an anomaly. The silt-clay (0-2) fraction always comprised more than 50% of the sediment ranging from 52.7% to 61.7%, except for the anomalous August sample when it

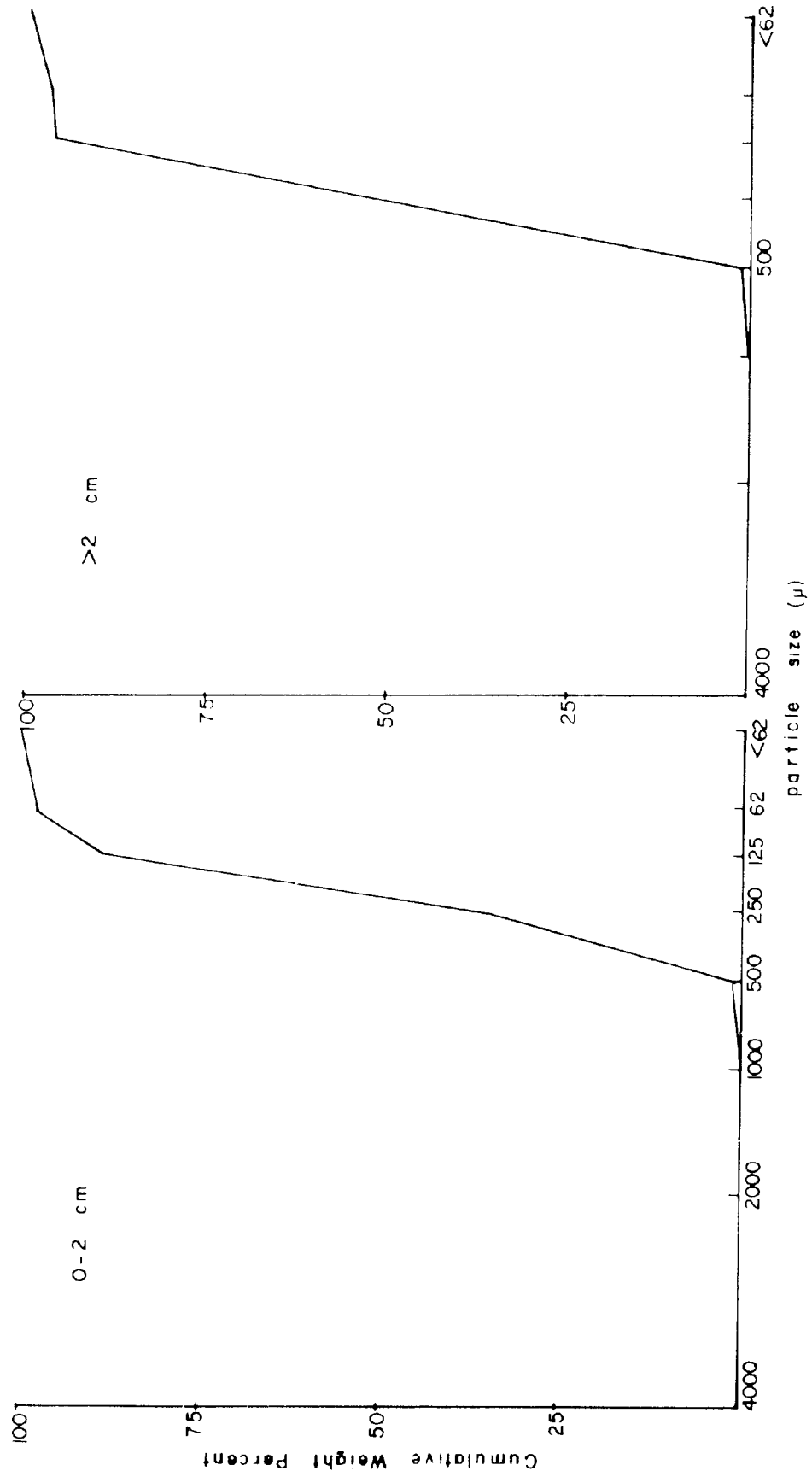


Figure 3. CHS - Typical cumulative sediment particle size analysis curves.

measured at 4.5%. The >2 sediment segment was much the same as the 0-2 segment ranging from 0.045 mm to 0.106 mm mgs and 45.8% to 67.0% silt-clay. Again, the August sample was anomalous with a mgs of 0.450 mm and the percent silt-clay at 30.7. Generally, the grain size distribution remained constant throughout the year.

Sorting coefficients were in the range of those indicating very-poorly sorted sediments, ranging from 4.67 to 5.60 for the 0-2 segment and 3.9 to 6.50 for the >2 segment. Phi median deviation values spanned from 2.80 to 3.25 (0-2 cm) and 2.70 to 3.33 (>2 cm). Figure 4 illustrates a typical CHD grain size distribution.

(3). Baileys Bay

Originally the survey included one station designated as Baileys Bay. However, after careful examination of the bay and its sediments it was noted that patches of coarse and fine sediments were uniformly distributed throughout the bay. The uniformity was prevalent during late spring, summer and early fall, and will be referred to as the "Summer Condition." During the late fall, winter and early spring a different sediment distribution was evident and will hereafter be referred to as the "Winter Condition."

The "Summer Condition" was characterized by the distinct patches of coarse and fine material uniformly distributed throughout the bay. The fine(r) sediment patches were situated near the Thalassia beds, the coarse(r) sediment was distant from the grass beds and surrounded by sands of varying grain size. The two stations, Baileys Bay Coarse and Baileys Bay Fine were established when the "Summer Condition" environment was evident. BBC was located in one of the coarse sand

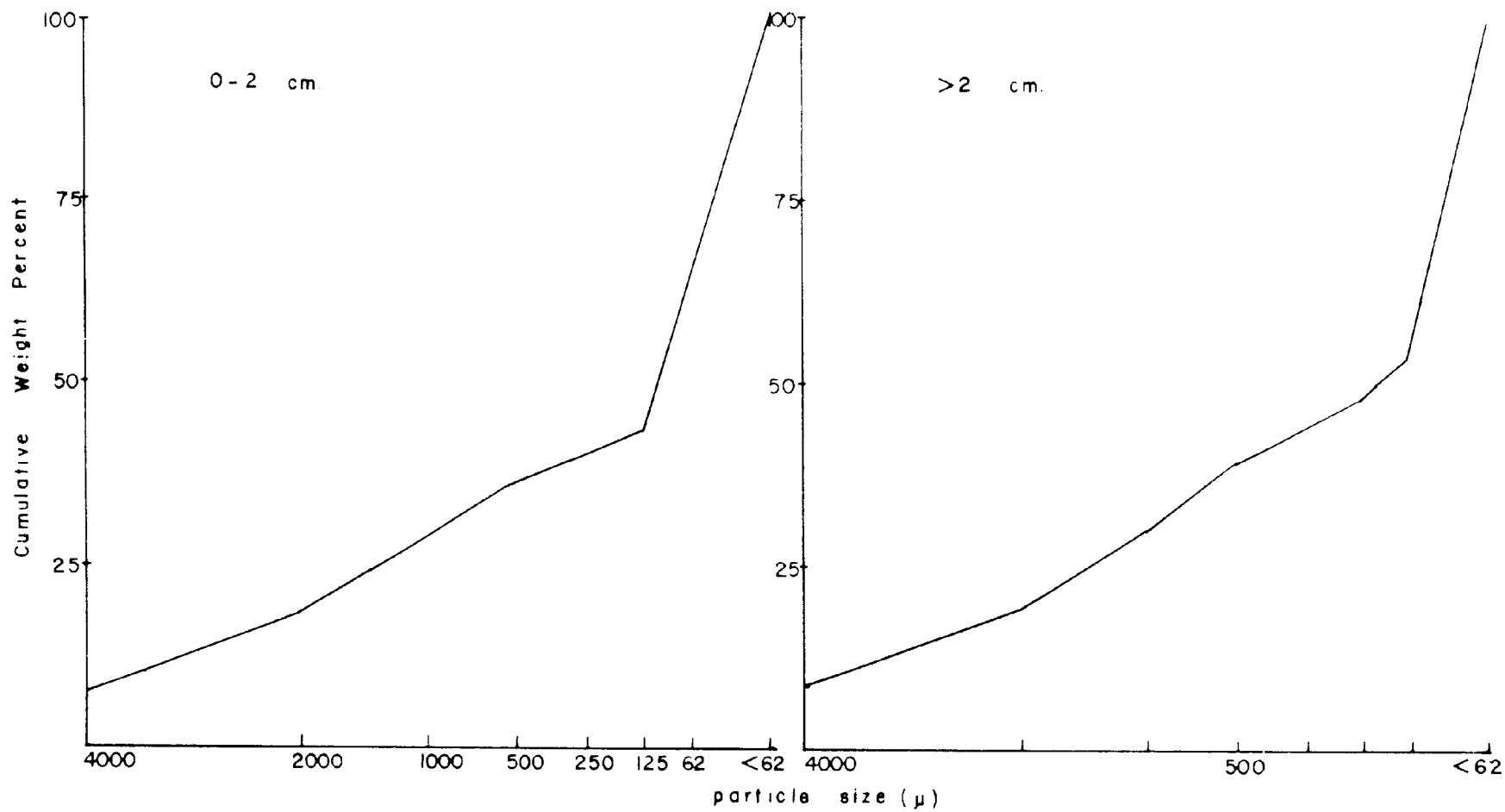


Figure 4. CHD - Typical cumulative sediment particle size analysis curves.

patches, BBF next to a Thalassia bed in the finer sediment.

During the "Winter Condition" the bay environment was altered. The grass beds were not evident and were often covered with sand. The coarse sediment patches were dispersed and the flat "Summer Condition" bottom was rippled.

A study to discern the bottom current direction through the bay on an incoming and outgoing tide was undertaken in September 1967 ("Summer Condition"). As evidenced in Figure 5, the fluorescein dye, marking the bottom currents, did not flow over the Thalassia beds but fastidiously avoided them and flowed only over the exposed sand passages.

(a). Baileys Bay Coarse

Earlier investigations, using the entire core sample for grain size analysis, had shown Baileys Bay Coarse (BBC) fine or finer than Baileys Bay Fine. After careful scrutiny, however, it was noted that only the upper two centimeters of BBC harbored the loosely packed, high porosity, coarse grained material; the sediment below was as fine as, or finer than, that of Baileys Bay Fine. The June 1967 samples were not split at the 2 cm level and a mgs of 0.480 mm was recorded. Samples were split as of July 1967 and median grain size for the 0-2 fraction ranged from 0.580 mm in July 1967 to 1.350 mm in August 1967.

The >2 fraction mgs ranged from a high of 0.490 mm in December 1967 to a low of 0.388 mm in August 1967. The mean of the medians was 0.435 mm.

During the summer the prevailing winds of Bermuda were generally



Figure 5. Distribution of fluorescein dye on an incoming tide, 13 September 1967, Baileys Bay. Except for the dye on the surface of the water, the dye marked bottom currents avoided the Thalassia beds and flowed only over the exposed sand. Arrows indicate the light green dye. The two Baileys Bay study stations are also indicated.

from the south and of low velocity. Baileys Bay, being on the north shore of Bermuda was on the leeward side of the island. When the "Summer Condition" was prevalent, the BBC sandy bottom was flat. 0-2 cm sorting coefficients were less than 2 (1.45 in July 1967 to 1.73 in May 1968), phi median deviation values were 1.50 or below (ranging from 0.95 to 1.50) and percentage silt-clay was low, ranging from 0.3% in May 1968 to 6.4% in April 1968. The overlying water was clear (no sediment in suspension) and the underlying root structure evident throughout the bay was at a sediment depth of 10-16 cm.

During the winter, the prevailing winds approaching Bermuda were northerly; Baileys Bay was therefore on the seaward side of the island. When the "Winter Condition" prevailed, three distinct grain size distribution characteristics changed: sorting coefficient (phi median deviation), percent silt-clay and depth of the sediment overlying the root structure. The median grain size did not change significantly. "Winter Condition" 0-2 cm sorting coefficients were always more than 2, ranging from 2.29 in March 1968 to 2.49 in December 1967. Phi median deviations were above 2.5, ranging from 2.56 to 2.70. Percent silt-clay of the 0-2 cm fraction was 3 to 70 times those recorded during the "Summer Condition," fluctuating between 18.4 and 21.0% in March 1968 and December 1967 respectively. The root structure, which was never found during summer sampling, was encountered at a sediment depth of 3-6 cm.

The >2 fraction did not vary as the 0-2 fraction did and remained relatively constant throughout the year, with sorting coefficients ranging from 1.59 to 1.97. The only major difference encountered in the >2 fraction was the percentage silt-clay which

was higher (11.6-19.3%) in the summer and lower (2.4-6.3%) in the winter, just the opposite of the 0-2 fraction.

Typical BBC grain size cumulative distribution curves for the "Summer Condition" and "Winter Condition" 0-2 ϕ m fraction are shown in Figure 6.

(b). Baileys Bay Fine

Baileys Bay Fine (BBF) was 50 m north of BBC on the southern edge of a Thalassia bed during the summer. There was no vertical layering of the sediment as at BBC. Median grain size of the 0-2 fraction ranged from 0.410 mm in August 1967 to 0.570 mm in December 1967, and 0.425 mm in August to 0.550 mm in December for the >2 fraction. All differences between 0-2 and >2 samples were well within the range of sampling error.

Sorting coefficients for the 0-2 fraction ranged from 1.51 in March 1968 to 2.30 in December 1967; phi median deviation from 0.93 in July 1967 to 2.35 in April 1968; and percent silt-clay from 2.3% in March 1968 gradually increasing to 29.6% in August 1967. >2 fraction values ranged from 1.61 (May 1968) to 1.97 (July 1967) for sorting coefficient; 0.65 (April 1968) to 1.34 (August 1967) for phi median deviation; and 2.4% (April 1968) to 10.9% (August 1967) for percent silt-clay.

No difference was noted between "Summer" and "Winter Condition" grain size distribution; all were within ± 2 S.D. units of the yearly mean. The major notable "Winter Condition" changes were percentage silt-clay, depth of Thalassia root structure and the gross morphological features of the grass bed and surrounding sediment.

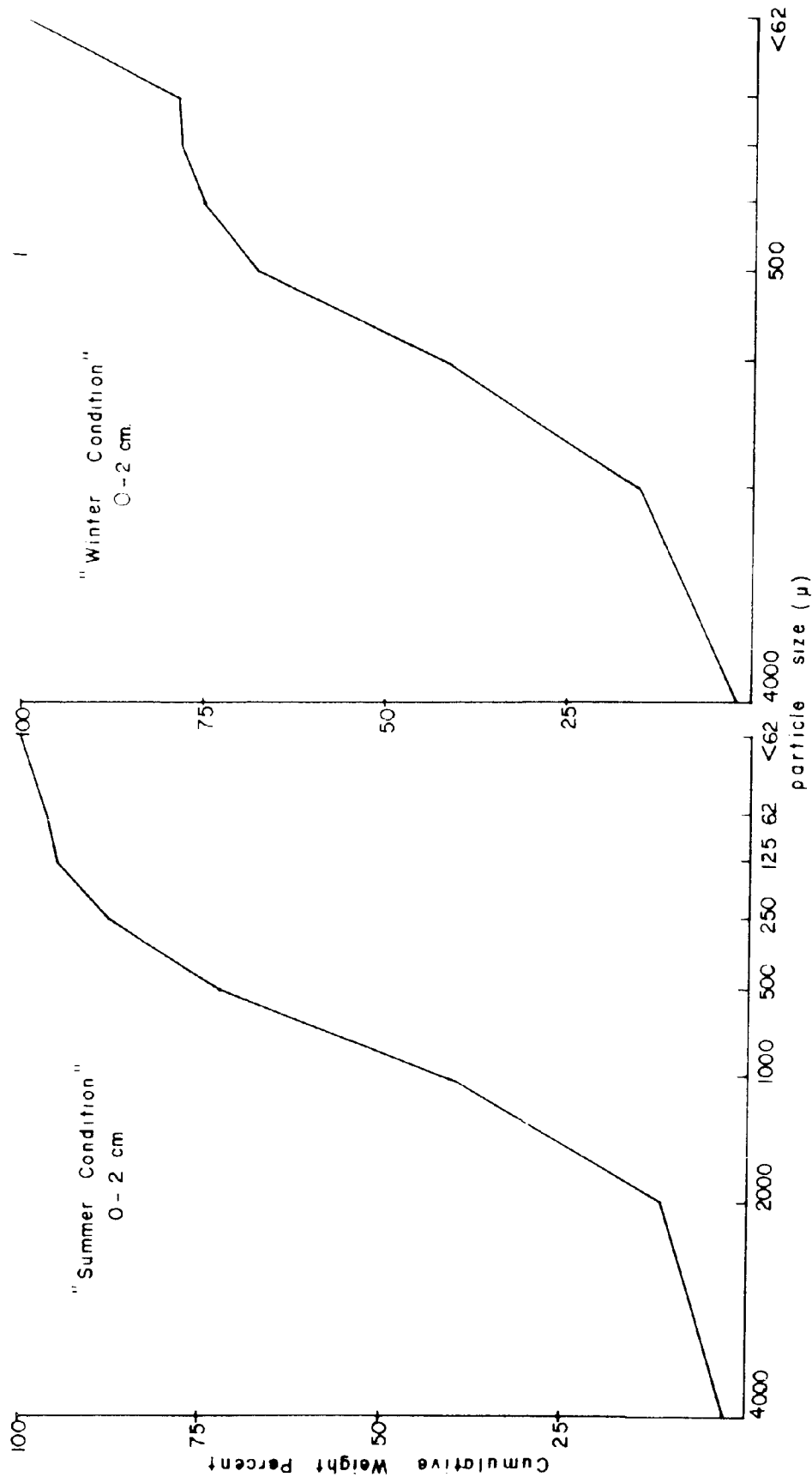


Figure 6. BBC - 0-2 cm typical cumulative sediment particle size analysis curves.

During November, December, January and February, the Thalassia bed abutting on BBF was covered with a medium sand. The station marker, usually found at the edge of the grass bed, appeared to be in the center of a large sand patch. The root structure during this "covering over" period was not evident at 5 cm, but at a sediment depth of 8-10 cm. Thus, the station was covered by an extra 3-5 cm of sand during the winter. The excess sand was almost completely devoid of the fine silt-clay fraction, as noted by the 2.3% silt-clay value recorded for March. Typically the "Summer Condition" silt-clay percentage of 29.6% (August 1967) must have been a result of the baffle and trapping characteristics of the turtle grass community. (Figure 7 for grain size distribution of BBF, 17 August 1967.)

(5). Trunk Island

Grain size distribution properties of the medium sand evident at Trunk Island (TI) are listed in Table 5. Properties were relatively constant throughout the year except for the increased silt-clay percentage, and higher sorting coefficient (phi median deviation values) recorded for both fractions in August 1967.

TABLE 5. SEDIMENT SIZE CHARACTERISTICS, T.I.
0-2 Fraction

<u>Date</u>	<u>ngs (mm)</u>	<u>S₀</u>	<u>$\sigma\phi$</u>	<u>%S.C.</u>
17 Aug. 1967	0.475	1.72	1.35	14.8
19 Dec. 1967	0.485	1.51	0.65	4.1
18 Mar. 1968	0.480	1.54	0.75	1.6
>2 Fraction				
17 Aug. 1967	0.540	1.77	1.22	9.1
19 Dec. 1967	0.540	1.55	0.68	7.9
18 Mar. 1968	0.613	1.47	0.83	4.0

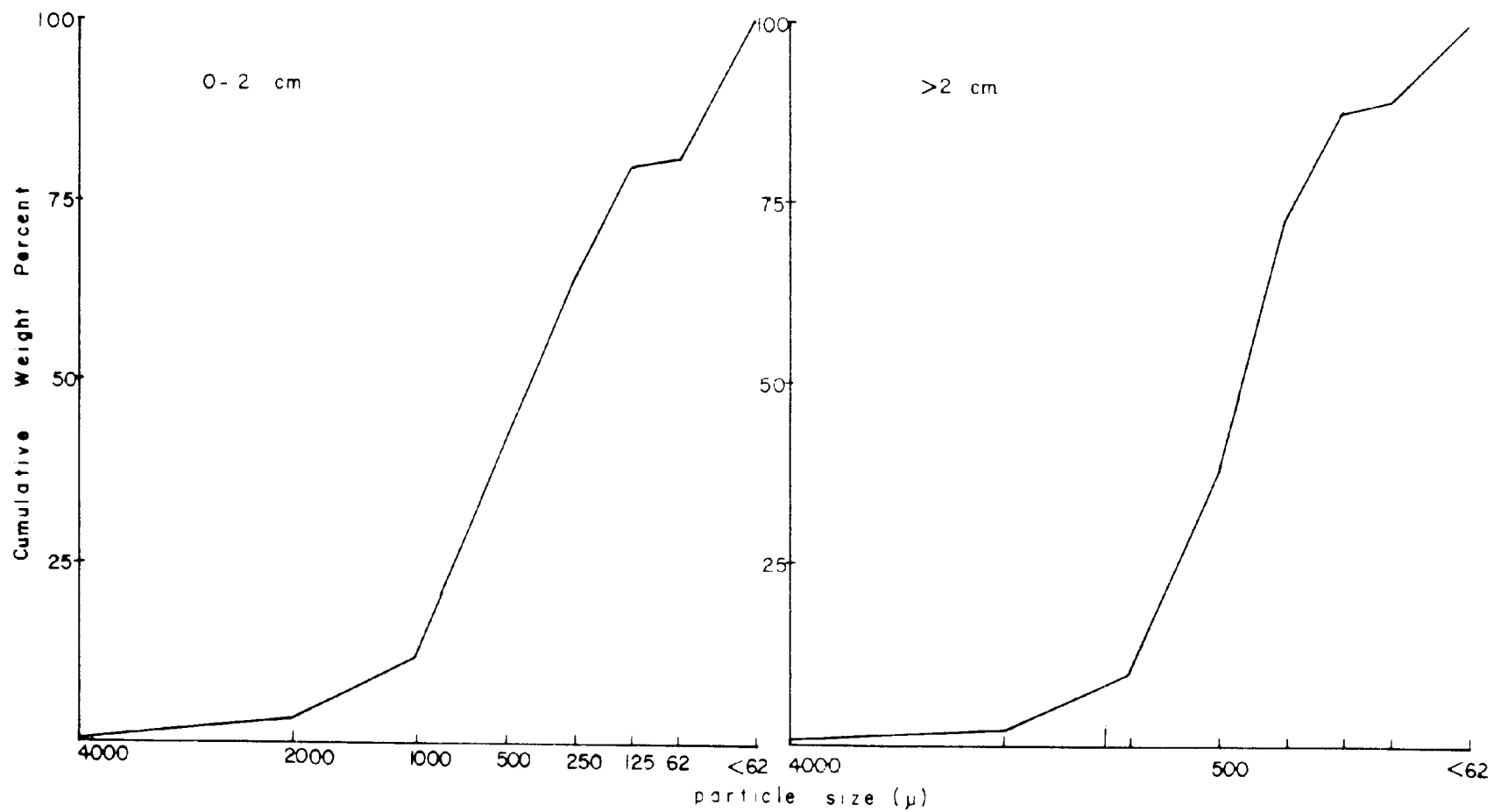


Figure 7. BBF - Typical cumulative sediment particle size analysis curves.

(6). Devils Hole

The fecal pelleted sediment in Devils Hole (DH) remained constant throughout the year. The coarse silt sediment characteristically had a median grain size of $63\mu \pm 10\mu$. Sorting coefficients were always above 2, ranging from 2.28 to 2.51, phi median deviation values between 1.75 and 2.15 and percent silt-clay approximately 60%.

b. Eh and pH

Eh and pH measurements were made at quarterly intervals. The values were consistent throughout the year (Table 6).

TABLE 6. QUARTERLY SEDIMENT Eh (mv), pH

Date	Station											
	CHS		CHD		BBC		BEF		TI		DH	
	pH	Eh	pH	Eh	pH	Eh	pH	Eh	pH	Eh	pH	Eh
21 June 1967	7.70	+33	7.70	-5	7.85	+30	7.83	+25	7.80	+10	7.50	-35
15 Sept. 1967	7.70	+30	7.75	0	7.85	+30	7.85	+30	7.85	+20	7.50	-45
19 Dec. 1967	7.71	+28	7.69	-10	7.86	+20	7.86	+20	7.85	+20	7.50	-25
16 Mar. 1968	7.85	+35	7.80	0	7.90	+30	7.85	+30	7.80	+15	7.35	-25

c. Interstitial Water(1). Castle Harbor Shallow

Mean percent water in the 0-2 fraction was 30.8% (ranged from 29.5-31.0%). That of the >2 fraction averaged 30.1% (28.1-33.6% range). No seasonal change was noted.

(2). Castle Harbor Deep

0-2 cm values averaged 51.6%, >2 cm segment characteristically contained 10% less water and values averaged 41.8%.

(3). Bailsys Bay Coarse

"Summer Condition" interstitial water values averaged 49.9% and "Winter Condition" values 34.2% for the 0-2 segment. Below 2 cm

the "Summer Condition" values averaged 43.3% and "Winter Condition" values 37.5%.

(4). Baileys Bay Fine

Water content values did not vary with the seasonal environmental changes. The 0-2 segment values averaged 33.8% (a 30.4-34.6% range). >2 cm values were always slightly higher than those of the 0-2 cm fraction and averaged 37.7%.

(5). Trunk Island

Mean percent water of the 0-2 cm segment was 26.0%, while that of the >2 fraction was 25.2%. The values for 0-2 and >2 were always within $\pm 1\%$; essentially no difference between the two segments.

(6). Devils Hole

This station, with the undetectable mud-water interface, had the highest percent water values recorded in the survey. Values averaged 57.9% for the 0-2 cm segment and 52.2% for the >2 segment.

B. The Meiofauna

1. All Stations - Total Populations and Biomass

Excluding Devils Hole (which, as will be noted later, is a special case), numbers for all meiofauna ranged from $12.2 \times 10^4/m^2$ (BBF, 19 December 1967) to $13.3 \times 10^5/m^2$ (BBC, 23 April 1968) and averaged $58.0 \times 10^4/m^2$. Dry weight biomass averaged $121.7 \text{ mg}/m^2$ and ranged from $33.0 \text{ mg}/m^2$ (BBF, 19 January 1968) to $259 \text{ mg}/m^2$ (CHD, 15 September 1967). Wet weight biomass was 4 times that of the dry weight (Wieser 1960; Tietjen 1966). Nematodes were the major meiofaunal constituents at all stations, except BBC ("Summer Condition"), BBF (periodically) and TI (twice). Overall, nematodes comprised 72.6%

of the total numbers and 71.8% of the biomass. Harpacticoid copepods were second in overall abundance and constituted 22.3% of the total numbers and 14.3% of the total biomass. Since the nematodes and harpacticoids comprised 90% or more of the total numbers, systematics were restricted to these two groups.

66.9% of all the organisms collected were in the upper 2 cm of sediment, 24.2% in the 2-5 cm segment, 7.0% in the 5-7 cm segment and 1.9% below 7 cm.

Sixty-six species of harpacticoids were collected during the survey. Of these, five were new species and twenty-nine were new distribution records for Bermuda. At each station, the harpacticoids will be discussed in detail and serve as the major study group in this survey. Their distribution, systematics, organism-sediment interrelationships, seasonal variation and population diversity will be closely examined. Ecological conclusions will be based primarily on the harpacticoid distributions, other meiofaunal groups will be noted in such detail as seems relevant.

One hundred and ninety-seven species of nematodes were identified by Bruce E. Hepper. Nine of the species have been established as new. Further systematic investigation will probably reveal more.

2. Castle Harbor Shallow

a. Total Populations and Biomass (Figure 8)

Mean total number of animals ranged from $45.5 \pm 2 \times 10^4/m^2$ in March 1968 to $99.7 \pm 2 \times 10^4/m^2$ in February 1968 and averaged $61.8 \times 10^4/m^2$. Mean dry weight biomass ranged from $96.2 \text{ mg}/m^2$ (March 1968) to $219.8 \text{ mg}/m^2$ (February 1968) and averaged $133.8 \text{ mg}/m^2$.

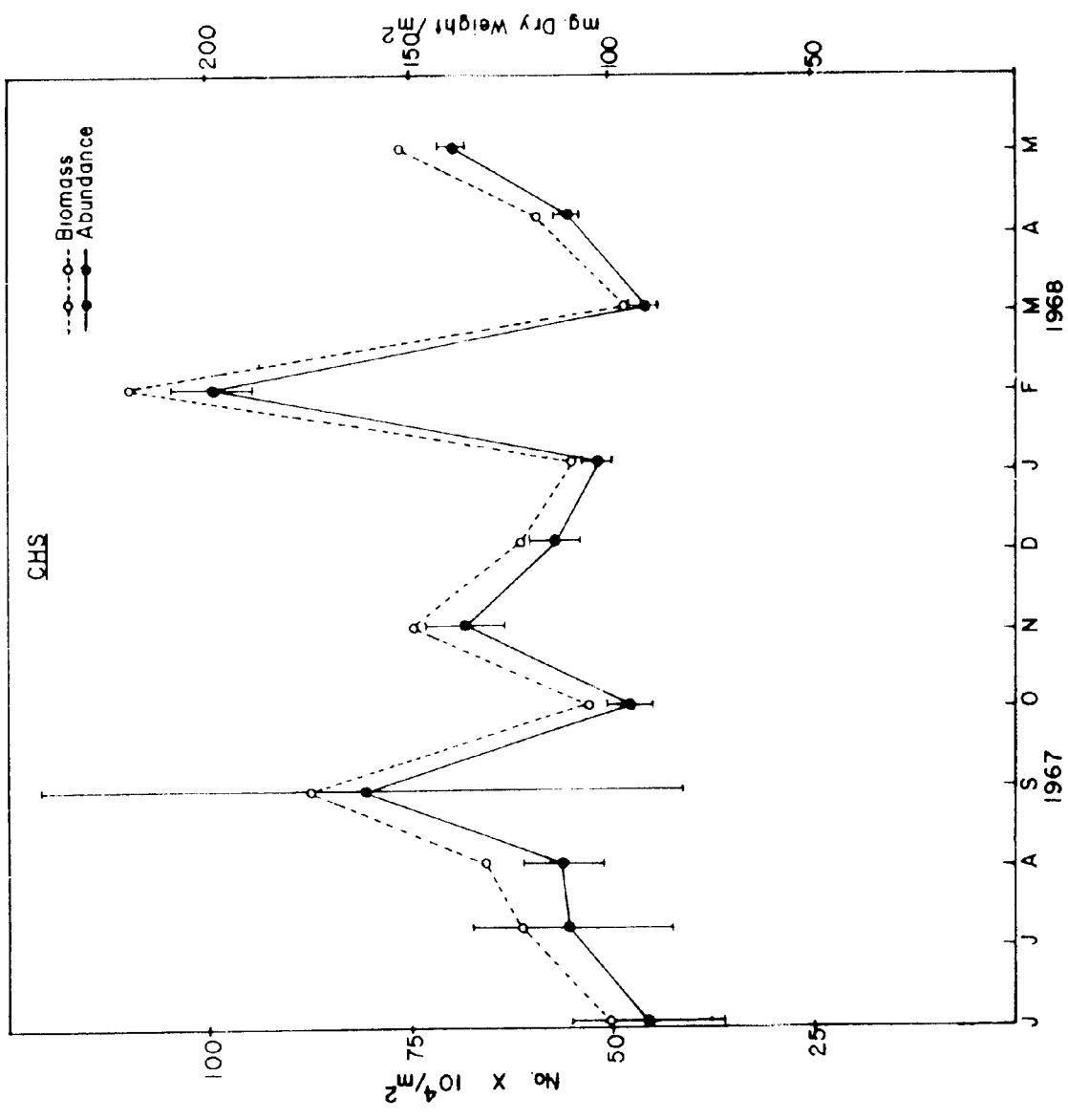


Figure 8. CHS - Population abundance (with standard deviation) and biomass.

Since the biomass was dependent on the number of organisms, a biomass peak was usually synonymous with a population increase. Seasonally, total population numbers stayed constant over the summer (ignoring the statistically invalid September 1967 peak), increased to a secondary abundance peak of $68.1 \pm 6 \times 10^4/m^2$ in November 1967, and decreased in late fall-early winter. The maximum value ($99.7 \pm 5 \times 10^4/m^2$) was recorded in February 1968, and the yearly low was reached in March. Another secondary abundance peak was detected in May ($69.5 \pm 1 \times 10^4/m^2$).

Dry weight biomass conformed to the same cycle, differing only in the magnitude of the November peak.

63.4% of the organisms were encountered in the upper 2 cm of sand, 23.7% in the next 3 cm (2-5), 10.3% in the next two cm (5-7), and 2.6% were found living below 7 cm.

The fauna inhabiting this station was reminiscent of typical beach psammon: small, vermiform, possessing a strong cuticle or spines (scales), and often a ciliated covering. The sediment granulometry, as previously noted, is very much like that of the beaches of Bermuda. Animals collected at CHS included nematodes, harpacticoid copepods, ostracods, polychaetes, turbellarians, tardigrades, archannelids, amphipods, and bivalve larvae. A complete listing of the fauna encountered at CHS, with mean numbers counted may be found in Appendix A1.

b. Harpacticoid Copepods (Table 7)

Harpacticoids never dominated the population at CHS, reaching 10% of the total fauna only once, September 1967 (10.8%). Overall

TABLE 7. HARPACTICOID COPEPODS, CHS - ACTUAL NUMBERS IDENTIFIED

SPECIES	1967												1968				Tot.			
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May								
<u>Longipedia helgolandica</u> (Klie)																				3
<u>Ectinosoma dentatum</u> (Steuer)	4	2	1	3	16	11			2	3				3						43
<u>Daniellssenia n. sp.</u>				19	4	1				3				3						26
<u>Harpacticus nicaeensis</u> (Claus)	1																			1
<u>Tisbe furcata</u> (Baird)		1																		1
<u>Dactylopusia tisburyoides</u> (Claus)		1																		1
<u>Eudactylopus latipes</u> (T. Scott)		1																		1
<u>Flavia crassicornis</u> (Brady)	1																			1
<u>Amphiascus minutus?</u> (Claus)			1																	1
<u>Aeonardia phyllopus</u> (Sars)	2																			2
<u>Robertgurneya rostrata</u> (Gurney)					2									1						3
<u>R. similis</u> (A. Scott)				4																4
<u>Ameira parvula</u> (Claus)		2				1								1						6
<u>Nitocra affinis</u> (Gurney)		3												2						2
<u>Praeleptomesochra africana</u> (Kunz)														1						79
<u>Apodopsyllus africanus</u> (Kunz)	1			5	2	1														40
<u>Leptastacus macronyx</u> (T. Scott)	4		2	74	8	34		1	1	1	13	12		1						250
<u>Cletodes dissimilis</u> (Willey)				1				18	7	5	41	51								1
<u>Enhydrosona propinquum</u> (Brady)				1																1
<u>Paralaophonte brevirostris f.</u> (Willey)	3		3	2	4	2														17
<u>P. perplexa</u> (T. Scott)		2		7										2						17
others				1										3						3
Total # species	7	7	4	10	6	6	5	2	6	9	4	3		21						
Total # individuals	16	12	7	117	36	50	14	19	93	19	56	64		503						

the harpacticoids comprised 5.1% of the total numbers and 2.4% of the dry weight biomass. Figure 9 shows seasonal percentages of copepods and nematodes.

Twenty-one species were collected during the course of the survey. Leptastacus macronyx (T. Scott) was the most abundant copepod as it comprised 49.7% of all the forms. The other important copepods were: Præleptomesochra africana (Kunz) (15.7%), Ectinosoma dentatum (Steuer) (8.5%), Apodopsyllus africanus (Kunz) (8.0%) and Danielssenia n. sp. (5.2%). The remaining 16 species constituted only 12.9%. Table 7 lists all harpacticoids collected at this station.

Since the copepods were responsible for only 5.1% of the total numbers and 2.4% of the biomass, the data presented below for seasonal species fluctuations cannot be considered statistically valid. For example, the August 1967 samples had only 7 individual copepods making each one worth (on a percent basis) 14.3%, whereas the September 1967 samples had 117 individuals, each individual thus being equivalent to 0.85%. This variation in total numbers must be kept in mind when analysing the seasonal pattern.

(1). Leptastacus macronyx (Figure 10)

This species was common throughout the year, except in July 1967 and February 1968. The pattern of seasonal abundance showed large fluctuations with maximum density recorded in January 1968. Only the August, September series and the February, March, April May series appeared regular. Large percent density fluctuations were noted from September to February.

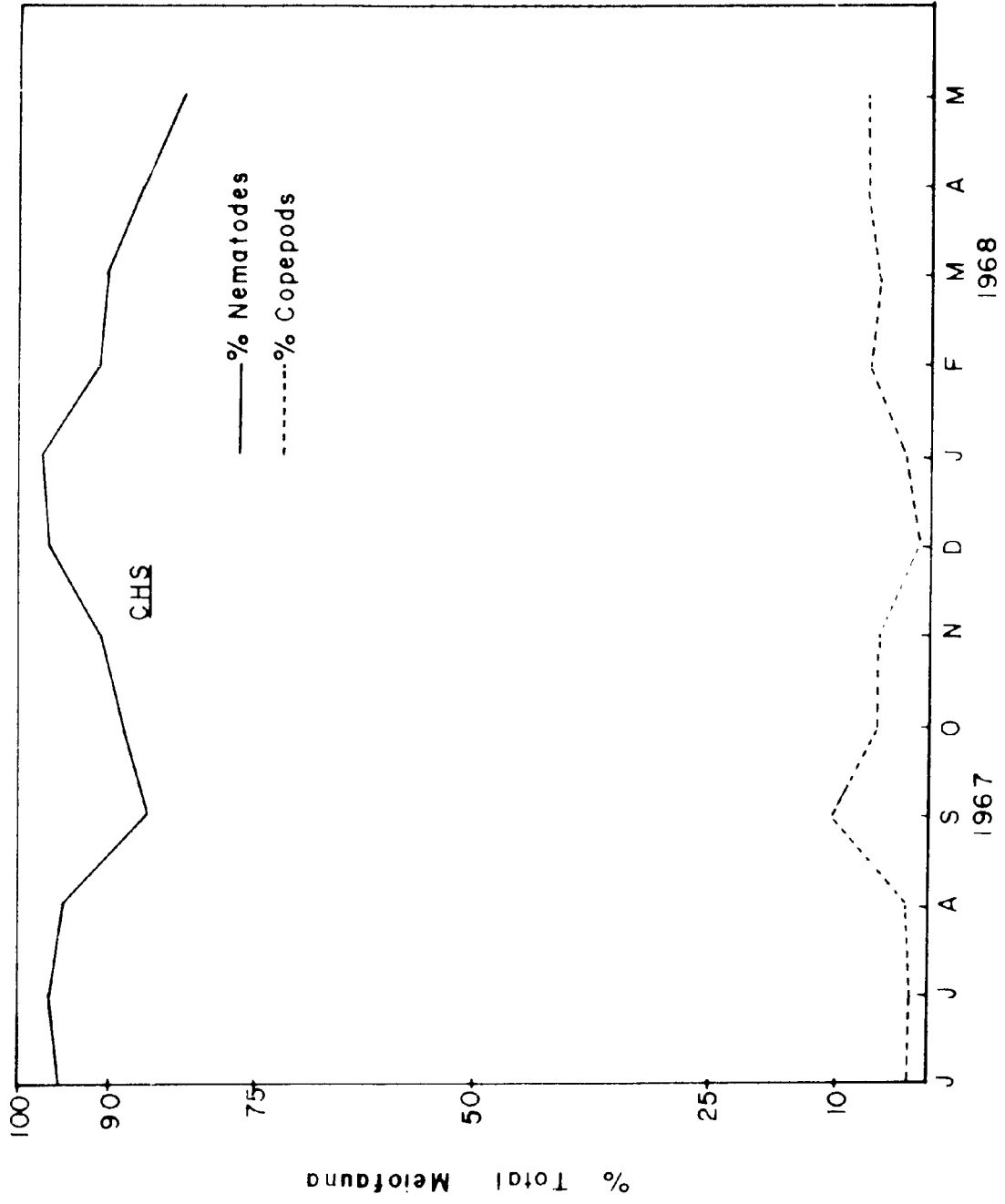


Figure 9. CHS - Nematode and copepod percentages of total population.

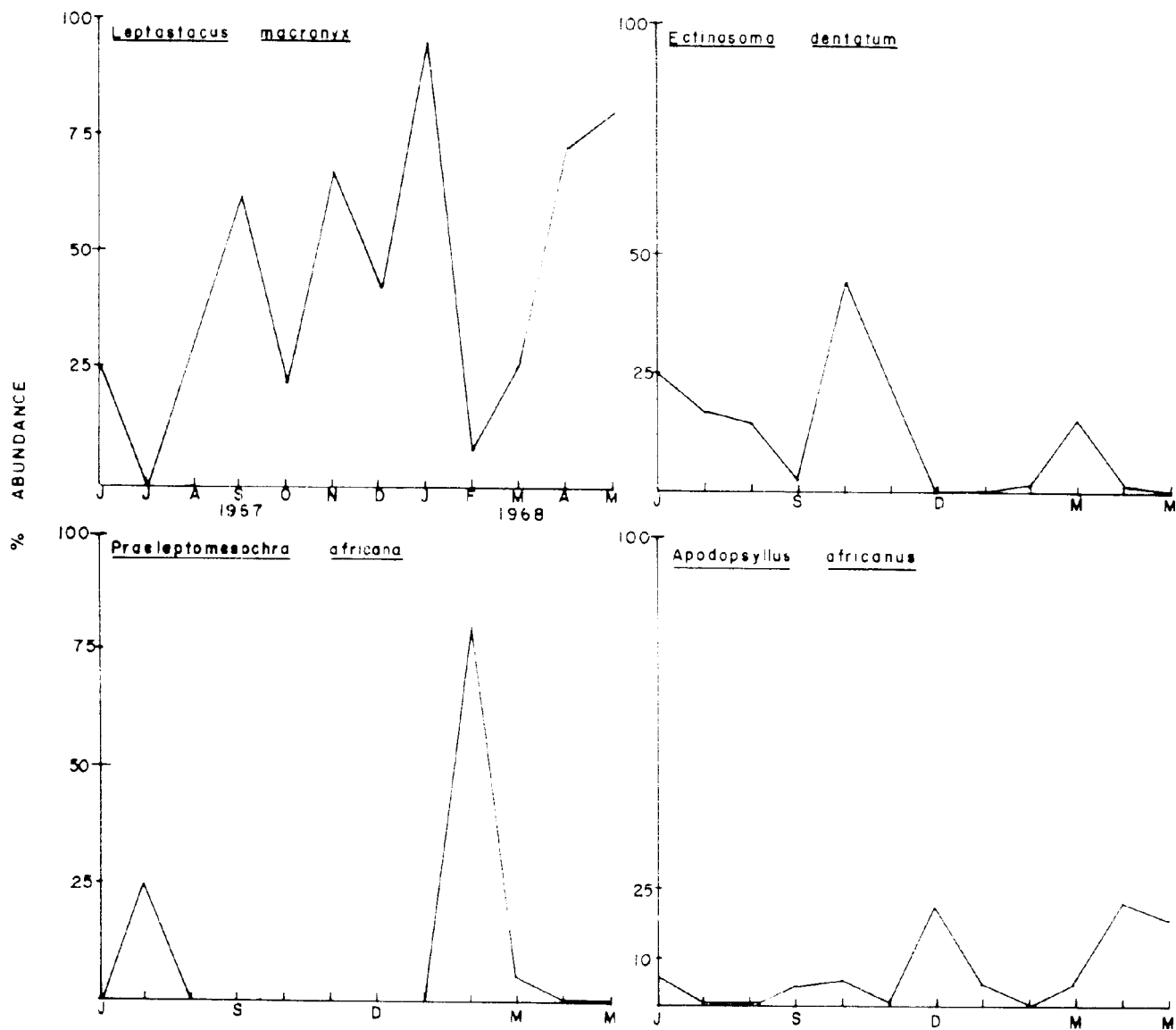


Figure 10. CHS - Percent abundance individual harpacticoid species based on total copepod populations.

(2). Praeleptomesochra africana (Figure 10)

Maximum density was recorded in February, when P. africana comprised 80.5% of the total copepod population. Another abundance peak was recorded in July 1967, when P. africana comprised 25.0%. The remainder of the survey was either devoid of any P. africana or the species was not prevalent.

(3). Ectinosoma dentatum (Figure 10)

E. dentatum reached a maximum in October 1967 (43.5% of the copepod population). Secondary abundance peaks were recorded in June 1967 (25.0%) and March 1968 (15.8%).

(4). Apodopsyllus africanus (Figure 10)

A somewhat regular seasonal cycle was recorded for A. africanus. The population remained at relatively low fluctuating levels during the summer and fall, increased in December, dropped gradually to 1% of the population in February, climbed to another abundance peak in April, and started to decline to the summer level in May.

c. Nematodes

Nematode percentages never fell below 80% (#/m²) and averaged 90.9% of the total numbers and 89.7% of the total dry weight biomass (Figure 9).

Seventy-three species were identified from CHS. Inadequate samples sent to Bruce E. Hopper (June-November) make the data from these months somewhat questionable. However, there was an increased number of taxa encountered as the survey progressed. The four most abundant species, Monoposthia sp., Theristus floridanus,

Metachromadora sp., and Pomponema tessellatum comprised 35.4% of the total population, the remaining 70 species, 64.6%. A complete list of those species collected at CHS may be found in Appendix B1.

In addition to systematic identification, nematodes were also grouped on the basis of their buccal apparatus. Group 2A (epistrate feeders) was the most abundant form, averaging 47.8% of all the nematodes. Group 2B (omnivore-predators) was second in nematode abundance (32.1%), Group 1A (selective deposit feeders) third (11.6%), and Group 1B (non-selective deposit feeders) fourth (8.5%). Seasonally, the epistrate feeders were most abundant in all months except for aforementioned July, and May 1968. The two deposit feeding groups (1A and 1B) fluctuated at low levels throughout the year. The monthly percent of nematode feeding groups and the mean yearly percentage of each group (Histogram) can be seen in Figure 11.

The four species of Eubostrichus encountered at CHS were all covered to some degree with a blue-green algal epiphyte, Schisothrix calcicola (J.H. Sharp, personal communication). This rather unusual relationship was most prevalent in October 1967 and May 1968, when the blue-green bearing Eubostrichus spp. accounted for 3.0% and 2.3% of the nematode fauna respectively. The systematic relationships, ecological preferences, ultra-structure and explanations of the mode of attachment are currently being investigated (Hopper, Coull and Sharp, in prep.).

d. Other Taxa

Tardigrades, ranking sixth in overall abundance, were found at

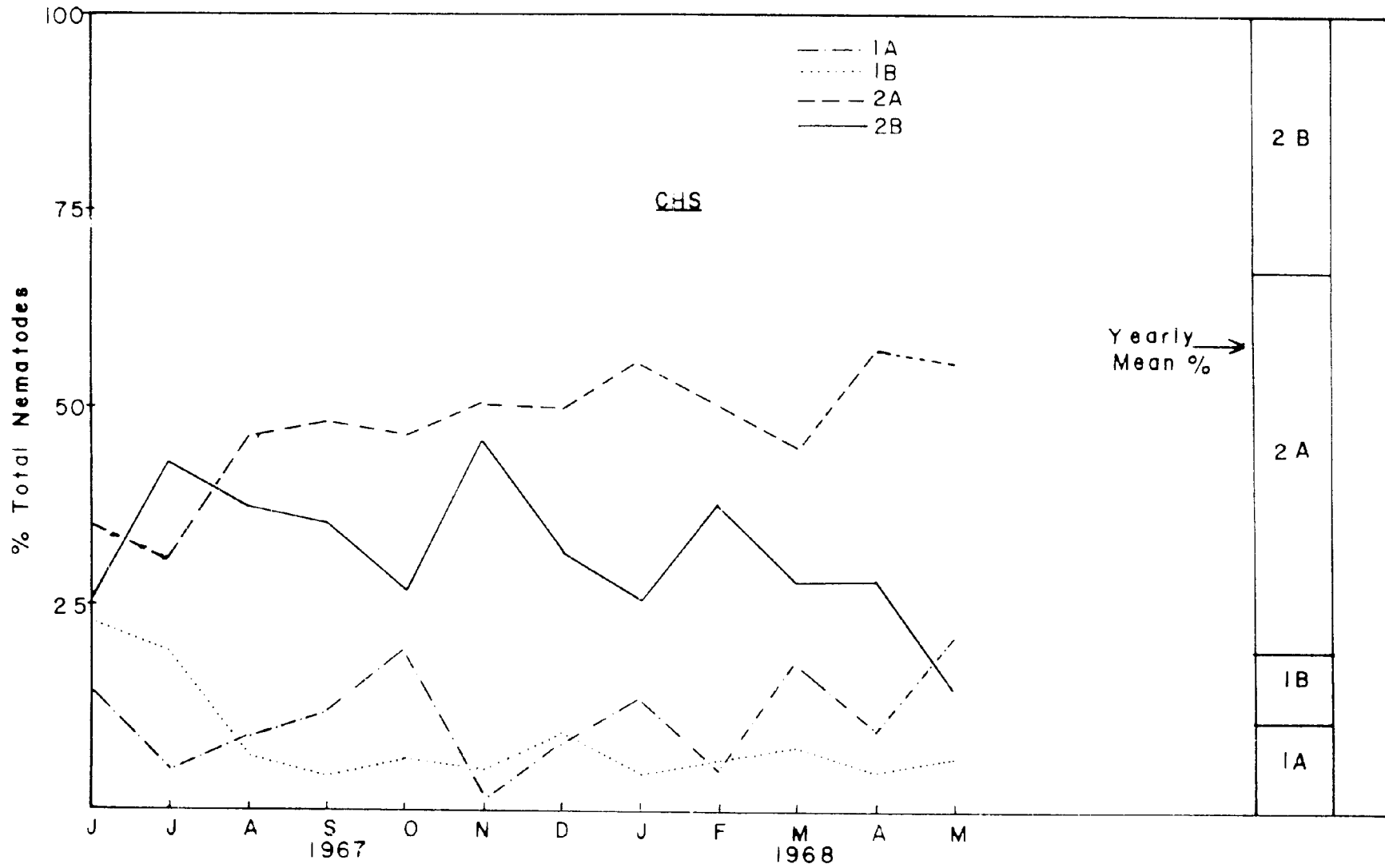


Figure 11. CHS - Nematode feeding groups - percent abundance (monthly) and mean yearly percent.

relatively high levels in May 1968, when they comprised 4.7% of the total population. Turbellarians occurred eight of the twelve times the station was occupied and ranked third in overall abundance. Polychaetes were regular components and ranked fourth in abundance. Ostracods were also present throughout the year and ranked fifth in overall abundance. Amphipods, archannelids and bivalve larvae appeared sporadically throughout the year, never comprising more than 0.7% of the total population.

3. Castle Harbor Deep

a. Total Populations and Biomass (Figure 12)

Mean total numbers of animals ranged from $30.5 \pm 2 \times 10^4/m^2$ (November 1967) to $118.5 \pm 11 \times 10^4/m^2$ (September 1967) and averaged $62.2 \times 10^4/m^2$. Mean dry weight biomass ranged from a low of 73.0 mg/m² in January 1968 to a high of 259.3 mg/m² in September 1967, averaging 141.8 mg/m². The low number value and the low biomass value did not correspond at this station because the November population was made up of 5.5% ostracods, while the January sample contained none. The relatively heavy ostracods in the November samples increased the dry weight biomass.

Considering the seasonal variation, one notes the maximum organism-biomass peak in September 1967, secondary peaks in July and December 1967, and another major population increase in late spring (March-May 1968).

94.4% of all the animals encountered were found in the upper 5 cm of sediment. A breakdown of the percent total organisms and sediment depth for CHD was as follows: 0-2 cm, 71.7%; 2-5 cm, 22.7%;

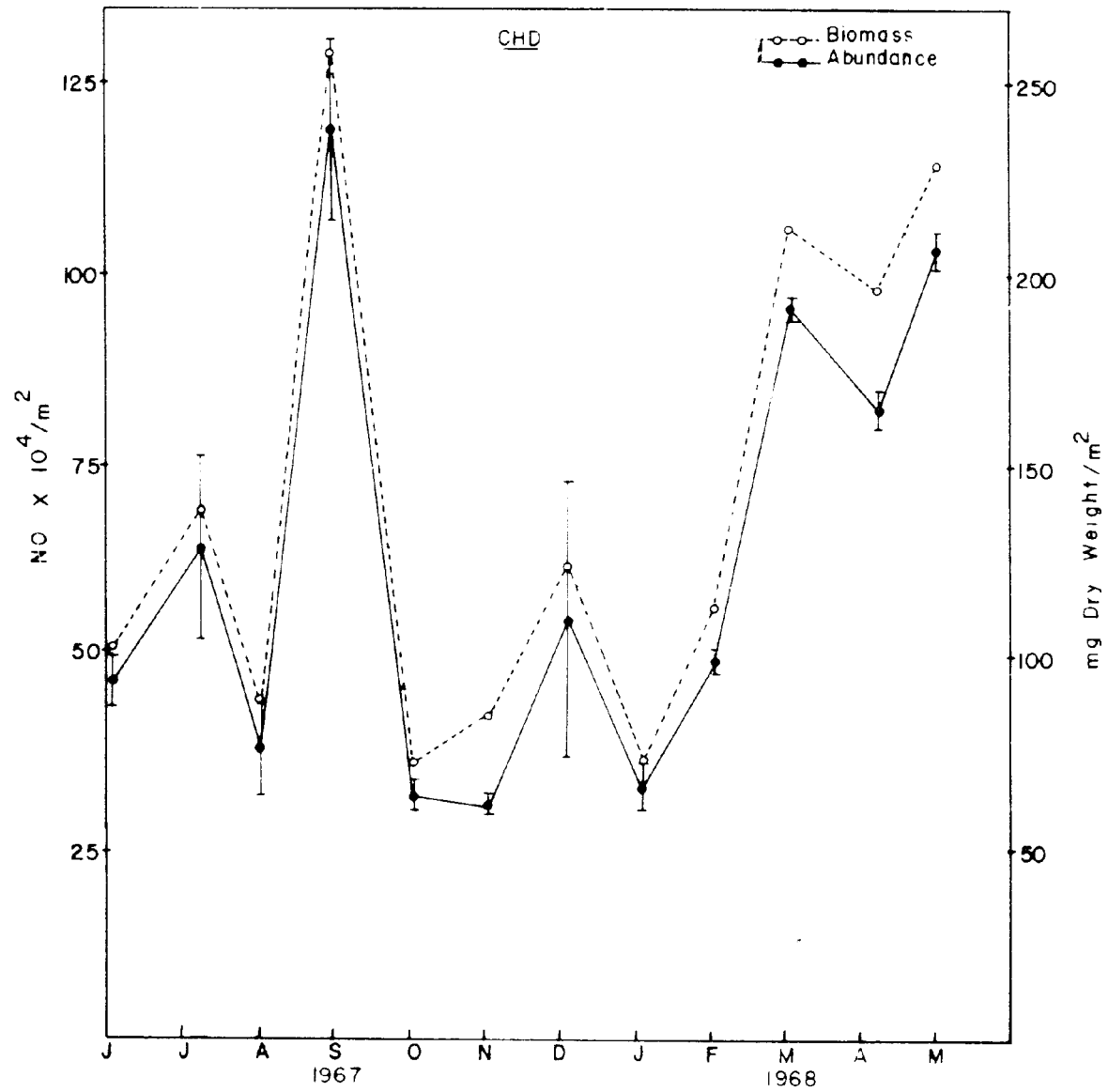


Figure 12. CHD - Population abundance (with standard deviation) and biomass.

5-7 cm, 4.5%; and >7 cm, 1.1%. Animals collected at CHD included nematodes, harpacticoid copepods, kinorhynchs, priapulids, ostracods, halacarids, bivalve larvae, cumaceans, polychaetes, amphipods, tanaidaceans, turbellarians and isopods. Appendix A2 is a complete listing of the fauna encountered at CHD.

b. Harpacticoid Copepods (Table 8)

The harpacticoids averaged 8.0% of the total population and only once comprised more than 20%. An increase in percentage harpacticoids did not necessarily mean an increase in the total fauna, although this relationship did hold true for the September samples. (Note November percent harpacticoids, Figure 13, and relatively low total population values, Figure 12.) Overall the harpacticoids comprised 4.8% of the total dry weight biomass.

Thirty-seven species of harpacticoids were collected at CHD. Stenhelia (D.) n. sp. was the most abundant form and made up 16.8% of all harpacticoids collected. This was followed by: Typhlamphiscus lamellifer (Sars), 14.9%; Ectinosoma dentatum, 12.0%; Cletodes dissimilis (Willey), 9.8%; and Enhydrosoma propinquum (Brady), 9.6%. The remaining 32 species were responsible for 36.9% of the total population. The five most abundant species, with the exception of E. dentatum, were forms endemic to CHD. Periodically these forms were encountered elsewhere, but never more than 1 or 2 per sample. Again, as at CHS, one must note the total number of individuals identified and consider this when analysing the individual species percentage distribution curves. 97.8% of all the harpacticoids collected at this station were found in the upper 2 cm of sediment and the

TABLE 8. HARPACTICOID COPEPODS, CHD - ACTUAL NUMBERS IDENTIFIED

SPECIES	1967						1968						Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Longipedia helgolandica</u> (Klie)	2			6					2	11	4		26
<u>Ectinosoma dentatum</u> (Steuer)	2	6	4	23	1	5	2	2	7	20	21	9	102
<u>Halectinosoma abrau</u> (Kricagin)				11		1	1		1	2	11		13
<u>H. sarsi</u> (Boeck)		7							1	3	2	1	21
<u>H. neglectum</u> (Sars)									1				7
<u>Danielssenia</u> n. sp.						1	1						1
<u>Haracticus nicaeensis</u> (Claus)		1			1	1							3
<u>Rhynchothalestris rufocincta</u> (Brady)		1											1
<u>Dactylopodia tisboides</u> (Claus)				3		5							8
<u>Paradactylopedia brevicornis</u> (Claus)	1	2				1							4
<u>Eudactylopus latipes</u> (T. Scott)		7	3	59	3	1	2			10	17	9	143
<u>Stenhelia</u> (D.) n. sp.	33												1
<u>S.</u> (D.) sp. (6AL)									1	1	2	3	59
<u>Robertsonia knoxi</u> (Thompson & A. Scott)	6	6	1	31	2				7				1
<u>Amphiascus varians</u> (Norman & T. Scott)			3										3
<u>Amphiascopsis cinctus</u> (Claus)					1								1
<u>Amonardia phyllopus</u> (Sars)		2											2
<u>Bulbamphiascus laus</u> (Brady)			8	14		5			2	3	8	2	42
<u>Robertgurneya rostrata</u> (Gurney)				10		1							11
<u>Typhlamphiascus lamellifer</u> (Sars)		14	4	38	5	10	2	3	6	5	12	12	127
<u>Amphiascoides debilis</u> (Hesbrecht)	16					3							3
<u>A. subdebilis</u> (Willey)	2				2								2
<u>Metis holothuriae</u> (Edwards)			2										4
<u>Ameira parvula</u> (Claus)				3					2	9			14
<u>Nitocra affinis</u> (Gurney)									3				3
<u>Ameiropsis nobilis</u> (Sars)													1
<u>Sarsameira parva</u> (Boeck)						1	1						1
<u>Phyllopopopsyllus hermani</u> Mihl			2			15		1	1				19
<u>Phyllopopopsyllus</u> n. sp. E						2							2

TABLE 8. HARPACTICOID COPEPODS, CHD - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967							1968					Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Laophontella armatus</u> (Willey)			1			13							14
<u>Diagoniceps laevis</u> (Willey)					1	3			1		7	5	17
<u>Leptastacus macronyx</u> (T. Scott)						1	1						1
<u>Cletodes dissimilis</u> (Willey)	11	12	6	20		1	8	1	1	3	13	8	84
<u>Enhydrosoma propinquum</u> (Brady)	11	1	2	22	1		3		4	7	14	17	82
<u>E. stylicaudatum</u> (Willey)	9	1											10
<u>Paralaophonte brevis</u> (Willey)		1	1	3		10							15
others		1	2		2								5
Total # species	10	14	14	13	11	18	7	6	14	11	11	9	37
Total # individuals	93	82	39	243	19	79	19	9	39	74	111	66	853

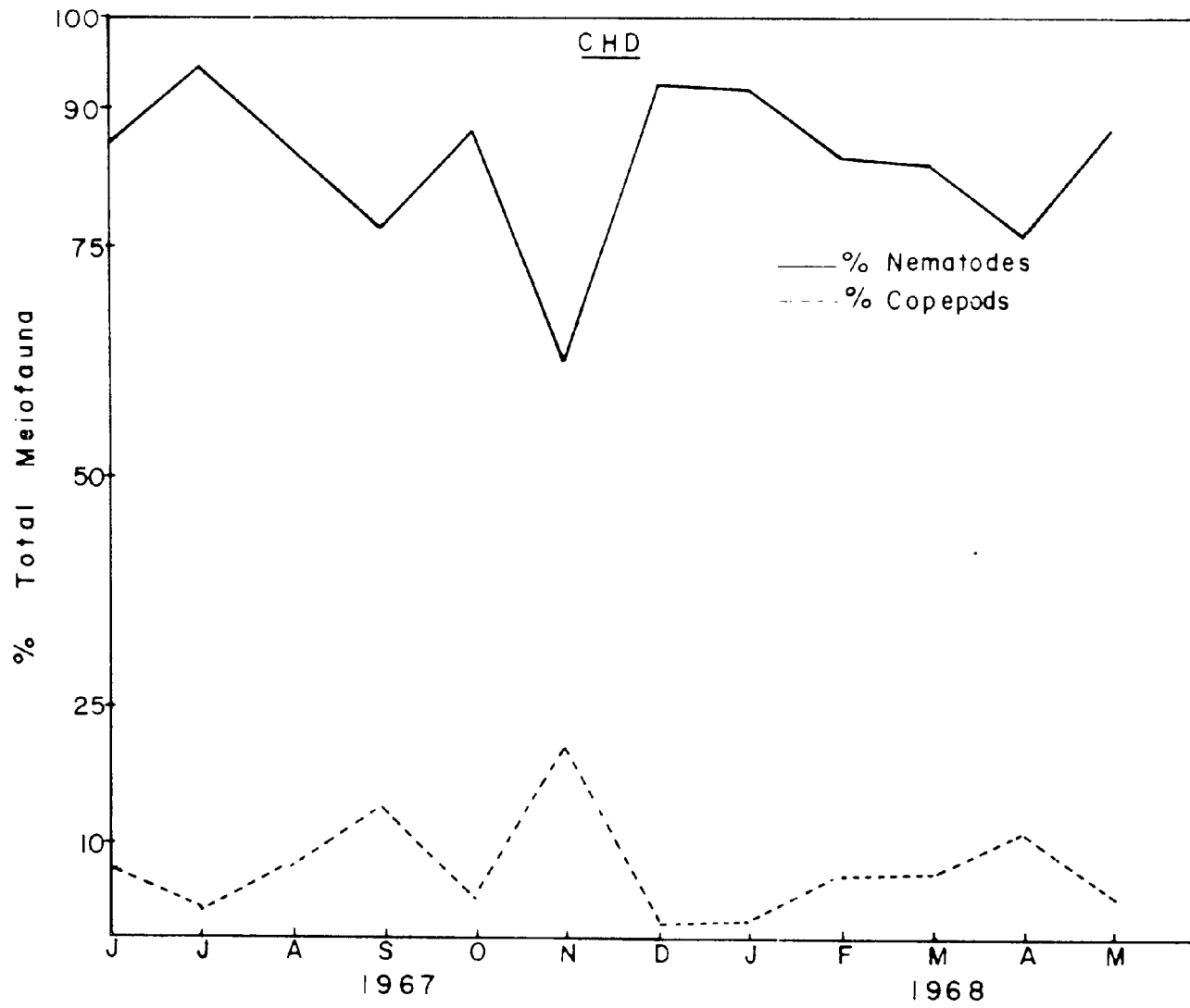


Figure 13. CHD - Nematode and copepod percentages of total population.

remaining 2.2% in the 2-5 cm segment. No harpacticoids were found below 5 cm.

(1). Stenhelia (D.) n. sp. (Figure 14)

A systematic description of this species is currently in preparation. This species was present throughout the sampling period except in November 1967 and January 1968. Stenhelia (D.) n. sp. was most prevalent in June 1967. It gradually declined in July and August, reached a secondary abundance peak in September, gradually declined to low winter levels and reached another secondary abundance peak in February, only to level off in March, April, and May.

(2). Typhlamphiascus lamellifer (Figure 14)

This species had previously been recorded from Norway, Iceland and Sweden. T. lamellifer reached its maximum density in January 1968, when it was responsible for 33.3% of the total copepod population. Secondary abundance peaks were recorded in July and October 1967; the lowest value (6.5%) in March 1968. During the remainder of the survey, T. lamellifer comprised 10-20% of the copepods.

(3). Cletodes dissimilis (Figure 14)

Willey (1935) originally described this species from Bermuda. The species has not been recorded elsewhere and may well be a form strictly endemic to the Bermudas. Except for one anomalous individual recorded from CHS in September 1967, this species was restricted to CHD during the meiofaunal survey. However, the author has collected C. dissimilis associated with the coral Occulina diffusa in other parts of Castle Harbor. A somewhat regular seasonal cycle was recorded with maximum percent abundance in December 1967 (41.0%)

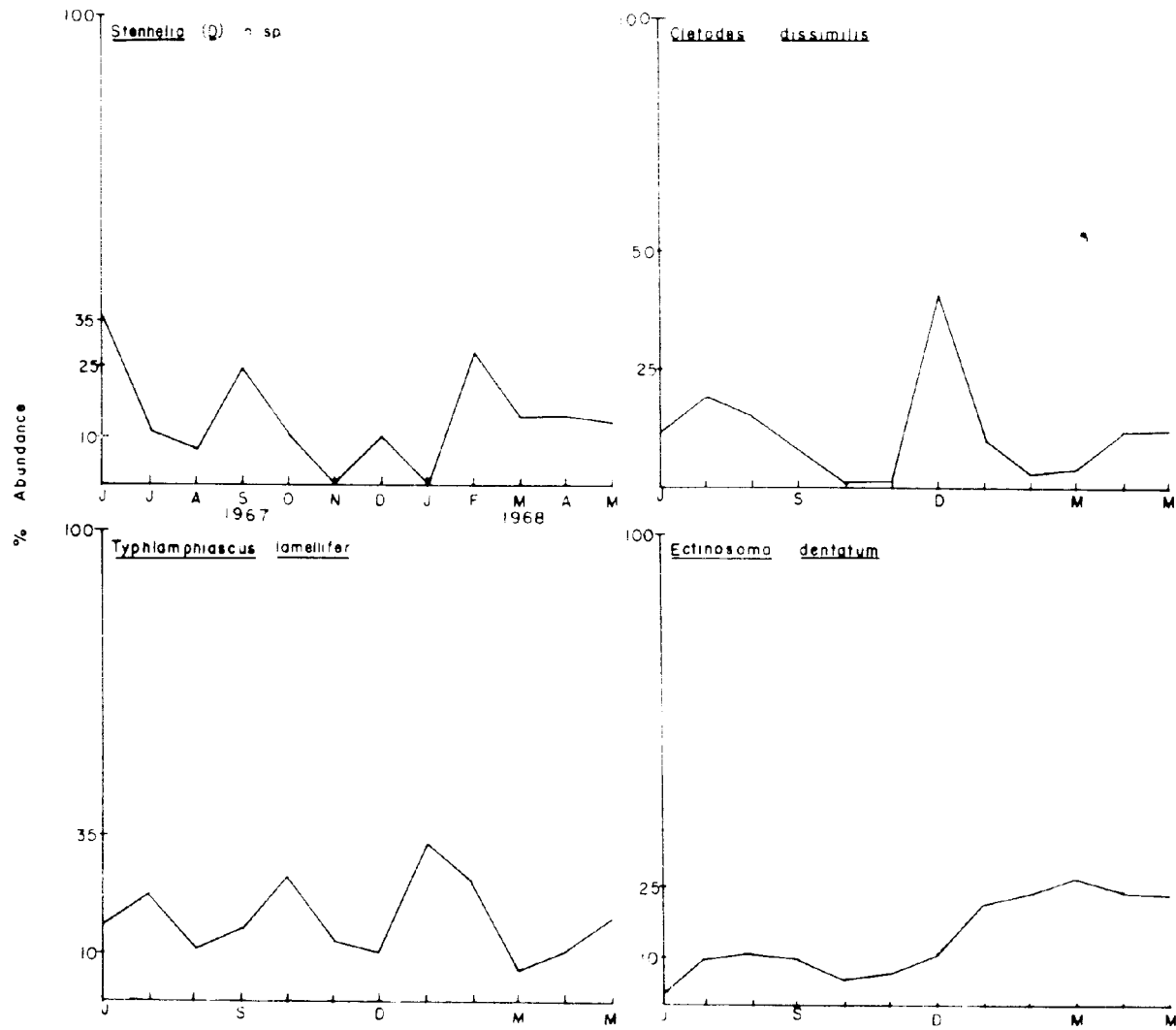


Figure 14. CHD - Percent abundance individual harpacticoid species based on total copepod populations.

and a secondary abundance peak (19.1%) in July 1967. During the remainder of the year the percent abundance of C. dissimilis gradually increased to and decreased from the peaks.

(4). Ectinosoma dentatum (Figure 14)

E. dentatum reached its maximum abundance in March 1968 (26.9%), after a gradual population increase from the October low of 5.5%. The low value was recorded in June 1967 and the period from March to May 1968 appeared to be approaching this level.

c. Nematodes

Nematodes were the most abundant form comprising 83.5% of the total numbers and 79.4% of the total dry weight biomass. Percentages for nematodes and harpacticoids are shown in Figure 13.

Ninety-seven species were identified from CHD (Appendix B2). The four most abundant species, Linhomoeid (l.o.) (34.8%), Comesoma sp. 2 (8.3%), Paracomosoma sp. 2 (6.4%), and Comesoma sp. (5.7%), made up 55.2% of the nematodes collected from this study station. The remaining 91 species comprised 44.8% of the total number identified.

Linhomoeid (l.o.), a selective deposit feeder, accounted for the preponderance of Group 1A when the nematodes were divided into their respective feeding groups. The two deposit feeding Groups (1A and 1B) were the most prevalent. Overall Group 1A was responsible for 60.1% of the fauna; Group 1B, 23.1%; Group 2A (epistrate feeders), 4.2%; and Group 2B (omnivore-predators), 12.6%. The selective deposit feeders (1A) were the dominant forms collected in all months except November, when the non-selective deposit feeders

(1B) composed 41% of the fauna. Omnivore-predators (2B) were always third in abundance except in October when they were second. The epistrate feeders (2A), unable to scrape the very fine sand silt-clay sized particles evident at CHD, were an uncommon inhabitant at this station, never comprising more than 9% of any monthly sample. Figure 15 illustrates the seasonal trend of the feeding groups as well as the overall percentages.

As with CHS, all species of Eubostrichus encountered were covered with the blue green epiphyte Schizothrix calcicola.

d. Other Taxa

Some of the most interesting minor taxa encountered in the survey were found at this station. Besides the standard inhabitants, polychaetes, ostracods, etc., a kinorhynch Centroderes spinosus (Reinhard), a priapulid and three species of halacarids were common inhabitants.

Centroderes spinosus was present on every sampling date except January. Maximum numbers were encountered in September, when C. spinosus comprised 2.0% of the total population. (See Appendix A2 for actual enumeration.) Overall, kinorhynchs were responsible for 1.1% of the fauna and were fifth in abundance (excluding the nematodes with blue-green algae from the ranking).

The priapulid (Figure 16) encountered at this study station is currently the subject of an intensive study by Dr. Robert P. Higgins, Marine Biological Laboratory, Woods Hole. The organism is modified for its burrowing (intersutial ?) mode of existence by the presence of its retractable proboscis, elongated caudal res-

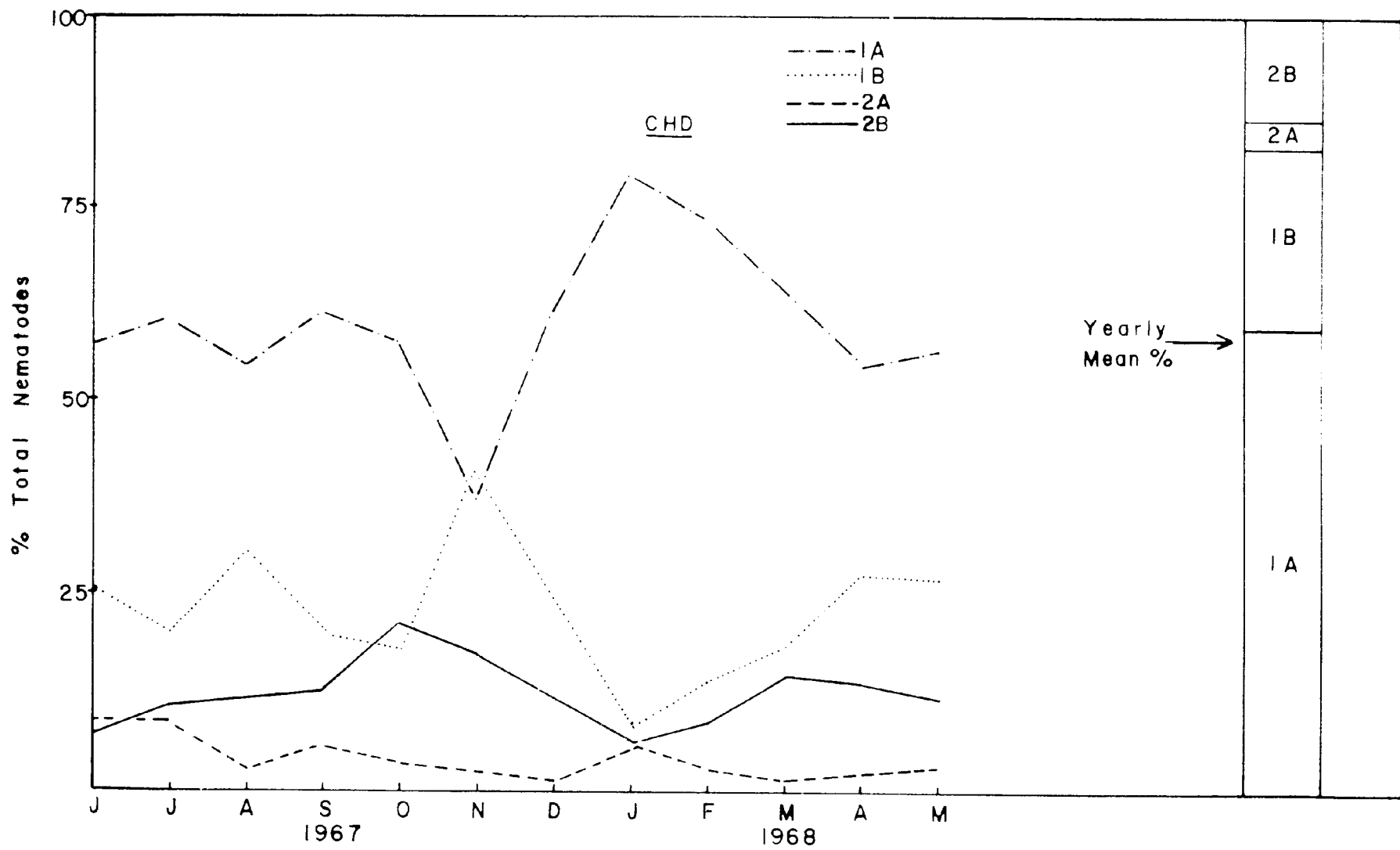


Figure 15. CHD - Nematode feeding groups - percent abundance (monthly) and mean yearly percent.

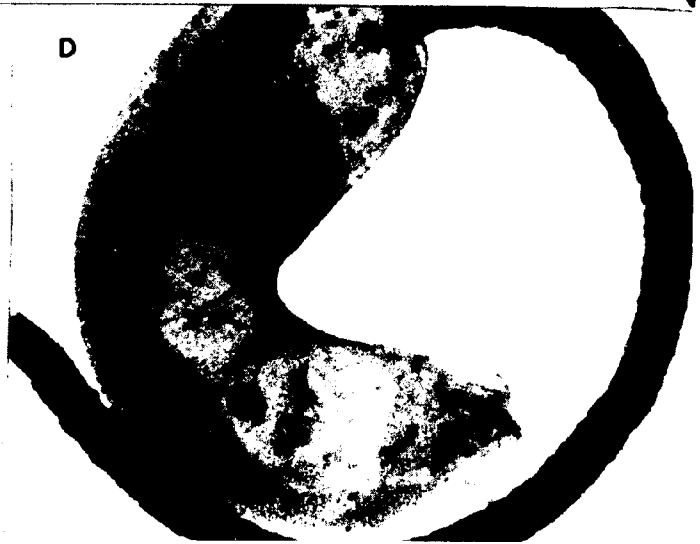


Figure 16. New priapulid: A) adult - 35x B) larvae - 125x C) adult - 125x D) adult - 125x.

piratory tree and reduced size. The organism cannot be identified to species and it is suspected that a new class or order will have to be constructed to include it. The organism was present every month and most abundant in April, when it was responsible for 4.7% of the total population. Overall, the animal was fourth in abundance and accounted for 2.0% of all the animals collected. The larvae were also encountered in the survey and are enumerated along with the adults in Appendix A2.

Polychaetes were also quite common at CHD. They were present throughout the survey, ranked fourth in overall abundance and made up 2.6% of the total population.

Ostracods occurred sporadically throughout the year at low levels of abundance. In November, when the total population was at its lowest, ostracods reached their peak, comprising 5.5% of the total population and 26.6% of the dry weight biomass.

Halacarids were found nine of the twelve months. Three species were common, Copidognathus pulcher, Copidognathus n. sp., and Pontarachna n. sp.

4. Baileys Bay Coarse

a. Total Populations and Biomass (Figure 17)

The highest mean population value was recorded in April ($133.2 \pm 1 \times 10^4/m^2$), the low value in December ($21.8 \pm 3 \times 10^4/m^2$). Dry weight biomass maxima and minima were recorded during the same months, $225.7 \text{ mg}/m^2$ (April) and $47.1 \text{ mg}/m^2$ (December). The mean total population value was $62.0 \times 10^4/m^2$, the mean dry weight biomass $121.5 \text{ mg}/m^2$.

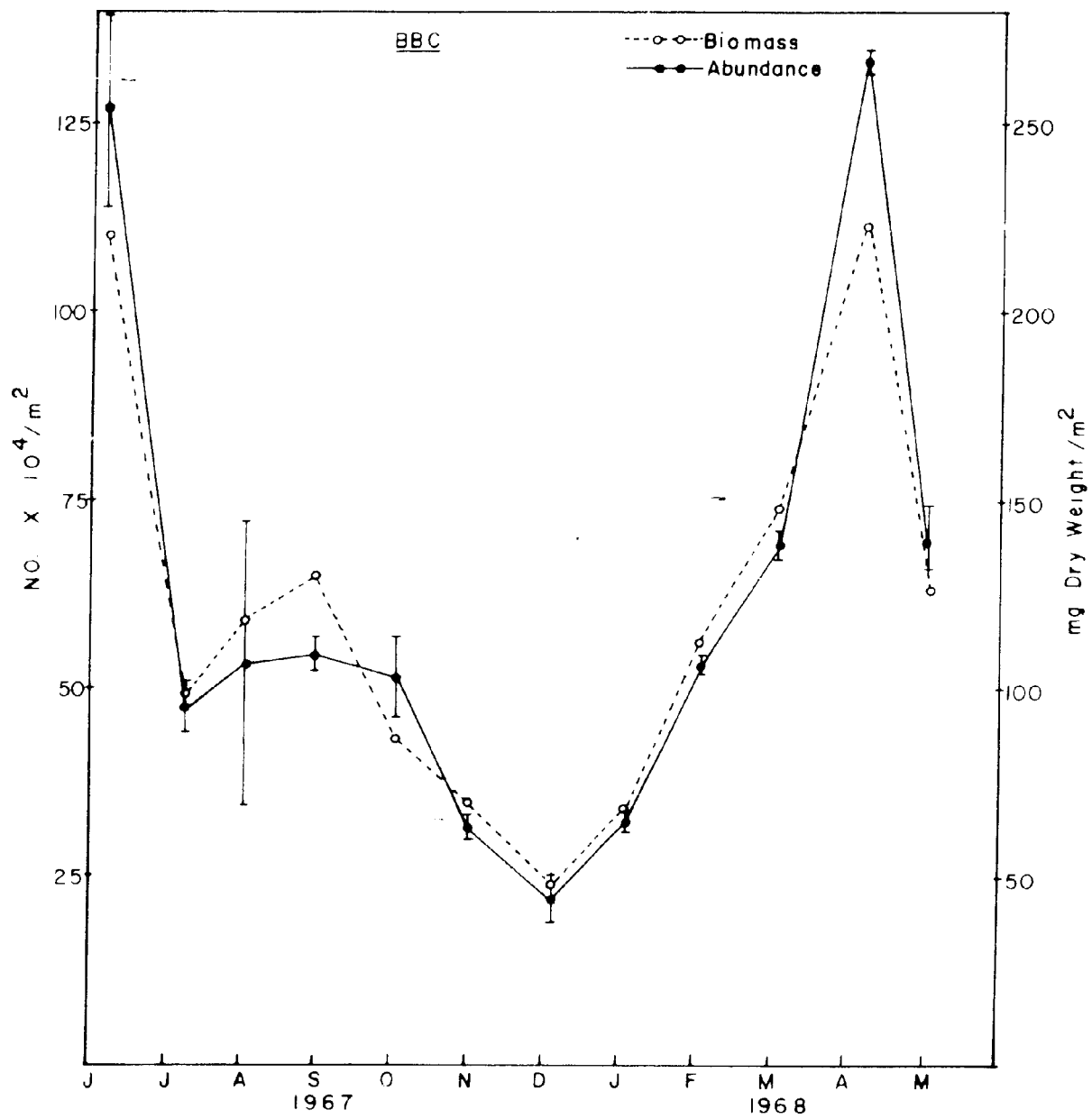


Figure 17. BBC - Population abundance (with standard deviation) and biomass.

High total population values were also recorded in June. Following the June value, the populations dropped to $47 \times 10^4/m^2$ in July and fluctuated around $50 \times 10^4/m^2$ during the "Summer Condition" (July-October). The population then decreased to the low December value and gradually increased to the high April peak. Dry weight biomass conformed to the same cycle, except for a distinct polychaete dependent peak in September.

65.1% of all fauna collected was located in the upper 2 cm of sediment, 26.5% between 2-5 cm, 6.4% between 5-7 cm and 2.0% below 7 cm.

Organisms encountered at BBC included nematodes, harpacticoid copepods, polychaetes, ostracods, halacarids, bivalve larvae, turbellarians, amphipods, priapulids, oligochaetes, prosobranchs, and isopods (Appendix A3).

b. Harpacticoid Copepods (Table 9)

Overall the harpacticoids accounted for 48.6% of the total numbers and 29.4% of the dry weight biomass. Except for anomalous August samples, the harpacticoids were the dominant organisms during the "Summer Condition." From December to March, the harpacticoids were second in abundance and nematodes dominated the populations. With the return of the "Summer Condition" in April, the harpacticoid copepods once again became the most abundant form (Figure 18, percent abundance nematodes and harpacticoids).

Forty-one species were collected at BBC during the course of the study. Phyllopodopsyllus hermani mihi was by far the most dominant species encountered, comprising 62.6% of all copepods. Para-

TABLE 9. HARPACTICOID COPEPODS, BBC - ACTUAL NUMBERS IDENTIFIED

SPECIES	1967						1968					Tot.	
	Jun	Jul	Aug	Sep	Oct*	Nov	Dec	Jan	Feb	Mar	Apr		May
<u>Longipedia helgolandica</u> (Klie)	2	1	2	1	1	6	8	1			3	19	28
<u>Ectinosoma dentatum</u> (Steuer)	27	24	51	4	1	1				5	3	39	166
<u>Halectinosoma sarsi</u> (Boeck)	3	1	3	12	7			2	2	2	1	2	1
<u>Danielssenia</u> n. sp.		7	5										34
<u>Harpacticus niccopensis</u> (Claus)	1											10	12
<u>H. obscurus</u> (T. Scott)			1										1
<u>Tisbe engifer</u> (Fischer)		1	6	3	4	7	1		1	1			11
<u>T. furcata</u> (Baird)			1										24
<u>T. gracilis</u> (T. Scott)			1										1
<u>Scutellidium longicauda</u> (Philippi)			2										2
<u>Tisbella tinsae</u> (Gurney)		1	4	3		4				1			8
<u>Dactylopodia tisboides</u> (Claus)		12	22	7	2	4	9				1		57
<u>Paradactylopodia brevicornis</u> (Claus)		2											6
<u>Dactylopusia falcifera</u> (Willey)		1		4									1
<u>Parastenhella spinosa</u> (Fischer)												2	20
<u>Stenhella</u> (D.) n. sp.					1					5	12		4
<u>Robertsonia knoxi</u> (Thompson & A. Scott)		2	2										4
<u>Amphiascopsis cinctus</u> (Claus)			20	5	1								4
<u>Amonardia phyllopus</u> (Sars)						1			1	1			27
<u>Bulbamphiascus imus</u> (Brady)		12	25	18	14	15	5		7	4	8	9	119
<u>Robertgurneya rostrata</u> (Gurney)		13		3	12	9	5	2	3	3	12	21	96
<u>Typhlamphiascus lamellifer</u> (Sars)	13	10		4	3	1	3		3			3	27
<u>Amphiascoldes debilis</u> (Giesbrecht)						2		1					3
<u>A. subdebilis</u> (Willey)		3											3
<u>Metis holothuriae</u> (Edwards)	1	1		1		5						1	2
<u>Ameira parvula</u> (Claus)	1			20					2	4			35
<u>Nitocra affinis</u> (Gurney)										3			3
<u>N. fragilis</u> (Sars)					2								2
<u>Ameiropsis nobilis</u> (Sars)	7	7	31	21		9							68

TABLE 9. HARPACTICOID COPEPODS, BBC - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967							1968					Tot.
	Jun	Jul	Aug	Sep	Oct*	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Praeileptomesochra africana</u> (Kunz)	1		8			13		12		3			37
<u>Phyllopodopsyllus hermani mihi</u>	223	107	36	105	471	2	3	41	16	32	896	251	2183
<u>P. furciger</u> (Sars)										1			1
<u>Phyllopodopsyllus</u> n. sp. B				8		14							22
<u>Laophontella armatus</u> (Willey)		1	2	8		1		1					13
<u>Orthopsyllus linearis</u> (Claus)	80	38	21	22	5	2	4	1	22	6	6	3	210
<u>Leptastacus macronyx</u> (T. Scott)		1		1					1	3	1	1	8
<u>Lourinia armata</u> (Claus)				2	1								3
<u>Enhydrosoma propinquum</u> (Brady)					1								1
<u>Paralaophonte brevirrostris f.</u> (Willey)	38	19	46	10	9	6	5	2	24	3	16	52	230
others	6	4									1	2	10
Total # species	13	22	19	21	15	16	9	10	14	14	11	15	41
Total # individuals	396	268	288	262	534	97	43	65	88	75	957	415	3489

* BBC - BEF combined

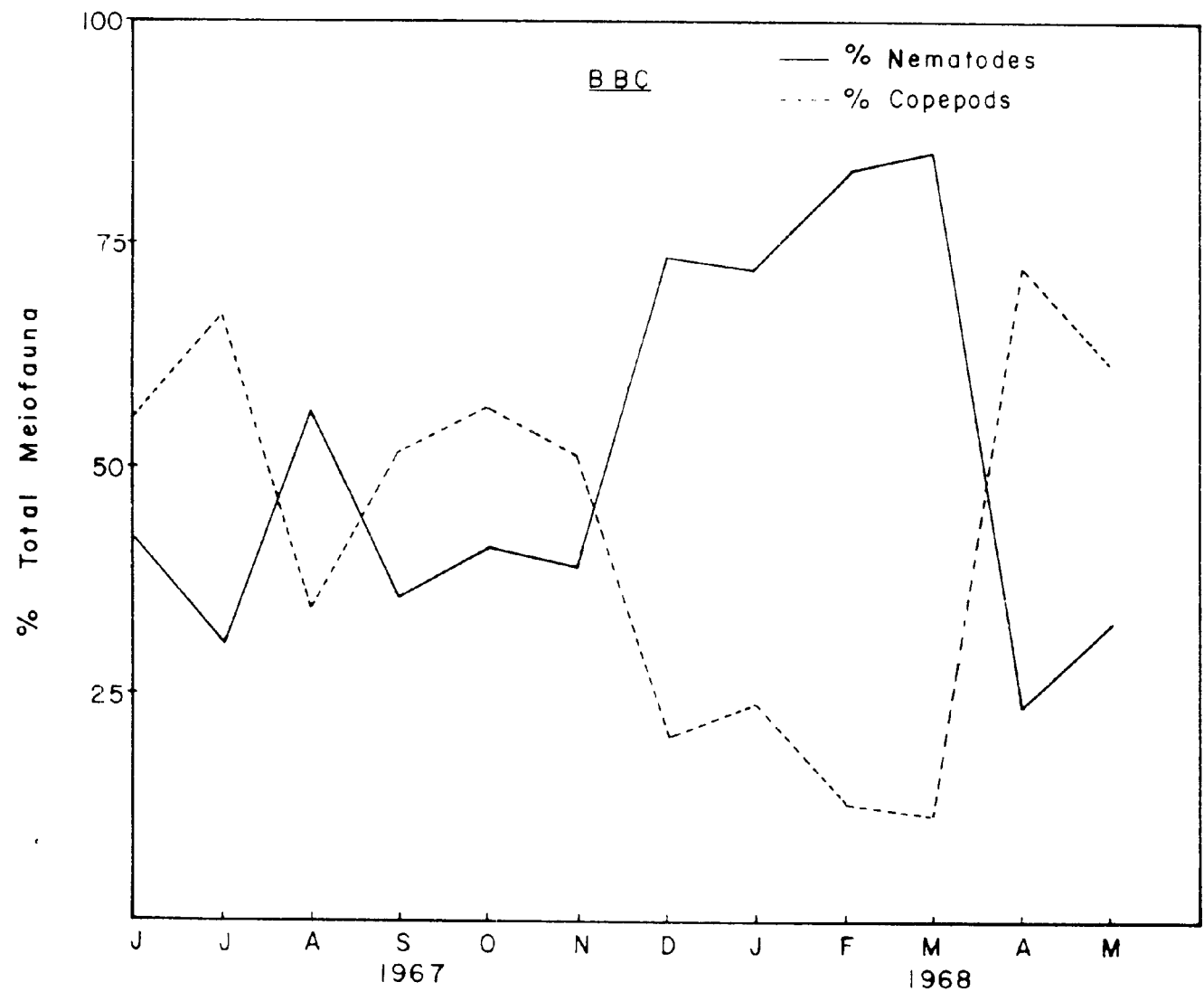


Figure 18. BBC - Nematode and copepod percentages of total population.

laophonte brevirostris fissirostris (Willey) (6.6%), Orthopsyllus linearis (Claus) (6.0%), and Ectinosoma dentatum (4.8%) were also significant members of the copepod population. The remaining 38 species accounted for the residual 20.0%.

Figure 19 indicates the percent abundance and seasonal cycle of the four most abundant species. It should be noted that the October species breakdown (Table 9 and Figure 19) includes both the BEC and BBF samples. Therefore, the October listings in Table 9 (BEC) and Table 10 (BBF) are exactly the same, as are the October percent species abundance curves in Figure 19 and 23.

(1). Phyllopodopsyllus hermani (Figure 19)

This previously undescribed species, in addition to being the most abundant copepod at this study station, was the most prevalent species encountered in the overall survey. Peaks of abundance occurred in October and April. High percentages of unidentified nauplii were collected in September and March, and it is likely that these were young P. hermani. This is further substantiated by the April samples where high percentages of identifiable immature P. hermani were collected. The significance of the January peak (Figure 19) is questionable because of the low total population present. Minimum values for P. hermani were recorded in November and December.

(2). Paralaophante brevirostris f. (Figure 19)

Because of the dominance of P. hermani, the abundance of other species is somewhat overshadowed. P. brevirostris f. was present in every collection but comprised only 6.6% of the copepod population.

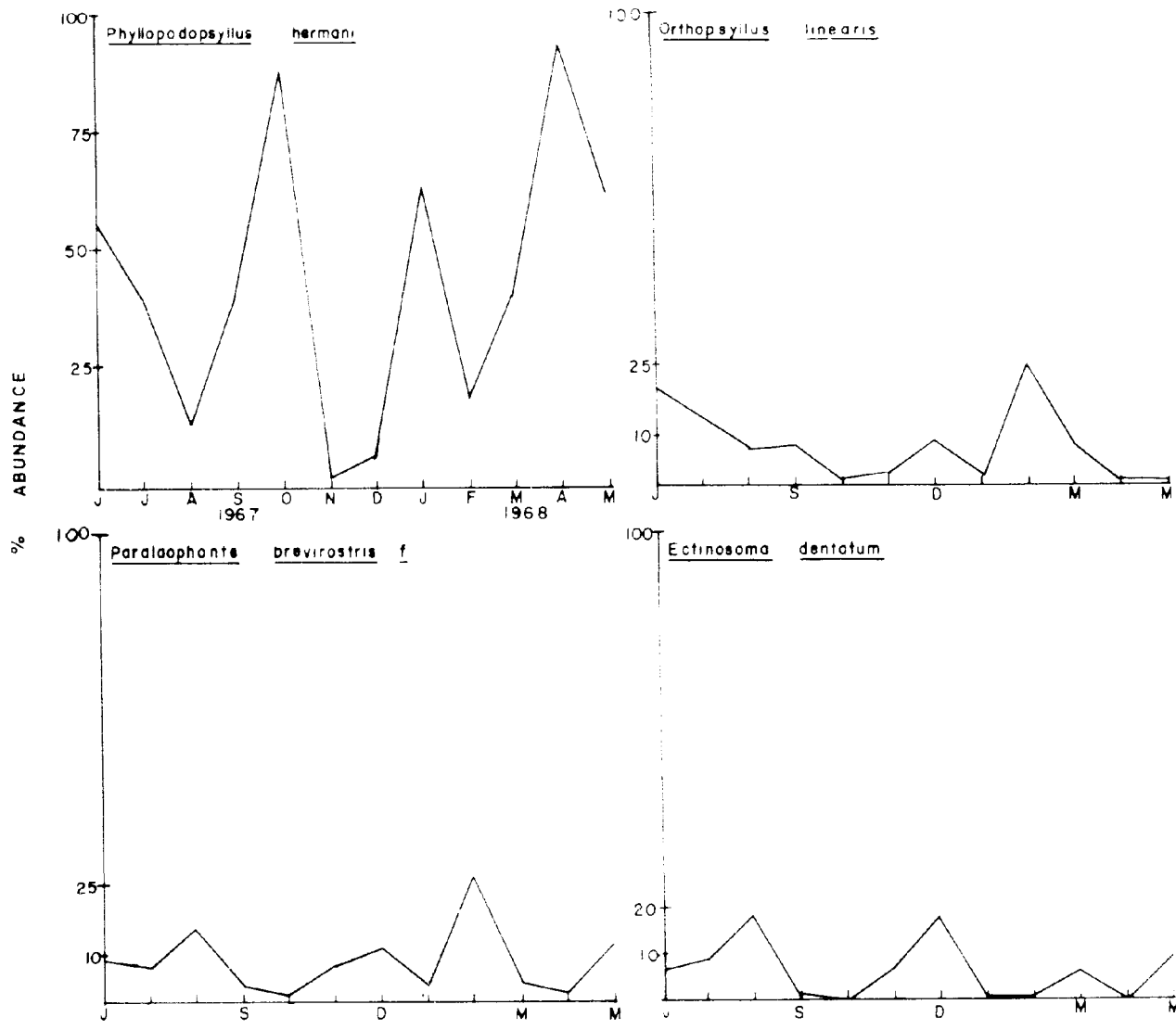


Figure 19. BBC - Percent abundance individual harpacticoid species based on total copepod populations.

Maximum abundance was reached in February when it was the most abundant species encountered. The remainder of the year, the percent abundance values fluctuated near the 6.6% mean.

(3). Orthopsyllus linearis (Figure 19)

Ranking third in overall abundance, O. linearis was prevalent in every sample and abundance peaks in June and February were recorded. This species was often found covered with an epizootic ciliate. Investigations of the occurrence and ciliate systematics are currently in progress.

(4). Ectinosema dentatum (Figure 19)

Two abundance peaks were noted for this ubiquitous species. During August and December, E. dentatum made up 18% of the copepod population. The periods between the peaks were of low magnitude and E. dentatum was not present in February or April.

c. Nematodes

Nematodes comprised 46.7% of the total numbers and 54.1% of the total dry weight biomass. Numerically, nematodes were the dominant forms only during the "Winter Condition" and anomalous August. Ignoring August, they comprised 35.1% of the summer fauna and 78.6% of the winter fauna.

The seven most abundant species accounted for only 34.7% of all nematodes identified, i.e. Meyersia minor (9.2%), Tripyloides sp. (5.5%), Prochromadorella sp. #5 (4.5%), Metachromadora sp. (4.0%), enoplolaimid (3.8%), Epacanthion sp. 1 (3.7%), and Pomponema tessellatum (3.6%). The remaining 94 species were responsible for the residual 65.3%. (Appendix B3 lists all nematodes encountered

at BBC; again note that, as with the harpacticoids listed in Table 8, there is no BBC-BHF distinction for October.)

Figure 20 illustrates the seasonal pattern of the nematode feeding groups as well as the mean yearly values (Histogram) at BBC. Overall the epistrate feeders (2A) and omnivore-predators (2B) were found in equal abundance; Group 2A, 41.0%; Group 2B, 41.5%. The deposit feeders, 1A and 1B were rarely responsible for more than 20% of the total nematodes and averaged 9.3% (1A) and 8.2% (1B). Seasonally, the epistrate and omnivore-predators fluctuated around the 40% level, the deposit feeders around the 10% level.

Eubostrichus spp., although not as common at BBC as at other stations, were all covered with the blue-green epiphyte.

d. Other Taxa

Polychaetes and ostracods were the third and fourth most abundant organisms, respectively comprising 2.4% and 1.4% of the overall population. Polychaetes were most abundant in September when they were responsible for 9.1% of the population. The ostracod high percentage value was recorded in August (2.7%). The two taxa were encountered regularly throughout the year.

Bivalve larvae and halacarids were fifth in overall abundance, appeared sporadically throughout the year and never made up more than 1% of the population in any given month.

5. Baileys Bay Fine

a. Total Populations and Biomass (Figure 21)

Numbers per m² reached the highest station value in September

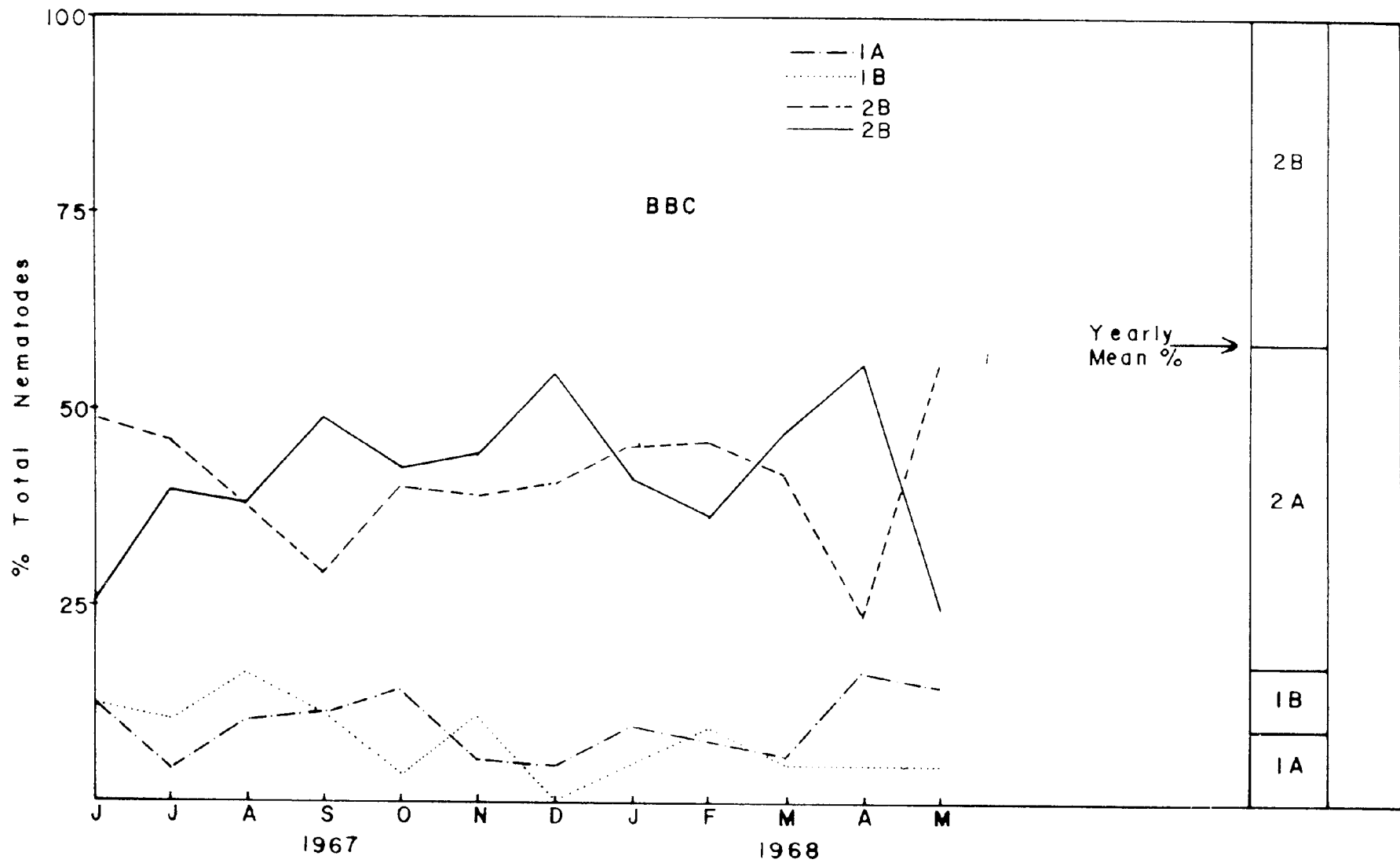


Figure 20. BBC - Nematode feeding groups - percent abundance (monthly) and mean yearly percent.

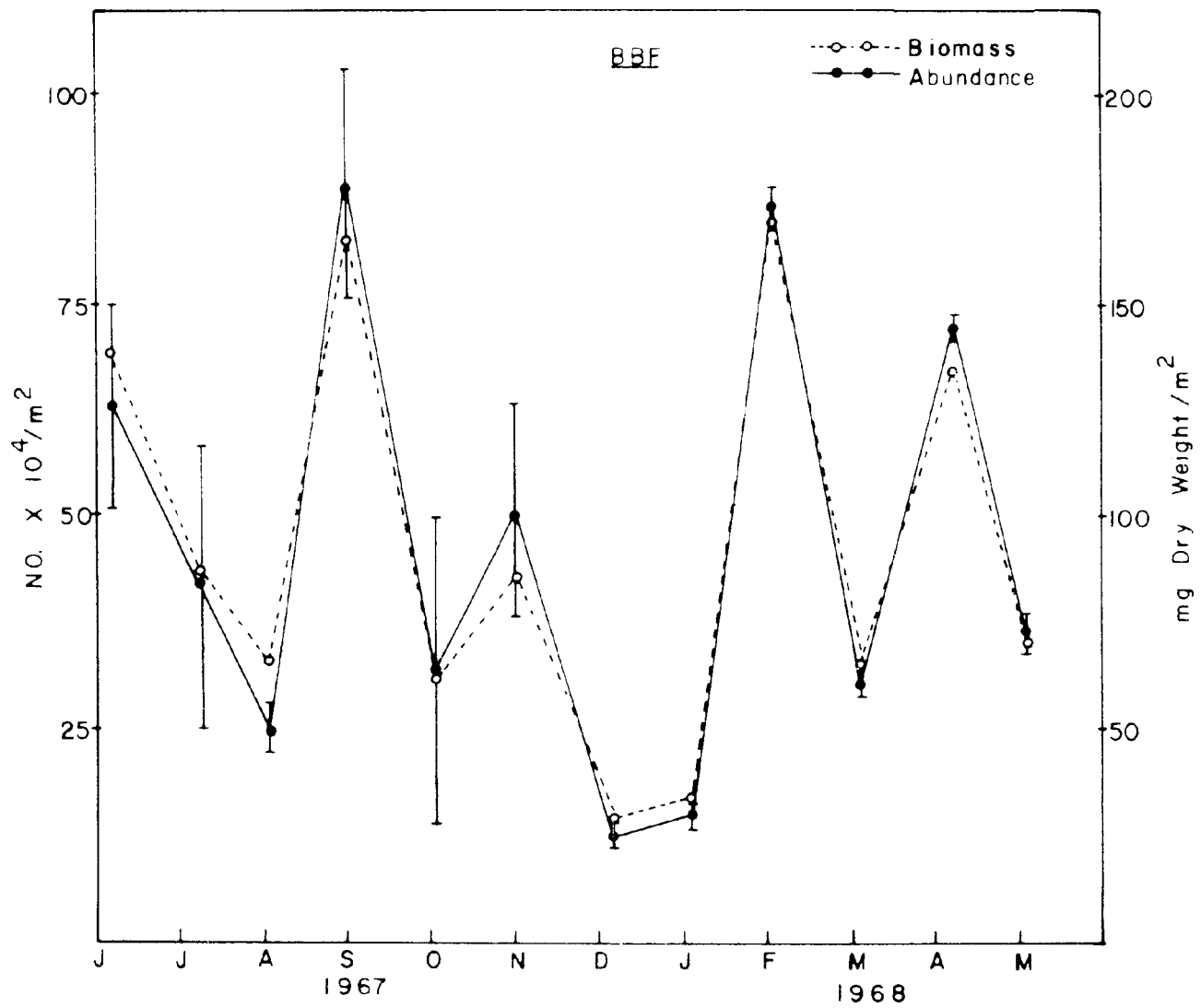


Figure 21. BBF - Population abundance (with standard deviation) and biomass.

($89.4 \pm 14 \times 10^4/\text{m}^2$); the lowest value occurred in December ($12.3 \pm 1 \times 10^4/\text{m}^2$). The dry weight biomass maxima and minima were recorded in February ($173.0 \text{ mg}/\text{m}^2$) and December ($26.2 \text{ mg}/\text{m}^2$). The yearly mean population was $46.4 \times 10^4/\text{m}^2$, the mean dry weight biomass $93.1 \text{ mg}/\text{m}^2$.

An irregular seasonal pattern, as evidenced in Figure 21, persisted. The two high abundance peaks in September and February were followed by abrupt decreases in numbers and biomass. Low "Winter Condition" (except February) values were recorded. Secondary peaks of abundance were evident in June and April, only to decrease the following months to relatively low levels. Following the June secondary peak ($62.9 \pm 12 \times 10^4/\text{m}^2$), the population gradually decreased to an August low ($25.1 \pm 1 \times 10^4/\text{m}^2$) and increased to the September survey maximum. Population density then dropped to a statistically invalid October low, which was followed by a questionable November increase. Considering the variations within samples, it is possible that a gradual population decrease was prevalent during the period from September to January. The February, March, April, May series were very irregular, with variations within samples negligible.

Vertically, 69.9% of all the fauna was located in the upper 2 cm of sediment, 22.9% between 2-5 cm, 5.5% between 5-7 cm, and only 1.7% below 7 cm.

Nine taxa were encountered at BBF. Nematodes and copepods were the dominant forms. Polychaetes, ostracods, halacarids, priapulids, bivalve larvae, turbellarians, and amphipods were also found. (Appendix A4 lists the monthly mean numbers of each taxa.)

b. Harpacticoid Copepods (Table 10)

Overall the harpacticoids comprised 39.1% of all animals collected and 20.8% of the dry weight biomass. Harpacticoids were the dominant forms encountered in November, April and May. All other times the population was dominated by nematodes (Figure 22).

Thirty-eight species of harpacticoids were collected. As with BBC, Phyllopodopsyllus hermani was by far the most abundant form, comprising 74.7% of all the copepods. Paralaophonte brevirostris f. (5.2%), Ectinosoma dentatum (3.2%), Danielssenia n. sp. (2.4%), and Bulbamphiascus inus (Brady) (2.4%) were also important members of the population. The 34 remaining species were responsible for the residual 12.1%.

The percentage abundance for four of the five dominant species is depicted in Figure 23. Again, the BBF and BBC values for species distribution are exactly the same for October.

(1). Phyllopodopsyllus hermani (Figure 23)

This species was the dominant form encountered in all but June, July and August. The remainder of the year P. hermani percent total copepod values fluctuated around the 80% mark. Although P. hermani was responsible for 66% of the December and January populations, the number actually encountered was approximately the same as in June, July and August (Table 10).

(2). Paralaophonte brevirostris f. (Figure 23)

After the 28.5% abundance peak in July (the maximum value for this species), a gradual population decrease occurred. The population fluctuated at low levels the remainder of the year. P.

TABLE 10. HARPACTICOID COPEPODS, BEF - ACTUAL NUMBER IDENTIFIED

SPECIES	1967												1968				Tot.
	Jun	Jul	Aug	Sep	Oct*	Nov	Dec	Jan	Feb	Mar	Apr	May					
<u>Longipedia helgolandica</u> (Klie)		2											2			1	5
<u>Actinosana dentatum</u> (Steuer)	17	34	35		1	4		1	2	5							99
<u>Arenosetella spinicauda</u> (Wilson)		6	6	25	7	12		1	1	2						1	2
<u>Danielsenia</u> n. sp.		6	1			1			9	2						2	74
<u>Harpacticus nicaeensis</u> (Claus)		1				1											8
<u>H. obscurus</u> (T. Scott)																	1
<u>Tilabe enslieri</u> (Fischer)																	1
<u>T. furcata</u> (Baird)		2			4												6
<u>Dactylopodia tiboldes</u> (Claus)		5	7	7	2		1	1									35
<u>Paradactylopodia brevicornis</u> (Claus)	12	1	2	9													12
<u>Parasthenella spinosa</u> (Fischer)									3		10	3					16
<u>Stenella</u> (D.) n. sp.					1												1
<u>Amphiascopsis cinctus</u> (Claus)			1	9	1												11
<u>Amonardia phyllopus</u> (Sars)			1														1
<u>Bulbamphiascus imus</u> (Brady)		7	14	5	14	5	4	2	4	5	3						74
<u>Robertgurneya restrata</u> (Gurney)	11		6	32	12	10			3	1							67
<u>Typhlamphiascus lamellifer</u> (Sars)	6			2	3	1			1								13
<u>Amphiascoides subdebilis</u> (Willey)							1		5	2							6
<u>Ameira parvula</u> (Claus)	4		2	9													18
<u>Mitocera affinis</u> (Gurney)																	1
<u>N. fallaciosa</u> (Klie)																	1
<u>N. fragilis</u> (Sars)					2												2
<u>Ameiropsis nobilis</u> (Sars)				3		3											6
<u>Præleptomesochra africana</u> (Kunz)	6	1	3	14		1	1	6	3	1	3	6					45
<u>Apodopsyllus africanus</u> (Kunz)	1																1
<u>Phyllopodopsyllus hermani</u> mihi	23	10	33	403	471	341	27	22	462	106	173	222					2293
<u>P. furciger</u> (Sars)						1			1			1					2
<u>Phyllopodopsyllus</u> n. sp. A												1					1

TABLE 10. HARPACTICOID COPEPODS, BEF - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967							1968					Tot.
	Jan	Jul	Aug	Sep	Oct*	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Phyllopedopsyllus</u> n. sp. B	15	1				3	1						20
<u>Laophontella armatus</u> (Willey)				1				1					2
<u>Orthopsyllus linearis</u> (Claus)	8	17	4	11	5	1	2		5	3	2	2	60
<u>Leptastacus macronyx</u> (T. Scott)	1			1					2	3		8	15
<u>Lourinia armata</u> (Claus)				1	1				1				3
<u>Enhydrosoma propinquum</u> (Brady)					1								1
<u>Laophonte cornuta</u> (Philippi)		2	1							1			4
<u>Paralaophonte brevirostris</u> f. (Willey)	21	37	23	16	9	28	4		15	1	4	2	160
others	1		2			1							2
Total # species	13	14	18	17	15	14	8	6	17	12	8	12	38
Total # individuals	126	130	143	549	534	412	41	33	520	126	201	256	3071

* BEF-BBC combined

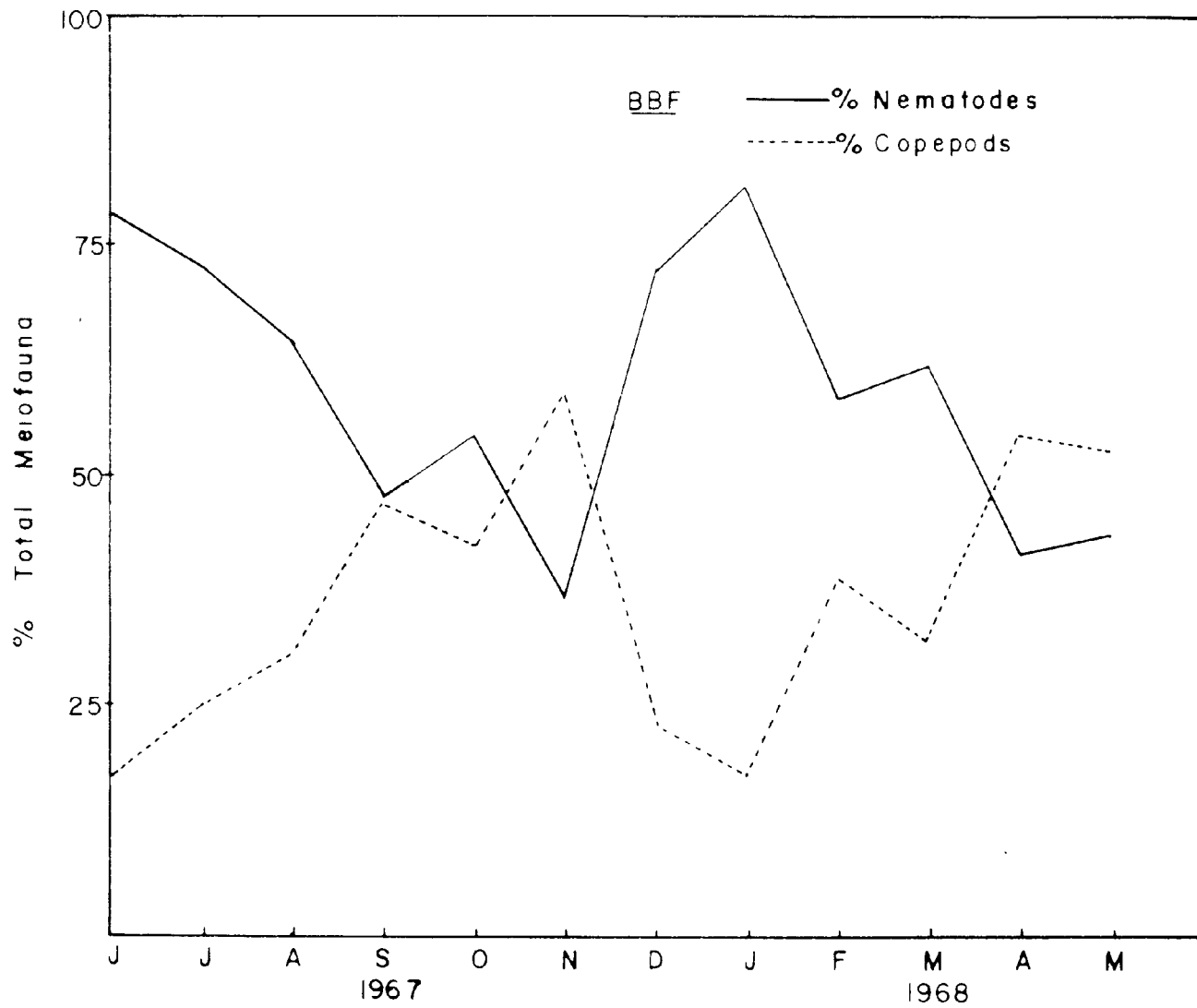


Figure 22. BBF - Nematode and copepod percentages of total population.

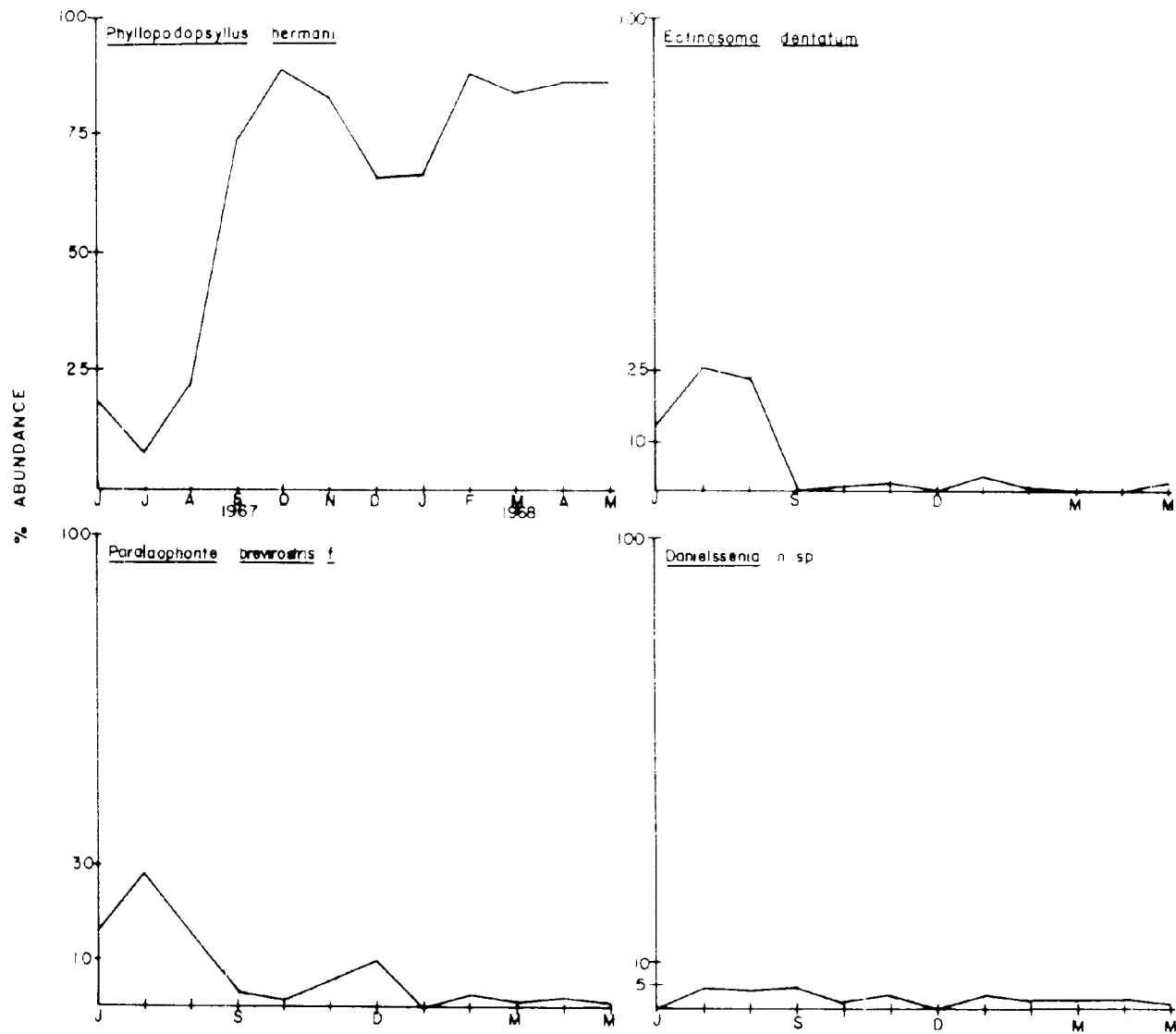


Figure 23. BBF - Percent abundance individual harpacticoid species based on total copepod populations.

brevirostris f. was present in all but the January samples.

(3). Ectinosoma dentatum (Figure 23)

E. dentatum followed the same pattern as P. brevirostris f.; maximum abundance in June, July and August, followed by very low level fluctuations the remainder of the year.

(4). Danielssenia n. sp. (Figure 23)

Danielssenia n. sp. is one of the subjects of a systematic manuscript being prepared by the author. No discernible seasonal pattern was evident. This species was present in all but the June and December samples.

c. Nematodes (Figure 22 - nematode and copepod percentages)

Except for the three months (November, April and May) when the harpacticoids dominated, the nematodes accounted for the bulk of the population (total numbers - 56.8%, dry weight biomass - 66.5%).

83 species have been identified from BHF. The four most common species accounted for 26.1% of all those collected. With the data available, it appears that no particular species was the dominant form. The four most abundant species were: Theristus floridanus (9.5%), Chromadorella sp. (5.8%), enopolaimid (5.4%), and Metachromadora sp. (5.4%). 79 species comprised the remaining 73.9% (Appendix B4 for all those identified from BHF).

Epistrate feeding (2A) nematodes were overall the most copious forms (40.1%), omnivore-predators were second (31.2%), non-selective deposit feeders third (17.2%), and selective deposit feeders fourth (11.5%) (Histogram, Figure 24). Seasonally, epistrate

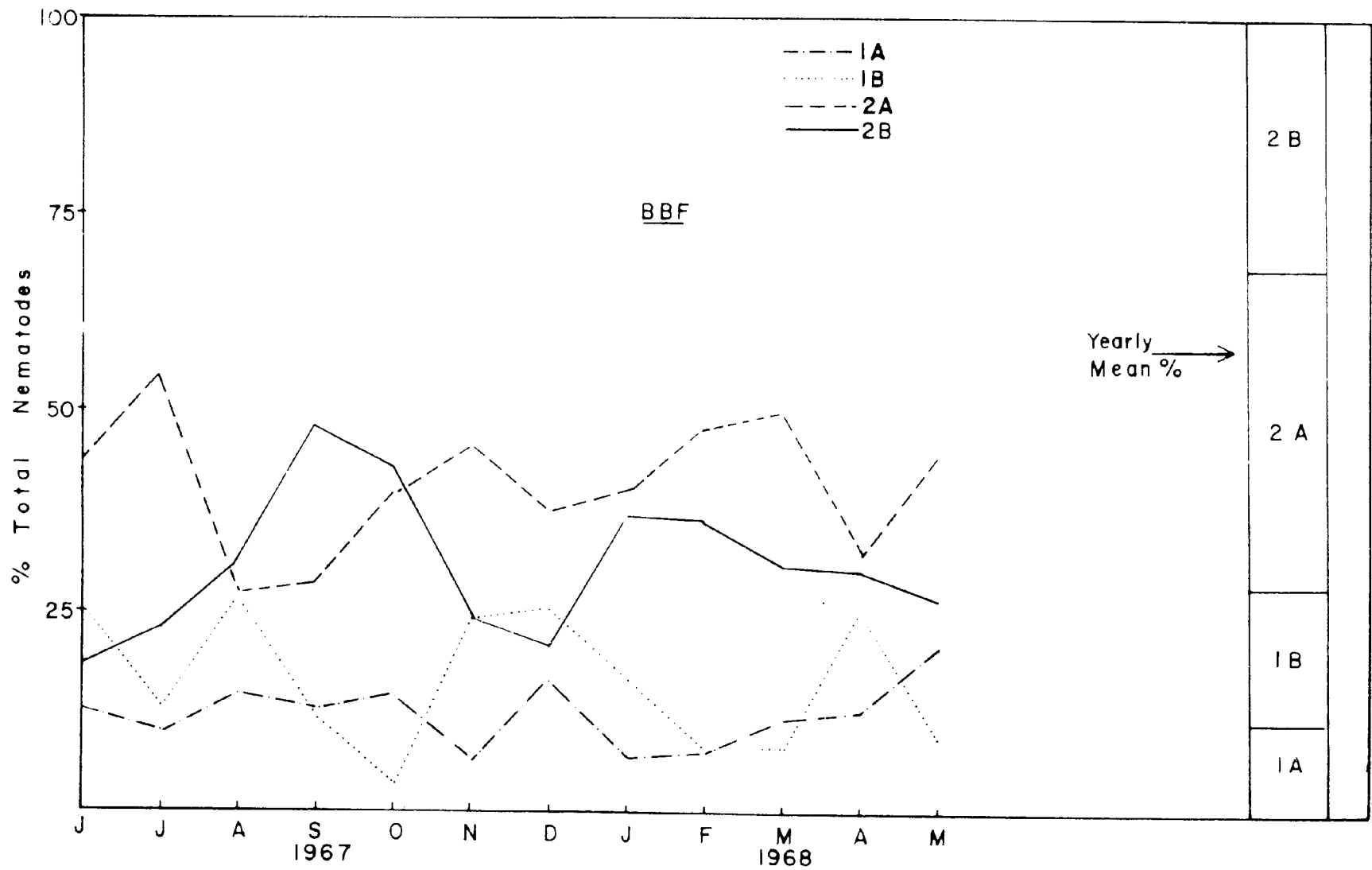


Figure 24. BBF - Nematode feeding groups - percent abundance (monthly) and mean yearly percent.

feeders were the predominant form encountered in all but three months, August, September and October. During the three aforementioned months, omnivore-predators (2B) were the prevalent forms. Omnivore-predators were usually second in abundance other times during the year, but during June and December, were third ranking behind the selective deposit feeders (1A). The non-selective deposit feeders (1B) fluctuated between the 5-25% level throughout the survey, occasionally second in abundance (June and December), and sometimes even less abundant (October, March and May). The seasonal pattern (Figure 24) is not as clear-cut as the previously mentioned stations because of overlapping of feeding groups.

All Eubostrichus spp. identified were those with the blue-green epiphyte.

d. Other Taxa

Only polychaetes and ostracods occurred in sufficient abundance to warrant mentioning. Polychaetes were present every time the station was occupied and comprised 2.2% of all fauna collected. Percentage wise the polychaetes were most abundant in September (3.7%) and least abundant in February (0.6%). Ostracods were present in all but the January samples and were responsible for 1.2% of the total yearly population.

6. Trunk Island

a. Total Populations and Biomass (Figure 25)

Mean total population values ranged from $35.2 \pm 4 \times 10^4/\text{m}^2$ in July to $102.2 \pm 3 \times 10^4/\text{m}^2$ in May and averaged $58.0 \times 10^4/\text{m}^2$. Mean dry weight biomass varied between $80.8 \text{ mg}/\text{m}^2$ (July) and 210.9

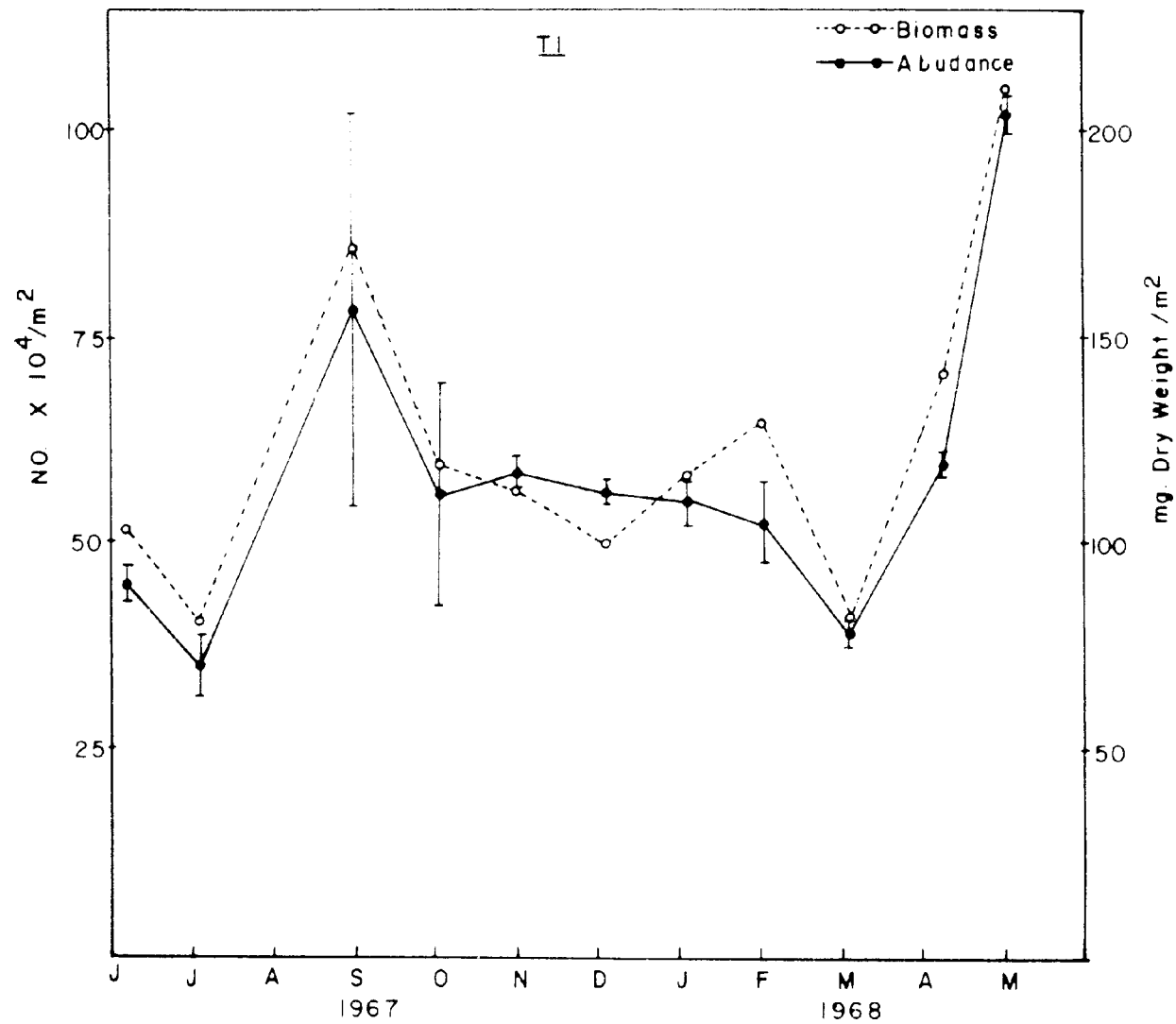


Figure 25. TI - Population abundance (with standard deviation) and biomass.

mg/m² (May) and averaged 126.7 mg/m².

Beginning with a relatively low population value in June and July, the population increased to a statistically invalid secondary abundance peak in September. Following this, a gradual population decrease was observed. The decrease continued through March, after which a gradual increase to the high May population value was recorded.

The biomass cycle was much the same as the #/m² cycle except for the magnitude of the January and February values. While the population decreased slightly, the biomass increased due to the increased number of ostracods in the samples (Figure 25).

Of all the fauna collected, 64.4% was found in the upper 2 cm of sediment, 25.0% in the 2-5 cm segment, 8.4% in the 5-7 cm segment and 2.2% below 7 cm.

Eight taxa were found at TI and included nematodes, harpacticoid copepods, polychaetes, ostracods, halacarids, turbellarians, bivalve larvae and tanaidaceans. (See Appendix A5 for a complete list of the fauna collected at TI.)

b. Harpacticoid Copepods (Table 11)

Harpacticoids were responsible for 27.5% of all meiofauna collected and 15.1% of the total dry weight biomass. With regard to total number of organisms, harpacticoids were the major constituents twice during the survey: December (50.8%) and May (53.3%) (Figure 26), but, in terms of biomass, were the predominant form only in May (43.8%). The nematodes comprised 54.2% of the biomass in December, the harpacticoids 35.5%.

TABLE 11. HARPACTICOID COPEPODS, TI - ACTUAL NUMBERS IDENTIFIED

SPECIES	1967												1968			Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May				
<u>Longipedia helgolandica</u> (Klie)	5				2		1		6	6	3	32	55			
<u>Ectinosoma dentatum</u> (Steuer)	10	2		5			1	3	5	6	3	17	52			
<u>Halectinosoma abrau</u> (Kricagin)										1			1			
<u>H. sarsi</u> (Boeck) ;										2		4	2			
<u>H. neglectum</u> (Sars)	5						32	4	5	6			20			
<u>Danielsenia</u> n. sp.	4	7		2	9	7			11	7	11	16	110			
<u>Harpacticus niceensis</u> (Claus)	1	2											3			
<u>Scutalidium longicauda</u> (Philippi)					1								1			
<u>Dactylopodia tiboides</u> (Claus)	7	15		10	3	5	6	2		2		1	50			
<u>Paradactylopodia brevicornis</u> (Claus)				2					1	4	3	7	3			
<u>Parastenbella spinosa</u> (Fischer)													15			
<u>Diosaccus valens</u> (Gurney)				3									3			
<u>Robertsonia knoxi</u> (Thompson & A. Scott)		1		1									2			
<u>Amphiascopsis cinctus</u> (Claus)							1			2	2		1			
<u>Bulbamphiascus imus</u> (Brady)	11			4		9	6	2	7	4	2	5	43			
<u>Robertgurneya rostrata</u> (Gurney)		1		13	5	6	8	10	4	4	4	5	60			
<u>R. similis</u> (A. Scott)	2												2			
<u>Typhlamphiascus lamellifer</u> (Sars)				5		2				1			8			
<u>Amphiascoides debilis</u> (Giesbrecht)				2		5							5			
<u>Metis holothuriae</u> (Edwards)													2			
<u>Ameira parvula</u> (Claus)					1	1					2		4			
<u>Præleptomesochra africana</u> (Kuns)	2	1		5		14	1	16	11		24	78	152			
<u>Scottopsyllus pararebertsoni</u> (Lang)											2		9			
<u>Phyllopedopsyllus hermani</u> mihl	21	36		71	81	223	299	52	38	112	188	452	1573			
<u>Apodopsyllus africanus</u> (Kuns)	1	1		2		3		2			2	7	18			
<u>Leptastacus macronyx</u> (T. Scott)	3												3			
<u>Orthopsyllus linearis</u> (Claus)	6	2			3	3	2	2		2	1	1	22			
<u>Paralaobonte brevivrostris</u> f. (Willey)	16	7		7	2	6	10	3	5	6	9	17	88			

NO SAMPLES

TABLE 11. HARPACTICOID COPEPODS, TI - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967							1968					Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Normanella</u> sp.			N. S.									1	1
<u>Paralaophontodes echinatus</u> (Willey)			N. S.								1		1
others	1												1
Total # species	15	11		14	9	12	11	11	10	14	14	13	31
Total # individuals	95	75		132	107	284	367	103	93	161	255	638	2310

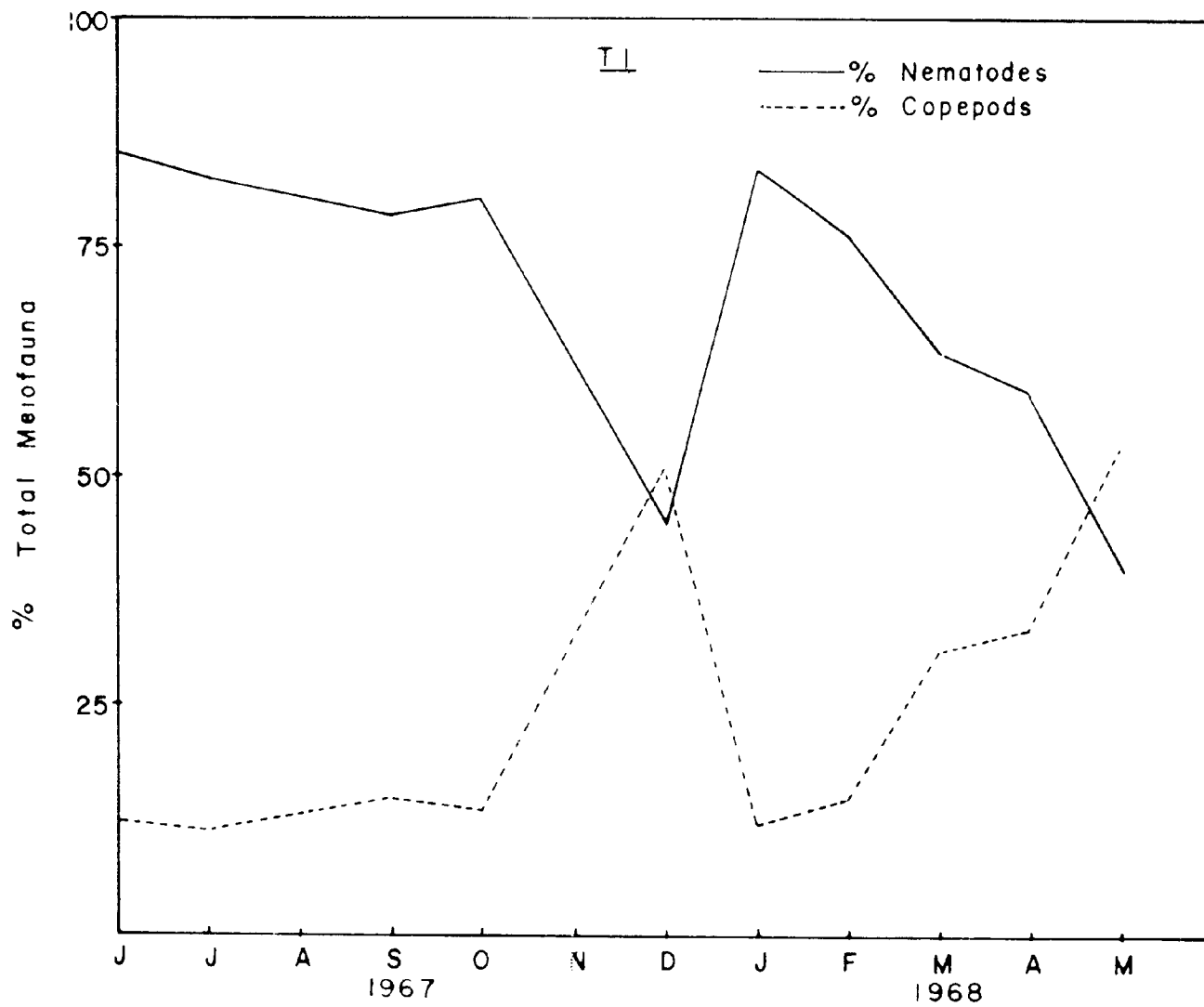


Figure 26. TI - Nematode and copepod percentages of total population.

Thirty-one species have been identified from this study station. Phyllopodopsyllus hermani was the major form found every time the station was occupied and was responsible for 68.1% of all the copepods collected. Other copepods of importance were: Praeleptomesochra africana (6.6%), Danielssenia n. sp. (4.8%) and Paralaophonte brevirostris f. (3.8%). The remaining 16.7% of the copepods was made up by 27 species (Table 11).

(1). Phyllopodopsyllus hermani (Figure 27)

P. hermani was always predominant, reaching its low value in June (22.5%). After June, the percent composition gradually increased to the highest value recorded (December, 81.5%). Following the December peak, the percentage dropped to a secondary February low, only to increase to the 70% mark in March and fluctuate around this line for the remainder of the survey.

(2). Praeleptomesochra africana (Figure 27)

After fluctuating at low levels for the first seven months of the survey, P. africana reached its maximum percent distribution in January (15.2%). The species was absent in March, but increased to secondary abundance peaks of 9.4% and 12.2% in April and May respectively.

(3). Danielssenia n. sp. (Figure 27)

This species reached maximum abundance in February (11.8%). The population densities vacillated regularly between 2 and 10%, and no seasonal pattern could be detected.

(4). Paralaophonte brevirostris f. (Figure 27)

P. brevirostris f. was most abundant in June, when it was re-

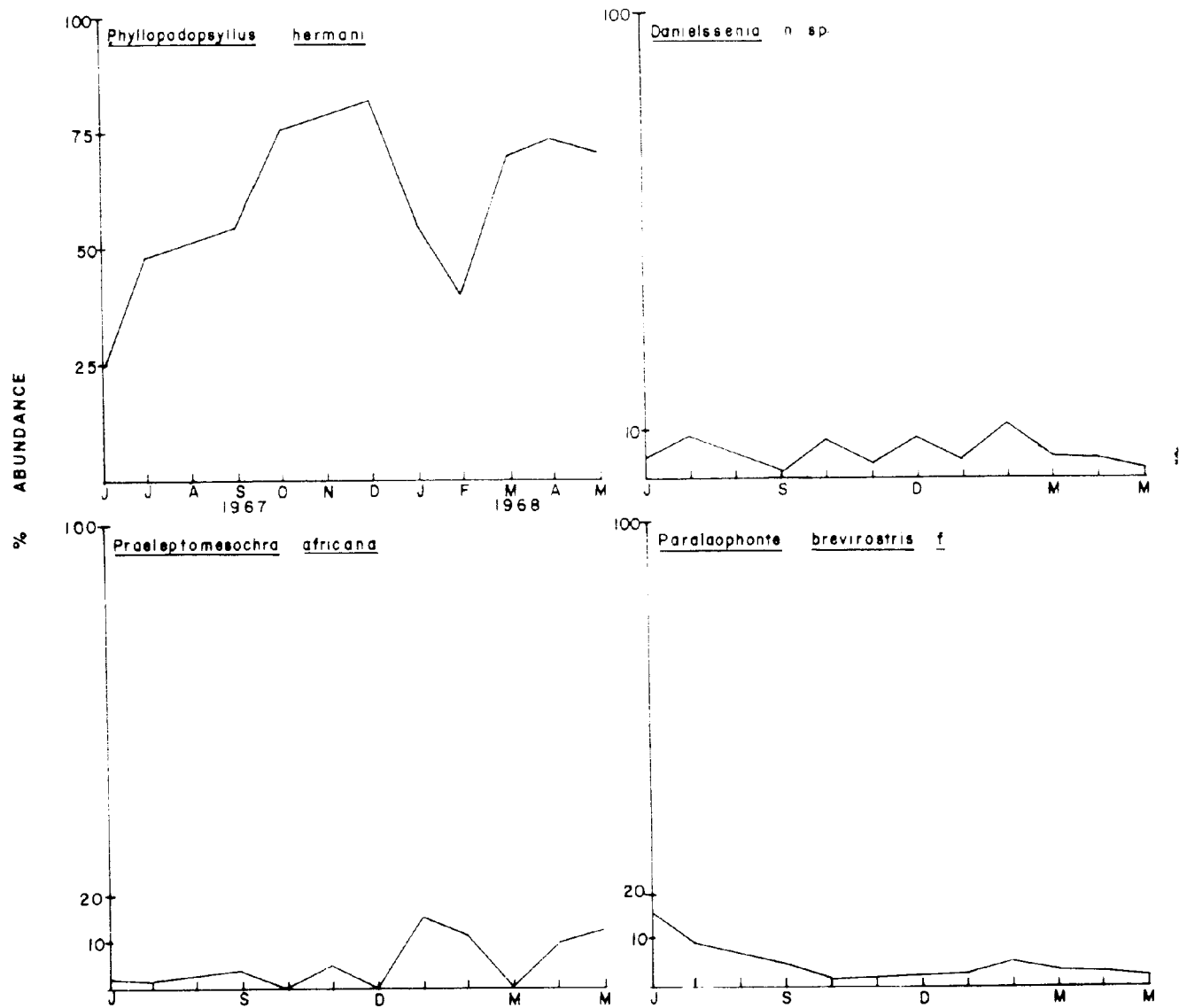


Figure 27. TI - Percent abundance individual harpacticoid species based on total copepod populations.

sponsible for 16.5% of all the copepods encountered. A gradual population decrease was evident throughout the year.

c. Nematodes

Except for the two months when harpacticoids dominated (December and May), the nematodes were the most abundant forms encountered. Overall they were responsible for 66.6% of the total numbers and 68.3% of the dry weight biomass (Figure 26).

Ninety-five nematode species were identified from T1. The four most abundant species made up 42.1% of all the nematodes identified, i.e. Comesoma sp. #2 (22.2%), Paradesmodora sp. #1 (7.4%), Comesoma sp. (7.1%), and Theristus sp. #4 or 5 (5.4%). The residual 57.9% consisted of the 91 remaining species. (Appendix B5 lists all those nematodes collected at T1.)

Epistrate feeders (2A) were, by far, the most numerous group apparent and accounted for 48.8% of the total nematode fauna. The omnivore-predators (2B) were second in abundance at 25.3%, while the two deposit feeding Groups (1A and 1B) were third and fourth in overall abundance at 13.1% and 12.8% respectively (Histogram, Figure 28). Seasonally, the same pattern existed, with the epistrate feeders always comprising more than 40%, the omnivore-predators fluctuating around the 25% line and the two deposit feeders alternating in dominance between 8% and 20%. There was no overlapping of feeding groups, except with the selective - non-selective deposit feeding forms (Figure 28).

The Schizothrix calcicola bearing Eubostrichus spp. were common T1 inhabitants appearing in 9 of the 11 samples. The forms were

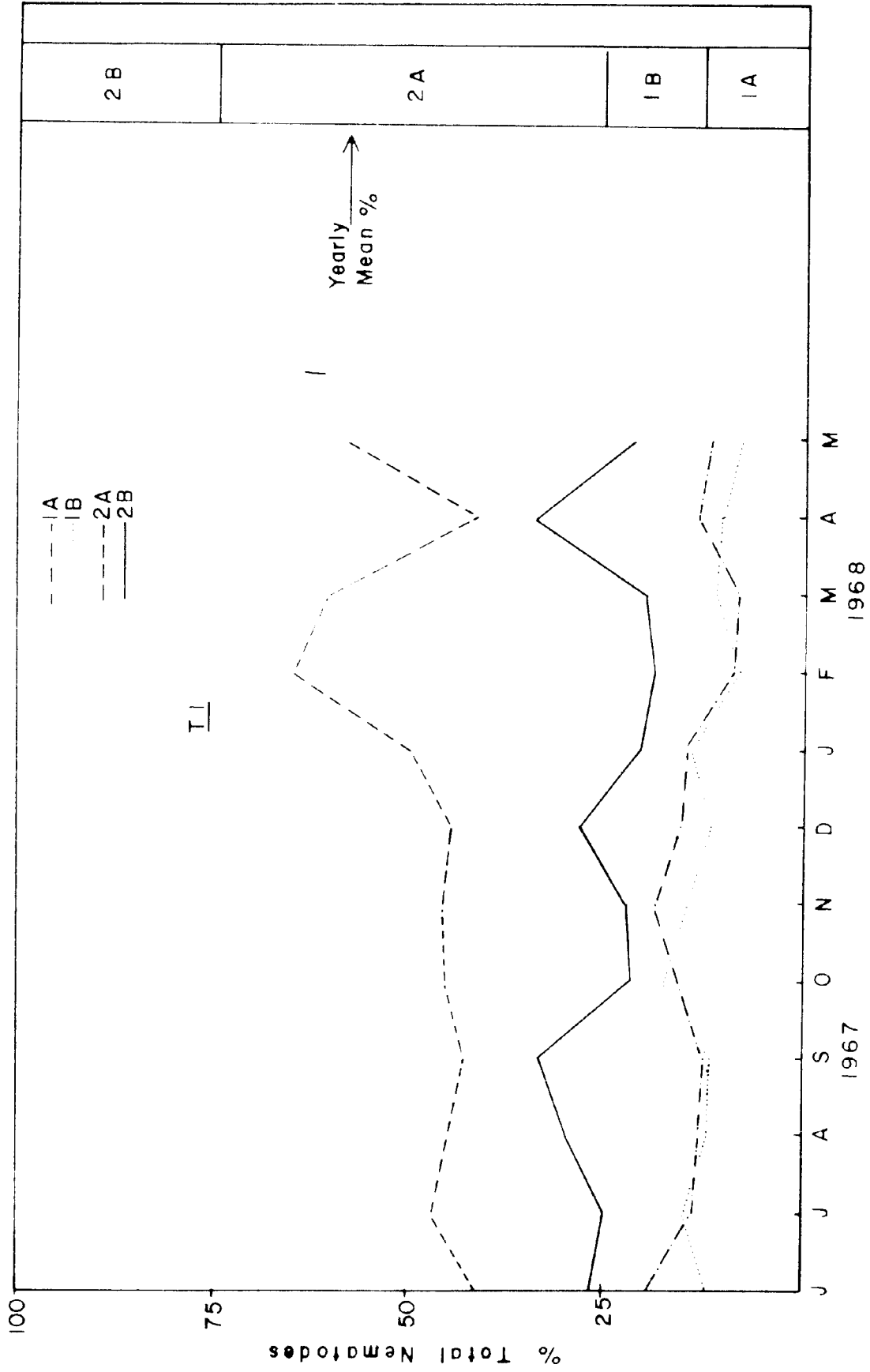


Figure 28. TI - Nematode feeding groups - percent abundance (monthly) and mean yearly percent.

most abundant in October and November when they were responsible for 3.9 and 3.8% of the total population and 4.8 and 5.7% of all the nematodes.

d. Other Taxa

Polychaetes were present in all samples, and were most common in September (4.4% of total population). Overall, polychaetes averaged 2.1% of all the meiofauna. Ostracods were another regular TI denizen. They were most prominent in late winter and early spring, e.g. they comprised 4.5% of the February fauna and, overall, 1.5% of the total population. During most of the year, bivalve larvae appeared sporadically. Only in May, after a large March-April increase in Harrington Sound meroplankton (Herman and Beers, in press), were they found in abundance. (Appendix A5 lists all forms encountered at TI.)

7. Devils Hole

a. Total Populations and Biomass

As illustrated in Figure 29, the following pattern existed: 0.2 to 0.9 x 10⁴/m² organisms present during June, July and August; no organisms present in September-October; another 0.2-0.9 population level until March-April; and then a late spring population increase (15.0-26.8 x 10⁴/m²). The population remained at the high spring levels for but a short time and, by late June, had dropped to the 0.2-0.9 x 10⁴/m² level. Samples procured during the two year preliminary survey had indicated that the cycle was not atypical since the same pattern prevailed. Total numbers of animals ranged from 0 (September) to 28.6 x 10⁴/m² (June 1968) and dry weight

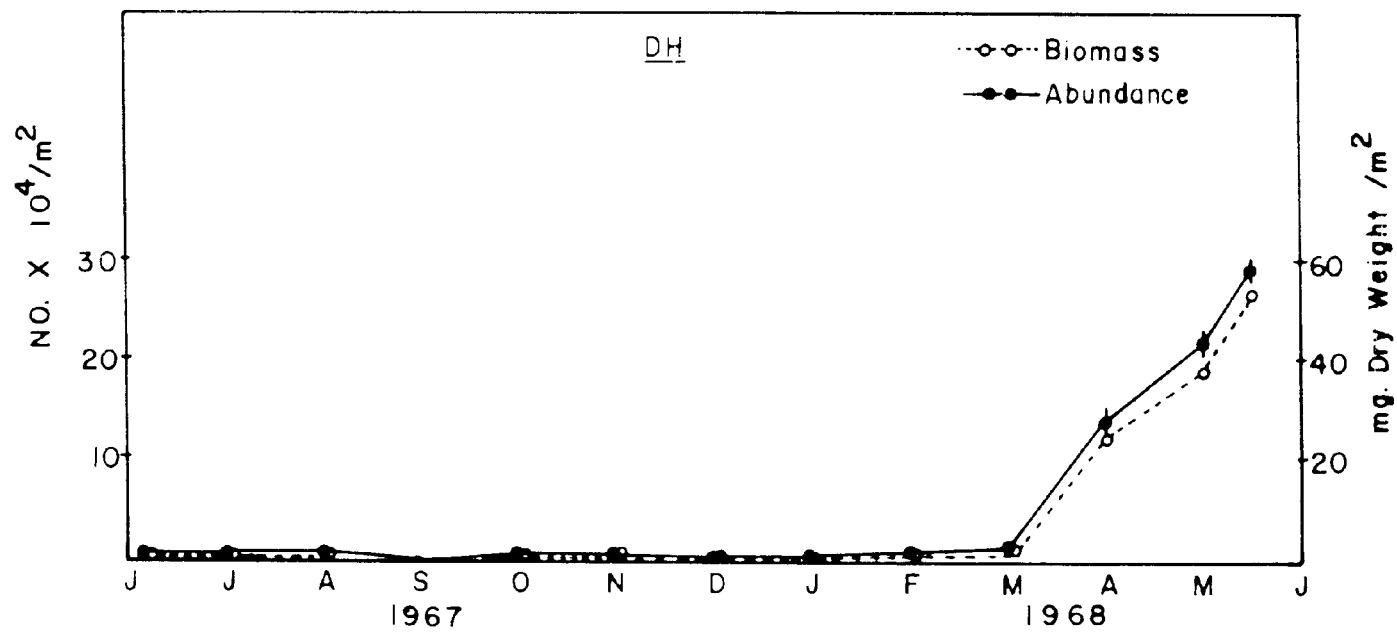


Figure 29. DH - Population abundance (with standard deviation) and biomass.

biomass from 0 to 58.0 mg/m².

During the summer when this study station was devoid of meio-fauna, several series of samples were taken on a transect which started in the Sandy Zone, traversed the Occulina Zone and terminated in Devils Hole (the subthermocline Zone). Five sub-stations were established along the transect: (1) Sandy Zone (5 m), (2) Upper Occulina Zone (12 m), (3) Lower Occulina Zone (17 m), (4) Upper Devils Hole (21 m), and (5) Devils Hole (26.5 m). The results of the September transect are given in Table 12.

TABLE 12. 15 SEPTEMBER 1967, POPULATION VALUES:
TRANSECT FROM SANDY ZONE TO SUBTHERMOCLINE ZONE,
HARRINGTON SOUND

<u>Station</u>	<u>Depth (m)</u>	<u># x 10⁴/m²</u>
S.Z.	5	50.8
U.O.Z.	12	18.6
L.O.Z.	17	18.9
U.D.H.	21	3.6
D.H.	26.5	0.0

The greatest population was found in the Sandy Zone. The two Occulina Zone stations were essentially the same, but 2-3 times lower than the Sandy Zone values. The values for Upper Devils Hole area was 5-6 times lower than those of the Occulina Zone and no organisms were found in Devils Hole proper.

b. Harpacticoid Copepods (Table 13)

Harpacticoids averaged 4.9% of the total population and 2.7% of the total dry weight biomass and never comprised more than 8.0% of the total numbers. Only three species of harpacticoids were found at Devils Hole: Longipedia helgolandica (Klie), Enhydrosoma propinquum and Paradactylopodia brevicornis (Claus).

TABLE 13. HARPACTICOID COPEPODS, DH - ACTUAL NUMBER IDENTIFIED

<u>Species</u>	<u>23 Apr. 1968</u>	<u>16 May 1968</u>	<u>3 June 1968</u>	<u>Tot.</u>
<u>L. helgolandica</u> (Klie)	5	11	6	22
<u>P. brevicornis</u> (Claus)	1	1	-	2
<u>E. propinquum</u> (Brady)	3	5	11	19

The samples obtained on the Sandy Zone-Devils Hole transect, when sorted, allowed some interesting harpacticoid comparisons. The percentage of copepods decreased as one progressed into deeper water. The percent harpacticoids encountered in each Zone was as follows: (1) S.Z. (8.2%), (2) U.O.Z. (3.4%), (3) L.O.Z. (2.7%), (4) U.D.H. (0.0%) and (5) DH (no animals). Those species encountered in the Sandy Zone were much the same as those present at the sandy study stations, i.e. Phyllopodopsyllus hermani, Robertgurneya rostrata (Gurney), Orthopsyllus linearis, Paralaophonte brevirostris f., Ameira parvula (Claus), Robertsonia knoxi (Thompson and A. Scott), and Longipedia helgolandica. The Occulina Zone samples harbored but three species, Bulbamphiascus imus, Longipedia helgolandica and Enhydrosoma propinquum.

c. Nematodes

Whenever the DH population density ranged from 0.2 to 0.9 x 10⁴/m², nematodes were the only organisms found. When the population increased during the spring, nematodes were responsible for 92.5% of the total numbers and 87.9% of the total dry weight biomass.

Thirteen species of nematodes have been identified from the spring Devils Hole samples. Pseudochromadora sp. (36.7%) and Theristus sp. (28.3%) were the most important members found, while eleven

species comprised the remaining 25.0%. Pseudochromadora sp. was endemic to Devils Hole and was not recorded from any other study station. (Appendix B6 lists the April and May DH nematode fauna.)

Based only on the April and May samples, the deposit feeding nematodes were by far the most copious form (90% of all nematodes; 47.0%, Group 1A; 43.0%, Group 1B). Epistrate feeders were not found and omnivore-predators composed the remaining 10.0%.

The nematodes found during the transect portion of the survey were not identified to species or separated into feeding groups. Generally, the percentage of nematodes increased as the water became deeper. At Upper Devils Hole, all of the population was nematode.

d. Other Taxa

Occasionally, polychaetes and ostracods were found during the spring population increase. Polychaetes were present in April (3.3% of total number) and May (1.4%), while ostracods were present in the May and June samples. Three small gastropods were also found in the June 1968 samples.

8. Diversity Analyses

The analysis of diversity at each station has been restricted to the harpacticoid copepod fraction of the samples. Since sufficient numbers of individuals were not available during certain periods of the year, the resultant diversity curves are based on the yearly total number of species and individuals at each station.

The yearly curves depicting the general diversity classification of the particular stations are shown in Figure 30. CHD was

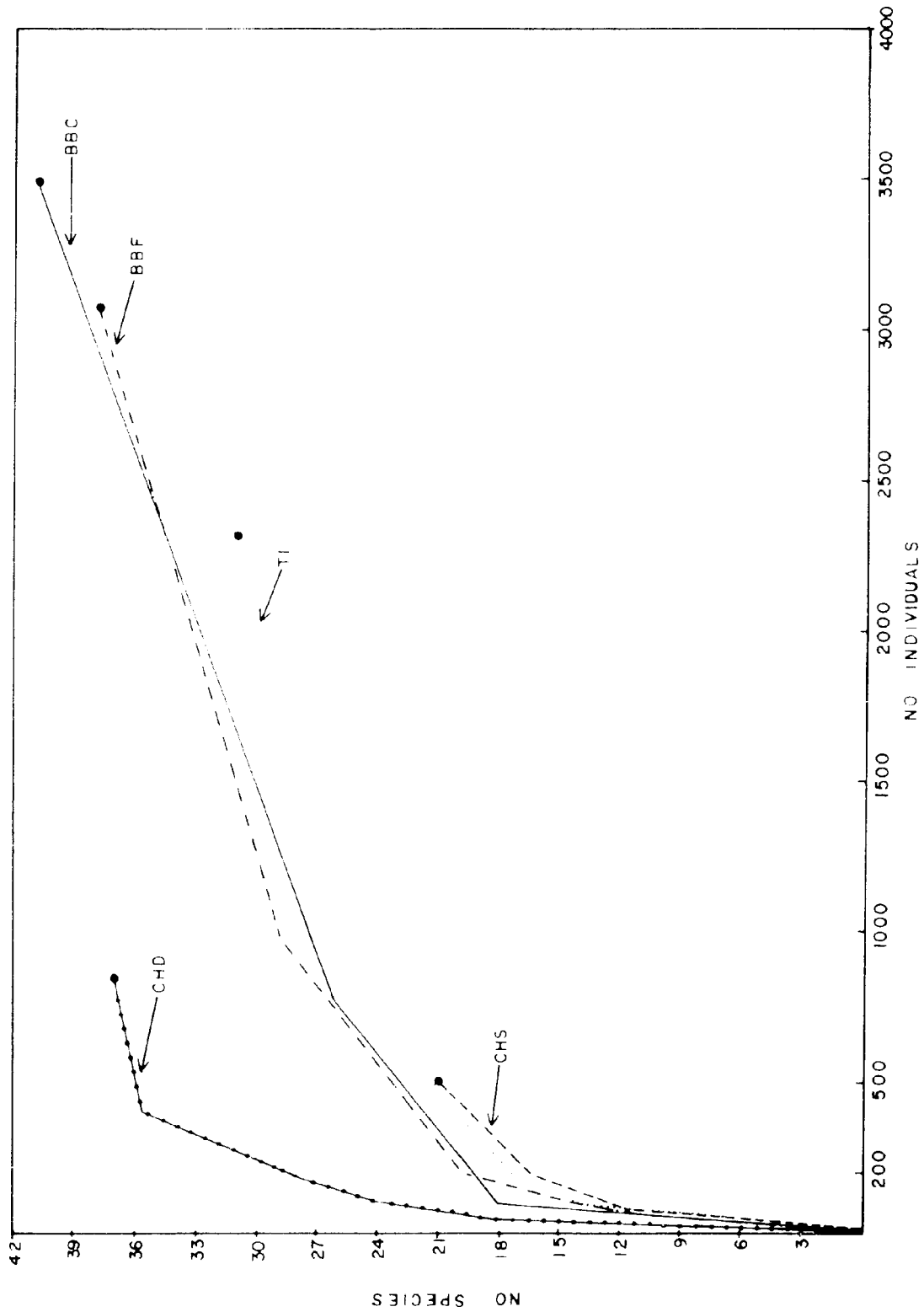


Figure 30. Arithmetical plot of number of harpacticoid species at different population levels using the rarification methodology. The termination of the curves is the actual number of individuals found in the samples.

the most diverse station and CHS the least diverse. When the CHS and CHD diversity curves were plotted on a monthly basis, the shapes of the curves were similar to those in Figure 30.

The curves for BBC and BBF were not the same throughout the year. Due to the lack of sufficient data in some of the months only speculation as to the validity of the resultant curves is possible. Generally, however, the fauna was more diverse during the "Summer Condition" and less diverse during the "Winter Condition" at BBF. The opposite was true at BBC in that the "Winter Condition" harpacticoid fauna was more diverse than those of the "Summer Condition."

The TI curves were consistent and the yearly mean curve depicted in Figure 30 shows an excellent example of the species diversity evident.

Sufficient data was not available from the two months copepods were present in DH to allow diversity analyses.

9. Laboratory Experiments

The results of the March laboratory experiment employing sand retained on the 0.5 mm sieve on one side of the aquarium and that retained on 0.125 mm sieve on the other are tabulated in Table 14. The experiment was conducted over a period of 66 hours; subsamples were collected at 5, 44 and 66 hours. The numbers listed under "Total #" in the Table are the total number of organisms counted, i.e. the sum of all the subsamples taken at different time intervals after initiation of the experiment.

The results of the April experiment, when 2.0-1.0 mm sand was used in one side of the aquarium and 1.0-0.5 mm sand in the other

are shown in Table 15.

In both Aquarium Experiment I and II, the greatest number of organisms (especially the harpacticoids) was found in the sand retained on the 0.5 mm sieve. *P. hermani*, the predominant meiobenthic harpacticoid in Bermuda, was very abundant in the 0.5 mm sands and almost non-existent in the 0.125 mm (Experiment I, March) and 1.000 mm (Experiment II, April) sands.

TABLE 14. MEIOFAUNA AQUARIUM EXPERIMENT I
Taxa and Number of Animals Found Inhabiting Two Different
Sized Sediments (1.000-0.500 mm and 0.250-0.125 mm)

<u>Sediment Size</u>			
1.000 mm-0.500 mm		0.250 mm-0.125 mm	
Taxa	Total #	Taxa	Total #
Nematoda	28	Nematoda	14
Ostracoda	5	Ostracoda	1
Polychaeta	4	Turbellaria	3
Harpacticoida	73	Harpacticoida	12
<u>P. hermani</u>	42	<u>L. macronyx</u>	4
<u>L. helgolandica</u>	4	<u>L. helgolandica</u>	3
<u>E. imus</u>	4	<u>E. dentatum</u>	1
<u>R. knoxi</u>	4	<u>Danielssenia</u> n. sp.	1
copepodites	4	<u>R. rostrata</u>	1
<u>O. linearis</u>	3	<u>A. cinctus</u>	1
<u>H. neglectum</u>	3	copepodite	1
<u>N. affinis</u>	2		
<u>E. dentatum</u>	1		
<u>P. brevirostris</u> f.	1		
<u>A. cinctus</u>	1		
<u>R. rostrata</u>	1		

TABLE 15. MEIOFAUNA AQUARIUM EXPERIMENT II
Taxa and Number of Animals Found Inhabiting Two Different
Sized Sediments (2.000-1.000 mm and 1.000-0.500 mm)

<u>Sediment Size</u>			
2.000 mm-1.000 mm		1.000 mm-0.500 mm	
Taxa	Total #	Taxa	Total #
Nematoda	113	Nematoda	149
Ostracoda	52	Ostracoda	8
Polychaeta	2	Polychaeta	1
Harpacticoida	21	Harpacticoida	93
<u>L. helgolandica</u>	5	<u>P. hermani</u>	43
copepodites	4	<u>L. helgolandica</u>	11
<u>P. spinosa</u>	3	<u>P. brevirostris</u> f.	8
<u>O. linearis</u>	3	copepodites	6
<u>R. rostrata</u>	2	<u>B. imus</u>	5
<u>P. hermani</u>	1	<u>O. linearis</u>	4
<u>P. brevirostris</u> f.	1	<u>Danielssenia</u> n. sp.	3
<u>E. dentatum</u>	1	<u>E. dentatum</u>	3
<u>Tisbe</u> sp.	1	<u>H. neglectum</u>	2
		<u>A. cinctus</u>	2
		<u>Ameira</u> sp.	2
		Cyclopoida	1
		?	1

IV. DISCUSSION

A. Species Distribution and Seasonal Fluctuations1. Castle Harbor Shallow (CHS)

The Castle Harbor Shallow fauna was typically reminiscent of beach psammon. The seven major inhabitant copepods, with the exception of Ectinosoma dentatum, were morphologically adapted for navigating the minute interstitial lacunae. The fine CHS sands, of uniform size, actually had much interstitial space, but because of the reduced size of the pores, the circulation of water between the grains was restricted and the common fauna reduced in size. The copepods were small, vermiform (Leptastacus macronyx, Praeleptosochra africana and Apodopsyllus africanus), or flattened and broad (Danielssenia n. sp., Paralaophonte brevirostris f., P. perplexa), and moved primarily by "wriggling" or "walking" over the sand grains. These are the true interstitial forms and must be distinguished from the two other meiobenthic modes of existence: "epipellic" (crawling on the sediment surface, at the mud water interface) and "endopelic" (burrowing into the sediment).

The small, bristle bearing nematodes, common CHS denizens, and the periodic appearance of tardigrades and archannelids, typically psammic representatives (Wieser 1959a, Delamare Deboutteville 1960) further substantiates the CHS-beach fauna affinities. There are no available data on the interstitial fauna of the beaches of Bermuda; a CHS-beach fauna comparison might prove enlightening.

Wieser (1959c) establishes median grain size limitations for different representatives of the psammic environment. He asserts that sand with a median grain size of 200 μ is the lower limit for the "interstitial" fauna; below 200 μ "burrowers" are the predominant forms. Since CHS was the only study station suggesting the beach environment, it was the only one to which Wieser's hypothesis could be applied. The station mgs was always 200 μ and, except for E. dentatum and some of the other migrant harpacticoids listed in Table 7, the fauna was typically "interstitial." In terms of the resident fauna, CHS represented a submerged beach.

The irruptive total population seasonal density pattern illustrated in Figure 8 was similar to that of most other stations with the exception of the maximum February abundance peak. At all other stations, BBF excepted, the low total population values were recorded during the winter, while the maximum abundance at CHS was recorded during February. This population increase was primarily dependent on the increased nematode fauna, particularly Monoposthia sp., and to a lesser extent on the harpacticoid Praeleptomesochra africana. Although the September peak was statistically invalid, a population increase peak during this month was common occurrence at most other stations.

Although the February total population peak was inconsistent with most of the other study stations, the inverse correlation between water temperature and maximum nematode numbers is not unusual as Hopper and Meyers (1967b) recorded the same phenomenon in Biscayne Bay, Florida.

The copepod, Praeleptomesochra africana, reached its maximum abundance in February (Figure 10), and the inverse water temperature-abundance relationship was present. At TI, the only other station where P. africana occurred in abundance, a similar January-February peak could be found.

The CHS environment, during the winter months, was under severe physical stress as evidenced by the increased ripple size. The predominant northerly winds, traversing all of Castle Harbor, agitated the shallow bottom continually. It is likely that the two abundant forms, the nematode Monoposthia sp. and the harpacticoid P. africana were the only forms able to cope with and flourish during the winter conditions.

The presence of relatively few harpacticoid species, as well as the succession pattern (Figure 10) is evidence of environmental homogeneity. Gause (1934) contends that two or more species cannot occupy the same niche simultaneously. If a particular taxonomic group is dominated by one species, the habitat is considered homogeneous, i.e., one niche. However, if several species are of equal abundance, the presence of different niches within the habitat is indicated. There appeared to be only one available copepod niche at CHS: the niche was always occupied, not necessarily by the same species, but rather by different species at specific times. This niche was first dominated by one species and then followed by another, whose breeding cycle and/or physiological needs were best satisfied under the environmental conditions which followed.

Environmental homogeneity was not indicated when the nematode

population was analysed. Several species were present in relatively equal abundance each time the station was occupied. Wieser (1960) found three or four more or less equally dominant nematode species in the sandy substrates in Buzzards Bay, and suggested that the sandy habitats were heterogeneous with respect to the nematode fauna. Indeed, the division of the CHS habitat into different nematode niches was indicated.

2. Castle Harbor Deep (CHD)

This sandy-silt sediment contained a distinct faunal assemblage. The fauna was primarily endopelic, with some epipels, but devoid of the interstitial components. All of the major harpacticoids were modified for the two major modes of existence. The predominant Diosaccidae (Stenhalia (D.) n. sp., Robertsonia knoxi, Bulbamphiascus imms, Typhlamphiascus lamellifer) and Ectinosomidae (Ectinosoma dentatum, Halectinosoma abrau, H. sarai) were all large (greater than 0.6 mm) and broadened at the cephalothorax, for the burrowing mode of existence. The Cletodidae, Cletodes dissimilis and Enhydrosoma propinquum, were the common epipels. Elongation of the limbs and furca allowed these species to crawl over the surface of this almost fluid mud without sinking.

The CHD nematode fauna was also characteristic of those found in mud bottoms. The elongated, spiraled linchomoeid (l.o.) and the phylogenetically related Comesomatidae (Comesoma sp. 1, Comesoma sp. 2 and Paracomesoma sp. 2) were typical mud-dwelling, burrowing nematodes. Wieser's (1960) Buzzards Bay survey has also indicated that species phylogenetically related to the above species were mud

dwellers. Linhomoeus buculentus and representatives of the Comesomatidae (Sabateria hirrlarula, S. ornata, S. vulgaris) were more abundant at his silt-clay station than at his sandy stations.

The various population density peaks (Figure 12) were due to increases in the different groups throughout the annual cycle (Appendix A2). Except for July, where sufficient data are not available, every nematode peak appeared to be related to the density of linhomoeid (l.o.). The September and late spring peaks recorded in Figure 12 are statistically valid; variations within the December and July samples were too great to warrant any conclusions. Disregarding the two months with large standard deviations, a regular seasonal cycle was evident. Minimal population and biomass values were well correlated with minimum temperatures. The spring peak was most likely related to warming waters and the triggering of the reproductive cycles, as evidenced by an increased number of copepod, nematode and priapulid larvae. Two factors stand out as being significantly different in September: (1) Beers and Herman (in press) report chlorophyll a concentrations (which they equate with phytoplankton standing crop) highest in September and (2) the sedimentary organic carbon values (Table 1) recorded during the present study were highest in September. If the increased phytoplankton and/or sedimentary organic carbon were not responsible for the population increase, then it is likely that some other undetectable intrinsic population control or environmental parameter not measured was involved. Regardless of the cause, the September peak was common at most other study stations and a similar population

increase was recorded at CHD in 1966 during a quarterly sampling program.

The interspecific seasonal fluctuations of the copepods (Figure 14 and Table 8) illustrate that the population was rarely dominated by one species. Even when the total yearly values are used, there is only a 14.5% difference in the first ranked species, Stenhelia (D.) n. sp., and the tenth ranked species, Enhydrosoma stylicaudatum, and a 7.1% difference in the abundance values of the first and fifth ranked species, Enhydrosoma propinquum. (See Table 8, page 59, for actual numbers.) The indication of environmental heterogeneity, more than one available niche, is evident. Associated with the species diversification is the unique seasonal succession pattern. Although rarely completely absent from the fauna, each species alternated (successionally) as the dominant form. The two most obvious CHD copepod niches were the endopelic and epipelic. The harpacticoids occupied both niches and possibly others which have not yet been described.

At CHD, where relative equal abundance of several harpacticoid species indicated different niches, the nematode fauna indicated the opposite. This fauna was dominated by linchomoeid (l.o.). Wieser's (1960) analyses of the Buzzards Bay nematode population were similar, one dominant species at the mud stations (in this survey, CHD-DH), and several equally abundant species at the sand stations, suggesting the occurrence of a varied and different assortment of nematode niches.

3. Baileys Bay

As illustrated in Figure 5, the dye marked summer bottom tidal

currents flowing into the bay fastidiously avoided the grass beds and flowed only over the sand patches. Bottom current velocities of 15 ft./min. were recorded. Dye that had "leaked" out of the weighted polyethylene bags and was dispersed on the surface spread in a unidirectional sheet over the entire bay, grass beds included, at 5-12 ft./min. As previously noted, the BBC sediment was vertically stratified; the coarse material restricted to the upper 2 cm, the 0-2 cm sorting coefficients below 2, and 0-2 cm silt-clay percentages lower than the >2 fraction. It is apparent that the bottom tidal flow (15 ft./min.) was scouring the sandy bottom and removing the fine silt-clay material purely by mechanical means. With the removal of the finer material from the top 2 cm of sediment, the resultant sediment was a well sorted coarse sand. Evidence that the scouring process is not effective below 2 cm was the higher silt-clay percentages and the prevalence of finer sediment (medium sand, similar to that at BBF).

It has been established that a seagrass community is effective in modifying sediment deposition by stabilizing the sand-sized material and trapping fine sediments through the baffle effect (Ginsburg and Lowenstam 1958, Odum 1966). The data available from this survey are in agreement. The grass beds at BBF trapped the finer silt-clay particles as evidenced by the BBF "Summer Condition" silt-clay percentages, grain size distribution curves and median grain size.

The "Summer Condition" sediment distribution pattern remained until a directional change in the predominating winds. The predomi-

nant "Winter Condition" northerly winds maintained the shallow bay in turmoil. Suspended sediment, rippled bottom, increased sorting coefficients, increased silt-clay sized particles and the removal of 3-5 cm of sand at BBC as well as the "covering over" and reduced silt-clay at BBF were the results of the northerly winds.

a. Baileys Bay Coarse (BBC)

The taxa at both stations (BBC-BBF) were controlled by the environment. At BBC interstitial harpacticoids were the dominant forms during the "Summer Condition," whereas nematodes were dominant in the winter. Three interrelated factors appear to be significant in governing the most abundant form. Firstly, total population values dropped during the winter. The lower population values were primarily due to the decreased number of harpacticoids and not nematodes, in that, the total population-biomass curves (Figure 17), except for the anomalous August samples, were similar in nature to the percentage harpacticoid curve (Figure 18). Harpacticoid percentages and the total population were lowest in the winter when water temperature was at its lowest point. Minimum values at minimum temperatures is suggested. Secondly, the BBC "Winter Condition" sediment characteristics were first found in December, the same month the harpacticoids ceased being the dominant form. The nematodes remained first in abundance through March; however, with the return of "Summer Condition" characteristics in April, harpacticoids again became dominant. When the well-sorted, coarse grained "Summer Condition" sediments containing 50% water were common (factor two), optimum space for the interstitial copepods was

prevalent. During the "Winter Condition," the silt-clay filled interstices excluded the interstitial harpacticoids and the environment was most suitable for nematodes (both burrowers and those capable of maneuvering in the smaller lacunae). Even though the percent copepod abundance curves (Figure 19) illustrate dominant species, total numbers were low. This is indicative of niche elimination and simple species survival on the part of the copepods. Thirdly, the factor of intrinsic population control must be considered. Reduced inter-taxa competition and the ability to cope with the winter stress environmental conditions are possibilities for the nematode dominance.

In summary, all three factors were interrelated. The temperature decreased, the sediment was altered, the harpacticoids disappeared, and the nematodes reached a population peak shortly after they became the predominant form. As previously mentioned, the change in population dominants was most likely dependent on the external physical controls: factors one and two. The nematode population, once established as dominant in the winter with reduced inter-taxa competition, and suitable environmental conditions, reached a February-March peak as the minimum temperature-maximum number relationship evident at CHS was approached.

The BBC seasonal total population cycle (Figure 17) indicated a regular pattern. It is likely that the June 1967 and the April 1968 population increases represented the same seasonal peak, i.e. late spring-early summer. Weather data from Kindley AFB indicated that the 1967 spring weather was "the worst in many years," (high

winds, rain, and cold temperatures) and did not "break" until late May. It appears that the late spring 1967 population maximum was delayed until June, whereas the favorable warming temperatures in spring 1968 triggered the peak in April. Both maxima were dominated by the copepod Phyllopodopsyllus hermani. Although data were not available for the months preceding June 1967, it is assumed that harpacticoid nauplii and copepodites were as common as they were prior to the April 1968 peak. Maximum populations are well correlated with warming waters, minimum populations and nematode maxima with colder water (Figure 2c, Figure 17, Appendix A3).

September total population peaks were common at all stations except BBC. The peaks were results of both increased nematode and harpacticoid populations. While the BBC harpacticoids increased in September during "Summer Conditions," nematodes did not. Nematodes are known to be depleted during this time period. The absence of the nematode peak in September further substantiates the grain size - silt-clay percent - sorting coefficient - interstitial space hypothesis.

Another reason for the decreased September nematode values was the subsequent increase in polychaetes. Nematodes were common in the guts of meiofaunal polychaetes. The data were suggestive of a predator-prey relationship and is in agreement with that of Rees (1940), Perkins (1958) and Tietjen (1966), who noticed inverse relationships between the nematodes and nereid polychaetes.

The BBC copepod fauna was dominated by Phyllopodopsyllus hermani eight of the twelve times the station was occupied. Specific

breeding periods were detected: late spring (when the total population number was greatly affected by the increased numbers of P. hermani) and early fall (when the total population did not increase). At these times, other copepod species were essentially non-existent. It appears that P. hermani filled every available copepod niche. At other times of the year (August, in particular), the indication that the habitat is subdivided into many niches and each niche occupied by a different species is apparent. Niche elimination in the winter as one of the causes of low harpacticoid abundance levels has already been discussed.

The morphological adaptations so markedly distinct at CHS and CHD were also prevalent at BBC, with some minor alterations. The forms were interstitial, but were not as remarkably reduced in size as the CHS fauna.

P. hermani is small (0.38 mm long; 0.16 mm wide at the cephalothorax) and elongate (not vermiform) and well suited for locomotion in the larger median to coarse sand interstices. P. brevirostris f. has already been established as an interstitial form; however, the forms encountered at BBC were generally larger than those at CHS. Orthopsyllus linearis, Robertgurneya rostrata, Bulbamphiascus imus and Ectinosoma dentatum were larger species with a broad cephalothorax and adapted to the "endopelic" mode of existence. At BBC, however, these species occupied the niche associated with the large interstitial lacunae and did not burrow. O. linearis and E. dentatum were observed navigating the lacunae in sieved coarse grained shelly sands. Also, the results of the grain-size experiments

to be discussed later substantiated the findings.

As with CHS, the segregation of the BBC nematode fauna into separate niches was indicated. Several species were present in approximately equal abundance, especially during the "Winter Condition."

b. Baileys Bay Fine (BBF)

The types of species prevalent at both BBF and BBC were similar, but the species seasonal distribution pattern and total population fluctuations were not. The BBC gradual population decrease from the high June value to the low winter values has already been noted. Except for large population increases in September and February, essentially the same pattern was prevalent at BBF. (See results, p. 80, for an analysis of the November peak.) The large September population peak, as at all other stations (except BBC), was dependent on an increase in the nematode and copepod fractions of the population.

The characteristic "Summer Condition" higher silt-clay, reduced median grain size and proximity of the Thalassia bed at BBF were apparently the factors governing nematode dominance. Several of the nematodes were foliicolous: Euchromadora sp., E. gaulica, Prochromadorella spp. indicating the relationship to the Thalassia (Hopper and Meyers 1967a). The station was dominated by nematodes until September. In September, when no measurable changes in the environmental factors were noted, harpacticoids were able to coexist in equal abundance with the nematodes. The harpacticoids were therefore able to inhabit an environment which had previously seemed

unacceptable or, the environment was always acceptable but the specific September changes (chlorophyll a increase, or organic carbon increase) were necessary to trigger the population increase. The harpacticoids remained in high abundance through November. During November, when the harpacticoids were the ~~major~~ major organisms, the "covering over" was first in evidence and percentage silt-clay decreased. It is probable that the September-October population increase coupled with the addition of 3-5 cm of sand in November and the subsequent smothering of the nematode Thalassia root structure habitat were the reasons for the harpacticoid dominance.

The low harpacticoid numbers present during December and January were well correlated with the other stations, i.e., low harpacticoid numbers in the winter. The February increase in nematode numbers in the colder waters has already been discussed and appeared to be a regular occurrence. The February P. hermani increase was not peculiar to BBF, as the same phenomenon was noted at TI. BBF, in February, was more distinctly "Winter Condition" than at any other time. Unfortunately, grain size analyses were not made. However, observations of the organism samples and the in situ sediment indicated a coarse, shell ridden sand 8-10 cm thick overlying the Thalassia bed. It is suspected that this coarse grained sand was the most suitable "Winter Condition" habitat for P. hermani, even though they did not dominate the fauna. The remainder of the cycle was irregular: low in March, high in April then low in May. Both major groups (nematodes and harpacticoids)

fluctuated accordingly. The irregular nature of the curves (Figure 21) appeared to be dependent on two factors: (1) the change over from the "Winter" to the "Summer Condition" and (2) the well documented, ubiquitous spring population increase associated with warming waters. The development of the "Summer Condition" environment was initiated in April and May. The grass bed was uncovered, but the luxuriant and extensive cover prevalent during late summer was not yet in evidence. The bed was not yet functioning at its maximum silt-clay trapping ability. As the "Summer Condition" progressed, percent silt-clay increased; 8.0% in April, 14.0% in May, 15.4% in June and the high 29.6% in August. Apparently, the typical copepod spring population increase was not hampered by the so-called "Summer Condition" in the low silt-clay months of April and May, but as the interstices were filled with the Thalassia trapped finer materials, inter-lacunae navigation was impossible and the burrowing nematodes became dominant.

Overwhelming abundance of P. hermani in all but the June, July and August samples was indicative of one apparent copepod niche: the interstitial lacunae. When the interstices contain the silt-clay particles evident during the summer, two possibilities existed. Firstly, the environment was divided into distinct, separate niches; thus, the relatively equal abundance of species or secondly, the same niche was occupied by different species but eventually P. hermani gained superiority and the other species were excluded.

Again, the sandy environment nematode population was in agreement with Wieser's (1960) observations. The change to distinct

and separable niches was evidenced by the relatively equal abundance of species (Appendix B5).

4. Trunk Island (TI)

The Trunk Island medium sand harbored essentially the same type of fauna as the Baileys Bay stations and the copepod population was dominated by P. hermani; other species were always minor components. Again, the possibility of a single copepod niche is suggested.

The copepods were primarily interstitial forms. The reduced size of the interstitial lacunae appeared to govern the abundance but not the type of species common. It is apparent that the median sands prevalent at BBF and TI, as well as the coarse BBC sand, were suitable for the habitation of interstitial forms. However, copepods were more abundant than nematodes only during P. hermani breeding periods.

The seasonal total population curve was regular: the September and spring population maxima occurred as at the other stations. Preceding and following the maxima, the population increased and decreased accordingly. Minimum total populations were found in the winter, but the typical winter increase in nematode numbers was noted in January, and not February. January water temperatures were the coldest recorded at Trunk Island. The explanations of the total population and nematode peaks are similar to those at the other stations, i.e., September changes, maximum nematodes at minimum temperatures, and spring warming of waters.

As with BBF, copepod dominance was noted during the winter (TI,

December; BBF, February; even though the TI total population values did not increase in December), and again in the spring (when population values increased). The harpacticoid dominance in December was dependent not only on the increased number of copepods (P. hermani) but also on the decreased numbers of nematodes, whereas the May dominance was strictly dependent on a three-fold increase in the numbers of copepods. The dominance peaks appear to be closely related to the reproductive cycle of P. hermani, since, preceding and during both population maxima, copepodites and nauplii were abundant.

In light of the data available on the seasonal abundance values of P. hermani from the three stations (BBC, BBF, and TI) where it is abundant, a specific life cycle becomes evident. Although the life cycles of several harpacticoids are known, there are no available data on any of the Tetragonicipitidae. Several life cycles have been elucidated in the laboratory: Johnson and Olsen (1948), Tisbe furcata; Fahrenbach (1962), Diarthrodes cystoecus; and B. Muus (1967), Tachidius discipes, Nitocra spinipes and Tisbe dilata. P. hermani exhibits tri-annual breeding, once in the early fall (BBC, BBF), once in the winter (BBF, TI) and once in the spring (BBC, BBF, TI). The BBC missing winter breeding has already been explained in light of changing environmental conditions. At BBC and BBF there were significant September increases in the number of P. hermani, while at TI the increase was prevalent but not as intense. Every time the P. hermani increase was noted, increased numbers of nauplii, copepodites and egg-bearing females were common. Each month preceding

the maximum population peak, the number of unidentifiable nauplii outnumbered total copepods found. This points to a maturation process of less than 30 days. Further laboratory observations would be needed to substantiate this, as well as the number of generations per female, the developmental anatomy and the fecundity.

The TI nematode fauna is once again indicative of segregation of the inhabitants into distinct and different nematode niches in agreement with the findings of Wieser (1960).

5. Devils Hole (DH)

The absence of meiofauna at Devils Hole was related to the hydrography: the temporary thermocline from June to October and accompanying anaerobiosis. As the dissolved oxygen decreased over the summer, the population followed the same decreasing pattern until both total population and dissolved oxygen values were zero in September. With the convective overturn of the thermocline in October, the bottom waters were mixed. The fauna, however, did not repopulate the area until late spring and distance-time factors appeared to be involved.

The meiofauna nearest to Devils Hole proper during the summer were located at the Upper Devils Hole substation (p. 100): the outer horizontal edge of the existing thermocline. Since the Hole is 107 meters in diameter, once conditions were suitable the meiofauna had to migrate at least 53.5 m to inhabit the area. Most macrobenthos have pelagic larvae which are carried by water movements into different areas. However, the benthic copepods and nematodes have bottom larvae and movement is only possible along the bottom.

Therefore some time would be expected in repopulation of a depleted area. Tulkki (1965) has noted that macrofaunal communities decimated by oxygen deficiency in the Baltic Sea have taken several years to recolonize after the influx of the oxygen rich waters, and many of these had pelagic larvae. Under the circumstances, the seven month interval between thermocline overturn and repopulation by meiofauna at DH must be considered rapid.

Shortly after the population was established, the thermocline was set up and the accompanying anaerobiosis decimated the population. The observations based on three years of sampling (July 1965-June 1968) indicated that this cycle was repetitive.

The two copepods found at Devils Hole during the spring, Longipedia helgolandica and Enhydrosoma propinquum, were both well suited for the environment. L. helgolandica was recorded at every station; it is one of the harpacticoids that belong to the natant fauna. Gonzales and Bowman (1965) collected the species in plankton tows in Bahía Fosforescente and assert that this form frequently swims freely just above the mud water interface. It is suspected that its Devils Hole existence is similar. E. propinquum has already been established as a common mud form leading an "epipellic" existence.

6. General

The species fluctuations and seasonal succession patterns of the meiofauna at all stations were in agreement with the work of Parker (1966). He states that temporal fluctuations in megafauna (macrofauna) in Buzzards Bay, Massachusetts were well correlated

with seasonal changes in the physico-chemical factors and amounts of benthic vegetation, but temporal meiobenthic fluctuations were closely tied to reproductive cycles and physical forces affecting the sediments. These same factors controlled the Bermudian meiobenthos.

B. Organism - Sediment Interrelationships

Field and laboratory results indicate specific grain size preferences of the Harpacticoida. Generally, a greater number of harpacticoids could be found in the coarser grained, low silt-clay sediments. The preliminary laboratory experiments have indicated that an optimum sand size was sought by the individual species. The fine grained study stations (CHS, CHD) excluded certain harpacticoid species, and favored an abundance of nematodes. The species prevalent at fine sediment stations were the same as those found in the fine grained sediments in Laboratory Experiment I (Leptastacus macronyx, the dominant CHS species). Wieser (1960), Baden (1962), Gray (1966) and Jansson (1967) have also indicated that certain interstitial species are limited in distribution due to their inability to colonize various grades of sand.

The medium to coarse grained sand stations (BBC, BBF, TI), although not necessarily dominated by harpacticoids, contained an increased harpacticoid fauna. As previously noted, the harpacticoids were more abundant in the low silt-clay percentage sands than in those where the interstices were filled. The median grain sizes at these three stations were between 0.5 and 1.0 mm; the same grain size range preferred by the majority of the copepods in both

laboratory experiments (Tables 14 and 15). In addition to median grain size, variation in the size and shapes of the grains are also important in governing the amount of interstitial space. Renaud-Debyser (1961) has pointed out that the irregular, angular biogenic origin carbonate grains, evident in the medium sands of Bermuda, allow for increased interstitial space. If the spaces are filled with small mineral and detritus particles, the small weight change of the fine particles makes little difference to median grain size, but the closure of the interstitial lacunae eliminates many of the interstitial forms (Boaden 1966).

The distribution of P. hermani in the well sorted laboratory sands was indicative of its grain size preference, and again was confirmed by the field results. To test the hypothesis that the copepods were seeking an optimum grain size and not the coarsest sand available, Aquarium Experiment II was initiated. The results again confirmed that P. hermani preferred the 0.5-1.0 mm sands. The occurrence of Longipedia helgolandica as the first or second most abundant form in all the samples is congruous with its semi-planktonic mode of existence: the ability to swim over all sediments. Bulbamphiascus imus, Robertgurneya rostrata and Orthopsyllus linearis were also more abundant in the 0.5 mm sand than in the others, indicative of their preference for sand with interstices large enough to permit maneuvering.

It is difficult to compare the present grain size-harpacticoid results with those of other studies as most other meiofaunal studies have been dominated by nematodes to such an extent that harpacticoid

numbers were insignificant. However, Wigley and McIntyre (1964), working off the New England Coast, recorded the highest copepod abundance (35%) at the station with the greatest median grain size (1.4 mm), and the next highest copepod abundance (14.0%) at the second most coarse station (mgs 0.58 mm), while at the remaining fine sand-silt stations harpacticoids were absent or in very low abundance. Similar relationships are apparent in the psammic environment. Renaud-Mornant and Serene (1967), in a beach survey in Malasia, noted that only one of their stations was dominated by harpacticoids: the station with a mgs of 0.77 mm, low silt-clay percentage, a low sorting coefficient (1.4) and 43% calcium carbonate. Kline (1968) in Miami, Florida, has also indicated that the greater median grain sized low silt-clay sands harbored an increased harpacticoid fauna. Noodt (1957) found that the grain size was less significant to bottom copepods than the amount of organic matter available in some psammic and estuarine environments in Germany. The only harpacticoid-organic matter relationship obvious in the present survey was the increased number of forms in September; no indication to harpacticoid-dominance at high sedimentary organic levels was evident.

The other major meiofauna taxa, nematodes, were restricted in the organism-sediment interrelationships portion of the study to analyses of buccal structure and associated feeding groups. Deposit feeding nematodes, selective and non-selective, were dominant at the mud stations, while epistrate feeders were dominant at the sandy stations. The predominance of the deposit feeders

at the mud stations was to be expected: the soft sediments, higher in organic content, were not suitable for the existence of the epistrate feeders since the hard particles necessary for scraping were not available.

Wieser (1953, 1959b) recorded omnivore-predators (not epistrate feeders) as the dominant forms in Germanic and Chilean "littoral" sands: those coarse and poor in deposits. Tietjen (1966), however, found that epistrate feeders were the most abundant forms in the sands of two New England estuaries, and was able to relate this predominant feeder to the benthic diatom population. Preliminary results of White (1967) and personal observations have indicated that the Bermudian carbonate sands are not rich in benthic microflora and, in fact, when compared to quartz sand areas are impoverished.

It is suspected that the preponderance of epistrate feeding nematodes in the carbonate sands of Bermuda, where benthic microflora production was reduced, was dependent upon the availability of the carbon rich aggregated coatings.

Chave (1965) and Chave and Suess (1965) have reported organic coatings associated with suspended carbonate particles in seawater and that these coatings often interfere with the precipitation kinetics of the carbonate-seawater interactions. Suess (1968) has been able to show that carbonate sands and muds are also coated with the carbon rich aggregated particles. Suess (personal communication) asserts that the only available data on organic coatings of quartz grains is the work of Lidström (1965) which indicates that

some specific amines do form a chemical bond with the surface of quartz between pH8 and 11. However, Suess comments: "Those 'coatings' reported by Lidström and others ... are on the order of 50 to 100 Å thick, and a grain scraping nematode must have a hell of a good scraping apparatus to make any use out of the organic layer, furthermore it must work over quite a number of grains per day to survive. What makes perhaps the carbonate grains such a delicatessen for the nematodes is the fact that they tend to aggregate organic matter into thick, visible, stainable layers. Aggregation of organic matter on silicate grains is completely unknown." Further studies to determine the minimum organic diet with which the nematodes are able to live satisfactorily would be necessary in order to determine the specific nutritive value of the coatings.

The seasonal relationships between the other feeding groups and sediment-population characteristics were not consistent except for the increase in omnivore-predators during or immediately following the periodic total population peaks. There was no correlation between the percent abundance of deposit feeders at the sandy stations during the September high sedimentary organic matter values and the increased and decreased silt-clay contents.

C. Vertical Distribution

The harpacticoids and ostracods at all stations were restricted (except for a few migrant forms) to the upper 2 cm of sediment. The nematodes showed less vertical stratification, but 94.3% were restricted to the upper 5 cm.

Previous studies on the vertical distribution of the meiofauna have shown that the lower limit for most meiofaunal organisms, except nematodes, was 2 cm (Moore 1931; Krogh and Spärck 1936; Mare 1942; Bougis 1946, 1950; Smidt 1951; McIntyre 1961; Wieser and Kanwisher 1961; and Tietjen 1966), with the majority of the nematodes confined to the upper 4 cm and reaching a lower limit of 6 to 8 cm. Moore (1931), Smidt (1951), McIntyre (1961) and Muus (1967) found harpacticoid copepods confined almost entirely to the upper cm of sediment while Tietjen (1966) indicates that the copepods were restricted to the upper 2-3 cm of sediment. The fauna from Bermuda also fit within the vertical limits of all these authors.

Three factors appear to be most significant in governing the vertical distribution of the fauna: (1) a decrease in interstitial water content with depth, (2) a decrease in amount of available oxygen with depth and (3) the mode of existence: endopelic, epipelic, interstitial.

At the two stations (CHS, TI) where no difference in 0-2 and >2 cm interstitial water values was noted, the sediment below 3 cm was discolored and H_2S was evident at 5 cm (TI). Teal and Kanwisher (1961), working in salt marshes, noted that sediment color changed with a change in Eh, lowest potentials were found in areas where organic matter accumulated due to insufficient aerobic composition, and H_2S was often prevalent as indicated by its odor. Baas Becking *et. al.* (1960), Wieser and Kanwisher (1961) and Kanwisher (1962) assert that the greatest potential

change is at 2 cm depth, due to the large drop in O₂ concentration. At GHS and TI, only those nematodes which were able to withstand certain periods of highly reduced conditions were able to exist in the lower confines.

At the stations where water content values decreased at the >2 cm segment level all three factors were important. At CHD the epipels were obviously not affected by the reducing conditions prevalent at 2-3 cm. Whereas the endopels were in turn affected by both a reduction in amount of interstitial water (responsible for the "stiff" muds below 2-3 cm) and the reduced conditions evident from a color change (from gray mud, 0-2 cm, to dark brown-black mud below 2 cm) and the overpowering H₂S odor emanating below 5 cm. At BBC, the large amount of interstitial water and large interstices in the 0-2 cm segment, along with a reduction in grain size, increased silt-clay, reduced water content and discoloration below 2 cm, were all responsible for the prevalence of the interstitial forms in the 0-2 fraction during the "Summer Condition." The BBC 2-5 cm population values were higher during the winter than at any other time of the year. In February, 41.9% of the fauna was encountered in the 0-2 cm segment, while 41.0% was in the 2-5 cm segment. The change to increased interstitial water and thus the ability of the population to inhabit the 2-5 cm segment is obvious. The discoloration, so evident of reduction, was not prevalent until the 7 cm level.

At BBF, where the >2 cm water content was always more than the 0-2 cm fraction, another factor was important. The increased

water content was caused by the intertangled Thalassia roots and root debris. However, a color change and H₂S odor was most noticeable at this station and was most likely due to the decaying root structure. It is likely that the increased water content was not as important as the strong reducing conditions in governing the vertical distribution of the fauna.

D. Species Diversification and Community Relationships

1. Species Diversification

Sanders (1967) discusses two contrasting abstract communities, the Physically Controlled Community (P.C.C.) and the Biologically Accomodated Community (B.A.C.). The P.C.C. is one where the adaptations of the inhabitants are primarily to the physical environment and where wide changes in the physical conditions expose the animals to severe physiological stress. Physically controlled environments are characterized by low diversity and often subsequent dominance by the one species which is best able to cope with the environmental conditions. The B.A.C. is present where physical conditions are rather constant and uniform and are not critical in controlling the success or failure of a particular species. He claims that "with time, biological stress (intense competition, non-equilibrium conditions in predator-prey relationships, simple food web, etc.) is gradually mediated through biological interactions resulting in the evolution of biological accomodation." The resultant assemblage is characterized by high diversity and relatively equal abundance of several stenotopic species.

The pure B.A.C. or P.C.C. is never present in nature. All communities are the result of the physical and biological components

and the relative proportions of each determines the community structure.

Sanders (1967) found that the closer the diversity curves approach the ordinate, the nearer the B.A.C. is approximated, while the closer the curves approach the abscissa the nearer they approximate the P.C.C. The curves can also be applied to a Stress-Time Model. In those communities where physiological stress has been historically low, the B.A.C. exists, while those where physiological stress has been high the P.C.C. exists. If an environment is one of an increase in the amount of physiological stress (as a result of increasing physical fluctuations or unfavorable physical conditions) the community will gradually change from one of Biological Accomodation to one of Physically Controlled, reaching an abiotic condition when the stress conditions are greater than the adaptive means of the animals.

In the current study, each station had its own unique diversity curve (Figure 30), indicating specific biological organization dependent on the proportions of the physical and biological components prevalent. The one particular station (CHD), where physical conditions (with the meiofauna, sediment granulometry) were constant over the year, the Biologically Accomodated Community was approached. The large number of species per unit number of individuals (high diversity) was indicative of a community dependent on intrinsic biological regulation (inter-specific competition, predator-prey relationships, niche diversification, etc.) and not external physical control. Rarely does one harpacticoid species

dominate the entire CHD population, but rather, due to the constant physical conditions, the community was an equal mixture of several species; typically high diversity in an area of low physical stress. Application of the temporal factor of the Stress-Time Model indicates a more evolutionary advanced harpacticoid community, having passed through the preliminary stages of physical stress and now modulated by biological control.

At CHS, EBC, BHF and T1 (the sand stations) copepod diversity was lower. The first three environments mentioned have already been discussed in relation to changing environmental conditions. These were environments subjected to severe physical conditions. At T1, however, where no change in the measured environmental conditions was noted, the same low diversity prevailed.

Although the nematodes were not subjected to an analysis of diversity, it is apparent from the somewhat fragmentary data that the converse of the harpacticoid distributions prevailed, i.e., one dominant species at the mud station, several equally abundant species at the sand stations. It must be assumed that nematode diversity is not governed by physical conditions, but rather, on the separation of the habitat into "microhabitats" which the nematode fauna can occupy regardless of environmental stress. It is suspected that within sandy habitats the three different sources of food, (1) sand grain epigrowth (carbon rich aggregates, benthic diatoms), (2) interstitial deposits and (3) interstitial fauna as prey, represent three distinct niches which the nematodes occupy regardless of the external physical factors. The mud station,

dominated by one species (suspected low nematode diversity), represented only one available food supply - deposits. This suspicion was supported by the very low numbers of epistrate feeders at CHD (4.0%), while at the sandy stations, the two deposit feeding groups (1A and 1B) comprised 23.1% of the fauna, and the omnivore-predators 35.3%, even though the epistrate feeders were most dominant. Both minor groups were filling their "microhabitat" successfully.

Since the harpacticoid population appeared to be dependent on physical stress conditions, and the nematodes were most likely dependent on the available food supply regardless of the stress, analyses of meiofaunal population diversity in light of a Stress-Time Model is best exemplified by an examination of the susceptible harpacticoids.

2. Community Relationships

Any benthic community should be defined by combining the names of two of the characteristic species, in which case the species should belong to different groups (Peterson 1913). Sanders (1958) reiterates the definition and defines the community as a group of species that shows a high degree of association by tending to recur together. The CHD harpacticoid community may be defined as the Stenhelia (D.) n. sp. - Cletodes dissimilis community: a highly diverse assemblage. The two forms belong to two different families: the Diosaccidae and the Cleotodidae. Although the community has been defined, the definition must be regarded with caution since CHD was the only example of carbonate

muds.

The beach-like CHS environment was one of severe stress: tidal activity, rippled bottom, etc. The probable copepod community (again, an isolated station as CHD), may be defined as the Leptastacus macronyx - Praeleptomesochra africana assemblage, but, perhaps more accurately, simply as the L. macronyx community. P. africana, although second in overall abundance, was a significant member of the population only in February, while L. macronyx was common in all but one month.

The other three sandy station assemblages (BBC, BHF, TI) were characterized by the overwhelming abundance of Phyllopodopsyllus hermani. The shallow, medium to coarse Bermudian carbonate sands appeared to harbor the same type of fauna. It therefore seems reasonable to designate this community the Phyllopodopsyllus hermani community and not one named by two species.

The communities at these medium to coarse grained stations characteristically exhibited low diversity, due to dominance of the one species. The changing environment in Baileys Bay obviously exerts severe stress conditions on the population and P. hermani appears to be the only form that can adapt and flourish under these circumstances. Thus, the dominance of one species and the subsequent low diversity values.

The Trunk Island community was a different situation. From the environmental parameters measured, the physical conditions at TI remained constant. There must be another environmental factor not considered in the present survey which was responsible for the

dominance of P. hermani and the low diversity. Abbott and Jensen (1967) have noted that the Bermudian Calico Clam (Macrocallista maculata) is found only in Harrington Sound, Janssen (1967) has found populations of the common Bermuda sea urchin, Lytechinus variegatus, in Harrington Sound significantly different in sex ratio, color and size from those of outside areas and Herman and Beers (in press) have found that while two species of the pelagic copepod Arcatia are common in Bermuda, A. bermudensis is restricted to Harrington Sound and A. spinata to the outside waters. These data indicate that the phenomenon is not peculiar to the meiobenthos.

Thorson (1957, p. 504) has indicated that "Parallel-bottom communities" or "isocommunities" are the rule in the marine benthic biocoenose. Following this author, isocommunities are ecological parallels since "the same types of bottom are everywhere inhabited by species of 'parallel' animal communities in which different species, of the same genera, replace one another as 'characterising species.'" Thorson (1966) and Sanders (1967), however, assert that the concept of macrofaunal parallel level bottom communities does not hold true and must be radically revised for tropical and warm temperate bottoms. Sanders (1967) has also noted that benthic diversity in the tropics can be quite variable; as is the case in semi-tropical Bermuda, depending on the local physical stress.

Although there is some doubt and diametrically opposed evidence to Thorson's (1957) isocommunity concept with regard to warm water macrofaunal communities, the harpacticoid fauna of Bermuda supports the concept on the meiofaunal level. Por (1964a) has established

isocommunities for the Harpacticoida and states that in sublittoral muds, the leading forms almost everywhere are species of Bradya, Stenhalia, Haloschizopera, Enhydrosoma, Cletodes, Typhlamphiascus and Eurycletodes. Representatives of four of these seven genera were the predominant mud dwelling forms at CHD (Stenhalia (D.) n. sp.; Enhydrosoma propinquum; E. stylicaudatus; Cletodes dissimilis; Typhlamphiascus lamellifer along with the Bradya related Ectinosomidae).

Por (1964a) further states that the shell bottoms, typically carbonate sediments, are inhabited by Ryncholagena, Robertgurneya, Bulbamphiascus, and some of the Tetragonicipitidae (Phyllopodopsyllus). In an analysis of distinct faunal assemblages in "coralline sands" in the Mediterranean and Red Seas, Por found the harpacticoid populations were composed of the same fauna, plus the specific forms Amphiascopsis cinctus, Orthopsyllus linearis, Robertgurneya rostrata, Paralaophonte brevirrostris f. and Laophonte cornuta. With the exception of Ryncholagena, all of Por's carbonate "shell" sand fauna are the same genera and sometimes the same species prevalent in the Bermudian sediments of similar composition. Overall, the Tetragonicipitidae, represented by Phyllopodopsyllus was the most abundant family inhabiting the Bermuda "shell bottom."

Another indication of the so called "isocommunity" was the "beach fauna" at CHS. Por (1964a) notes that typical psammic representatives are Leptastacus spp., while Kunz (1951, 1962) notes that certain members of the Leptomesochra group of the Amsirdae and of the Paramesochridae are distinct psammic species. The occurrence

of Leptastacus macronyx, Praeileptomesochra africana and Apodopsyllus africanus primarily at CHS is indication of a psammic isocommunity.

Except for the indication to world wide distribution of the mud community and its related genera, the distribution of the shell bottom fauna is restricted to those tropical, semi-tropical, warm temperate carbonate sediments of biogenic origin. However, from the small amount of data available from eulittoral carbonate sands, the indication is to a few representative genera and agreement with Thorson's earlier concept of the isocommunity.

E. Comparisons With Other Areas (Table 16)

It is extremely difficult to compare the fauna of Bermuda to those of other areas of the world, primarily because of the differences in sediment composition: quartz vs. carbonate.

From the data available, it appears that the carbonate sands, because of the irregularly sized biogenic particles, harbor an increased number of harpacticoid copepods. Of course, specific variations do occur, but harpacticoids rarely dominate in quartz sands, whereas the occurrence of harpacticoid dominance in the medium to coarse carbonates was not unusual.

The mean total number values from Bermuda were in agreement with those of Boug's (1950) and Wieser (1960), but were in the lower limits of the other surveys. Mare's (1942) values are suspected of being too low (Wieser 1960) and since her biomass values are not consistent with the number values, a comparison with her values is excluded. Of all the other surveys, the estuaries harbor the largest meiofaunal populations (Smidt 1951; Tietjen

TABLE 16. SUMMARY OF QUANTITATIVE SUBTIDAL MEIOFAUNAL RESULTS FROM DIFFERENT AREAS

<u>Author</u>	<u>Locality</u>	<u># org. x 10⁴/m²</u>	<u>DRY Wt., mg/m²</u>	<u>% Nematodes</u>
Mare (1942)	Plymouth, England (45 m)	14.7	287	59-66
Bougis (1950)	Bay of Lyon, Mediterranean (30 m)	66.3	—	66-76
Smidt (1951)	Danish Wadensea (6 m)	190.9	2500	55
Wieser (1960)	Buzzards Bay, Mass. (18 m)	17-186	100-600	89-99
McIntyre (1964)	Loch Fladen (146 m) Scotland Loch Nevis (101 m)	54-316	659-1601	61-97
Wigley and McIntyre (1964)	Atlantic Ocean off Martha's Vineyard, Mass. (40-465 m)	12.2-98.8	150-1139	39-94
Tietjen (1966)	Estuaries (Conn., R.I.) (2-3 m)	220.0	6250	83
Muus (1967)	Danish Estuaries (3-40 m)	130.3	—	60
Present Study	Bermuda (2-27 m)	0-133.0	0-259	22-98

1966; B. Muus 1967).

Comparing the numbers and biomass values of the two major non-estuarine meiofaunal surveys, both Bermudian values approach the lower limits recorded by McIntyre (1964), while maximum Bermudian biomass values are close to Wieser's minimum values. The inference is to the lighter weight harpacticoids, which comprise a greater percentage of the Bermuda meiobenthos, reducing the total biomass values.

There appears to be, in general, a reduction in the number and biomass of the Bermudian meiofauna. Tietjen (1966) indicates that shallow waters often support more meiofauna than deeper waters. However, this is not necessarily the case in Bermuda. The present study was conducted in shallow water, and the values recorded were in the lower range of most previous surveys.

Chave et al. (1962) found numbers of macrofauna significantly lower on the Bermuda slope than on the North American continental shelf and slope and attributed this to a ten fold decrease in the amount of organic carbon. Nutrient and plankton studies in and around Bermuda (Menzel and Ryther 1960; Deevey 1962; Grice and Hart 1962; and Herman and Beers, in press) have indicated that the nutrient poor Sargasso Sea harbors a reduced zooplankton population when compared to temperate or boreal waters. Renaud (1955) has also indicated reduced numbers of psammon in the carbonate environment (Bahamas), which she also attributes to lower available organic carbon. The data from the present survey is in agreement with these previous studies in that the meiofaunal

population was also reduced.

F. Zoogeography (Table 17)

As stated by Walls (1967, p. 354), "any attempt to rationalize the zoogeography of meiobenthic copepods suffers from a lack of data from large parts of the world. Most of the work to date is European and, while there is adequate data from the Atlantic coasts of Europe and considerable information on the Mediterranean littoral, no other area has been adequately studied." The present study has increased the number of species known from Bermuda and expanded the distribution list of others.

Of the 57 species for which previous records were known, 29 were new to Bermuda. 4 species, however, have not been recorded elsewhere and appear to be strictly Bermudian.

Those species listed as most probably cosmopolitan would have been listed with the North Atlantic forms, except for a single listing of each species in the Pacific.

Significant changes in distribution records are noted for Halectinosema neglectum and Typhlamphiascus lamallifer. These had previously been recorded as strictly boreal forms.

Per (1964a) mentions "Bermudian-Mediterranean affinities" in light of his work and Willey's (1930, 1931, 1935) papers on the Bermudian harpacticoids. The present survey indicates that these associations are not as distinct as previously thought. Several of the species listed by Per have now been found elsewhere and belong to either the cosmopolitan, warm temperate or the North Atlantic-Mediterranean zoogeographical groups. Per (1964a) lists

TABLE 17. ZOOGEOGRAPHY OF THE MEIOBENTHIC COPEPODS OF BERMUDA

1. Cosmopolitan species

(a) previously known as cosmopolitan

*Tisbe ensifer
*T. gracilis
T. furcata
*Scutellidium longicauda
*Phyllothalestris mysis
Rynchothalestris rufocincta
*Dactylopodia tisboides
*Paradactylopodia brevicornis
*Parastenhelia spinosa
*Amphiascopsis cinctus
*Bulbamphiascus imus
*Robertgurneya similis
*Amphiascoides subdebilis
*Ameira parvula
*Laophonte cornuta
*Paralaophonte brevirostris f.

(b) most probably cosmopolitan

Amphiascoides debilis
Amphiascus varians ?
Phyllopodopsyllus furciger
Enhydrosoma propinquum

2. Warm temperate and tropical

Ectinosoma dentatum
Harpacticus nicaeensis
Tisbella timsae
Eudactylopus latipes
*Dactylopusia falcifera
Diosaccus valens
*Robertsonia knoxi
*Robertgurneya rostrata
*Metis holothuriae
*Nitocra affinis
Scottopsyllus pararobertsonia
*Laophontella armatus
*Lourinia armata

3. North Atlantic

Longipedia helgolandica
Halectinosoma neglectum
H. sarsi
Arenosetella spinicauda
Harpacticus obscurus
*Amonardia phyllopus
Typhlamphiascus lamellifer

4. North Atlantic-Mediterranean

Halectinosoma abrau
*Amphiascus parvus
Ameiropsis nobilis
Sarsameira parva
Leptastacus macronyx

5. Endemic to Bermuda

*Diagoniceps laevis
*Cletodes dissimilis
*Enhydrosoma stylicaudatum
*Paralaophontodes echinatus

TABLE 17. ZOOGEOGRAPHY OF THE MEIOBENTHIC COPEPODS OF BERMUDA (Cont.)

6. Uncertain (with previous record)

Flavia crassicornis (New Zealand)
Nitocra fallaciosa (Barents-Sea, Portugal)
N. fragilis (Norway)
Praeleptomesochra africana (S.W. Africa)
Apodopsyllus africanus (S.W. Africa)
Orthopsyllus linearis - taxonomy doubtful
Paralaophonte perplexa (Norway, Iceland, Spitzenberg)

* previously recorded from Bermuda

a new species of Laophontella (L. horrida) and emphasizes that the type species (L. armatus) was known only from Bermuda. Sewell (1940), Wells (1967) and Geddes (1968) have now recorded L. armatus from the Maldiva Archipelago, Mozambique and Rimini respectively: the species (and perhaps the genus) is now "warm temperate-tropical" and not "Bermudo-Mediterranean." Por also lists Robertgurneya rostrata and Amphiascoides subdebilis as characteristic "Bermudo-Mediterranean" forms. Vervoort (1964) has recorded R. rostrata from the Caroline Islands, and Wells (1967) from Mozambique. Por (1965) has recorded A. subdebilis from Norway and Wells (1967) has recorded it from Mozambique.

The zoogeographical ranges of the harpacticoids will continue to change as more areas are studied. Several of those species, supposedly restricted, will most likely join the ranks of the cosmopolitan forms.

SUMMARY

1. The distribution and abundance of subtidal meiofauna (benthic animals which pass through a sieve with a mesh opening of 0.5 mm, but are retained on a sieve with an opening of 0.0062 mm) were studied from June 1967 through May 1968 at six stations on the Bermuda platform; two in Castle Harbor, two in Baileys Bay and two in Harrington Sound. Total number of individuals ranged from 0-133.3 x 10⁴/m² and dry weight biomass from 0-259.3 mg/m².
2. Free-living nematodes were the most abundant organism at all but one station. Overall they averaged 72.6% of the total numbers and 71.8% of the biomass.
3. Harpacticoid copepods were second in overall abundance, and were the predominant organism at one station. Ostracods, polychaetes, priapulids, halacarids, bivalve larvae, archannelids, kinorhynchs, turbellarians, cumaceans, tanaidaceans, amphipods, isopods and tardigrades were also collected.
4. 66.9% of all the fauna collected was located in the upper 2 cm of sediment, 24.2% between 2 and 5 cm, 7.0% between 5 and 7 cm and 1.9% below 7 cm. Possible causes of vertical stratification were discussed: most important were interstitial water and oxygen content.
5. Three distinct environments were found: a well rounded "beach sand" with typical psammic representatives, a poorly sorted carbonate mud and a medium to coarse grained sand.

6. The meiofauna had distinct seasonal patterns, minimum total population values were generally recorded in the winter, maximum values in late spring. Nematodes often reached maximum values in winter (January-February) and were correlated with minimum temperatures.

7. The periodic disappearance and repopulation of Devils Hole, Harrington Sound was related to the hydrography of the area: temporary thermocline and anaerobiosis.

8. The harpacticoids were more common in the medium sands and were the most abundant organism in the coarse sands. Field and laboratory results indicated specific grain size preferences of harpacticoid species.

9. Sixty-six species of harpacticoid copepods were collected during the survey, five of which were new species. Phyllopodopsyllus hermani mihi was the most abundant form encountered. The three environments were inhabited by distinct and different harpacticoid assemblages.

10. At the stations where harpacticoids were present in significant numbers, seasonal changes in taxa dominance (Nematoda vs. Harpacticoida) were well correlated with reproductive cycles and physical forces affecting the sediments.

11. One hundred and ninety-seven species of nematodes were identified. Nine of these were new species.

12. The nematodes were divided into four basic feeding groups (selective deposit feeders, non-selective deposit feeders, epi-growth feeders and omnivore-predators) on the basis of their buccal

cavities. There was good agreement between the distribution of various feeding types and the substratum at each station. Deposit feeders were most abundant at the silt-clay station and epigrowth feeders at the sandy stations. Epigrowth dominance was probably the result of the carbon rich aggregated particles known to be coating carbonate sediments.

13. Diversity analyses of the harpacticoid populations in light of a Stress-Time Model indicated more highly evolved, stable assemblages (several species of equal abundance) in those areas of low physical stress and less stable assemblages (one predominant species) in areas of high physical stress.

14. Nematode populations indicated the opposite of the harpacticoid populations and appeared to be related to separation of the habitat into "microhabitats" on the basis of available food, and not environmental stress conditions.

15. Three distinct harpacticoid communities were defined: (1) the Leptastacus macronyx (T. Scott) - Praeleptomesochra africana (Kunz) community in the well rounded "beach sand"; (2) the Stenhalia (D.) n. sp. - Cletodes dissimilis (Willey) community in the muds and (3) the Phyllopodopsyllus hermani mihi community in the medium to coarse grained sands.

16. All three communities agreed with Thorson's (1957) concept of the "parallel level bottom community."

17. When compared to previous meiofaunal surveys, the Bermudian meiobenthos was reduced in both numbers and biomass. The reduced values were in agreement with other studies indicating

lower populations in the nutrient poor Sargasso Sea.

18. Twenty-nine harpacticoid copepods were new to Bermuda. Significant changes were noted in the distribution records of several species. The meiobenthic copepods were separated into 6 distinct zoogeographical groups: (1) cosmopolitan, (2) warm temperate and tropical, (3) North Atlantic, (4) North Atlantic-Mediterranean, (5) Endemic to Bermuda and (6) uncertain.

APPENDIX A1. CHS - MEAN NUMBER OF MEIOFAUNA COUNTED FROM REPLICATE CORE SAMPLES (9.62 cm²)

	1967						1968						Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
Nematoda	418	512	515	704	404	598	530	469	876	397	470	548	6441
Harpacticoida	11	9	12	77	26	38	8	13	63	24	39	43	363
Ostracoda	4	6	6	11	5	1	3	2	1	1	4	8	52
Polychaeta	2	1	3	3	6	15	2	3	8	4	1	8	56
Tardigrada	3											29	32
Turbellaria	1	1	3			6	9			5	26	16	67
Amphipoda	1	1	4									1	2
Lamellibranchia larvae	1	1				1							7
Nematoda w/b.g.	3			5	14	1	6	6	5		2	16	58
Arohanellida				2			1				1		2
others ?										1			3
Total	443	531	543	802	455	660	550	502	953	432	543	669	7083

APPENDIX A2. CHD - MEAN NUMBER OF MEIOFAUNA COUNTED FROM REPLICATE CORE SAMPLES (9.62 cm²)

	1967						1968						Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
Nematoda	374	546	315	882	270	184	491	293	411	778	605	871	6020
Harpacticoida	39	29	29	162	15	61	10	6	34	63	90	44	582
Priapulida	6	8	6	14	7	4	5	3	11	22	37	19	142
Polychaeta	5	6	8	41	8	22	12	5	14	15	33	21	190
Ostracoda	2	4	1	3	2	16	1		1	4	1	1	36
Kinorhyncha	7	3	3	23	2	1	3		4	13	7	12	78
Halacarida	2	3	1	1	1	1			4	6		5	24
Amphipoda	1												1
Tanaidacea	1					1		2	1				5
Nematoda w/b.g.	12			13	5	4	7	4	3	24	20	21	113
Turbellaria			1			1	2	1	1	1	2		2
Lamellibranchia larvae			1	2		1							12
Cumacea			1	1									1
Isopoda												1	1
others ?	1												1
Total	450	599	365	1142	310	295	531	314	484	928	795	995	7208

APPENDIX A3. BBC - MEAN NUMBER OF MEIOFAUNA COUNTED FROM REPLICATE CORE SAMPLES (9.62 cm²)

	1967						1968					Tot.	
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr		May
Nematoda	522	135	282	190	203	119	154	227	424	563	309	223	3351
Harpacticoida	679	307	185	267	283	156	44	75	68	80	931	412	3487
Polychaeta	5	7	23	48	3	20	9	7	8	7	12	23	172
Ostracoda	15	5	14	14	2	5	1	1	3	8	25	8	101
Halacaridae	1	1	1	2	1	1			1	4	3		15
Turbellaria	1		1						2		1		5
Oligochaeta	1												1
Prosobranhia		1											1
Lamellibranchia larvae			5	4	1				1		3	1	15
Nematoda w/b.g.			3	2	2	1	2	4	5			1	19
Priapulida	1			1									2
Amphipoda				1	1	2	1						5
Isopoda												1	1
Total	1225	456	514	529	496	304	211	314	512	662	1284	669	7175

APPENDIX A4. BEF - MEAN NUMBER OF MEIOFAUNA COUNTED FROM REPLICATE CORE SAMPLES (9.62 cm²)

	1967							1968					Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
Nematoda	477	292	190	411	165	184	85	122	498	175	292	153	3060
Harpacticoida	105	101	101	409	131	292	28	22	336	91	384	184	2104
Ostracoda	12	3	4	5	2	5	2		14	4	12	3	66
Polychaeta	10	5	8	27	7	9	3	5	6	9	11	9	118
Halacaridae	1					1			3	2	1		8
Priapulid	1			1									2
Lamellibranchia larvae	1		2	1			1				1		6
Turbellaria	1		1	2					2				6
Nematoda w/b.g.			1	6	3	1		1	1	2			15
Amphipoda						1							1
Total	608	401	307	862	308	493	119	150	860	283	701	349	5386

APPENDIX A5. TI - MEAN NUMBER OF MEIOFAUNA COUNTED FROM REPLICATE CORE SAMPLES (9.62 cm²)

	1967						1968					Tot.		
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr		May	
Nematoda	368	289	NO SAMPLES	605	434	360	246	442	386	233	339	392	4094	
Harpacticoida	52	31		103	71	184	276	67	78	116	190	525	1693	
Polychaeta	3	9		33	6	5	9	7	10	7	17	21	127	
Ostracoda	9	5		3	6	2	2	4	23	8	12	16	90	
Halacaridae	1									1		1	3	
Turbellaria	1				1							7	9	
Lamellibranchia larvae		1			1			2	1	1	2	5	25	38
Tanaidacea		1												1
Nematoda w/b.g.					11	21	22	8	9	8	3	3	6	91
others ?									1					1
Total	434	336		756	539	573	543	531	507	369	574	985	6147	

APPENDIX B1. NEMATODES, CHS - ACTUAL NUMBERS IDENTIFIED

SPECIES	1967						1968					Tot.	
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr		May
<u>Anticoma trichura</u>		1					2		3				6
<u>Oxystomina</u> sp.										1			1
<u>Trefusia</u> sp. 1 (l.t.)										1	1		2
<u>Trefusia</u> sp. 2										4			4
<u>Halalaimus fletcheri</u>										1			1
<u>H. meyersi</u>											1	1	2
<u>H. sp.</u>								2					2
<u>Cytolaimium</u> sp.	1												1
<u>enoplolaimid</u>		1						1	3	2	1		8
<u>Mesacanthion</u> sp.		1	1	1	2	5		1	3	1	2	1	18
<u>oncholaimid</u>	1		1				1						3
<u>Meyersi minor</u>							1						1
<u>Viscosia</u> sp.	2	1	1					1	4		6		15
<u>Metancholaimus amplus</u>				1									1
<u>Oncholaimellus</u> sp.		1		1					6		7		15
<u>Monocholaimus</u> sp.			1										1
<u>Prochromadorella</u> sp.										1			1
<u>Chromadorella</u> sp.	1								2	1	1		5
<u>Pseudochromodora</u> sp.												2	2
<u>Hypodontolaimus</u> sp.												1	1
<u>H. sp. (Pty.)</u>										1			1
<u>Neochromodora</u> sp. 1										1			1
<u>Graphonema</u> sp.												2	2
<u>Comesoma</u> sp.		1		1			8						10
<u>C. sp. # 2</u>										2			2
<u>Paracomesomea</u> n. sp.	2	3	2		2			1	4	3	5	12	34
<u>P. sp.</u>	2							1					3
<u>P. sp. 2</u>										1			1
<u>Choniolaimus</u> sp. ?							1						1

APPENDIX B1. NEMATODES, CHS - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1968												Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Pomponema tessellatus</u>	4			1	1	3	13	2	10	8	9	11	60
<u>P.-like</u>													2
<u>F. sp.</u>							2	1		2			4
<u>Munsocephalus sp.</u>				1				3					4
<u>Phylloidalimus sp.</u>				2					3				2
<u>Cheironchus vorax</u>												1	10
<u>Kosswigonema sp.</u>						2							1
<u>Microlaimus sp.</u>										4			2
<u>Spirinia (setae) sp.</u>							2			1			8
<u>Chromospirinia sp.</u>							1			1			5
<u>Pseudocetachromadora sp.</u>										1			1
<u>Metachromadora 'p'</u>			1	3				1	2	5	16	42	70
<u>M? Chromospirinia sp. ?</u>				1						2	1		3
<u>Eubostrichus parasiteferus</u>	2						1					7	12
<u>E. sp.</u>	4			1	2				2				3
<u>E. # 3 n. sp.</u>												14	29
<u>E. sp. (b.o.)</u>												1	3
<u>Leptonemella sp.</u>								2					3
<u>stilbonematid</u>					1								3
<u>Robbea sp.</u>										1			4
<u>'Catanema' sp.</u>								1		2			4
<u>Paradesmodora sp. 1</u>	2							13		15	3	16	47
<u>P. sp. 2</u>			2				2	2		6	3	19	28
<u>Desmodorella cephalata</u>									1	1	8	10	23
<u>D. sp.</u>								1	4				1
<u>Dasynebella sp.</u>								1			3		4
<u>Dasyneoides sp.</u>								1					1
<u>Ceramonea reticulatus</u>				1			1					2	4
<u>C. sp. 2</u>												1	1
<u>Monoposthia sp.</u>	2			4	1		2	8	32	11	11	12	83

APPENDIX B1. NEMATODES, CHS - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967						1968					Tot.	
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr		May
<u>Axonolaimus spinosus</u>							1						1
<u>Axonolaimus sp.</u>	1			1				1	10	5	2		20
<u>Odontophora sp.</u>	3	3		2	1		1	3	4	1	7	7	32
<u>Camacolaimus prytherchi</u>												2	2
<u>Procamocolaimus sp.</u>											1		1
<u>Linhomoeid</u>		1										4	5
<u>Theristus floridanus</u>	2	1		3	1	1	8	5	14	22	11	10	78
<u>T. ostentator</u>							2						2
<u>T. sp.</u>	3	5					1	1					10
<u>T. sp. ?</u>	2												2
<u>T. sp. # 4-5</u>	1		1				4	2	3	2	4	13	30
<u>Paramonohysteria canicula</u>							1						1
<u>Xysla striata</u>	6			2	2		5	8	5	5	8	6	47
<u>Xenolaimus striata</u>							1	2	2	5	4	5	19
Total # species	17	12	9	13	12	4	19	25	21	34	27	30	73
Total # individuals	40	22	10	22	17	11	57	66	118	125	119	210	822

APPENDIX B2. NEMATODES, CHD - ACTUAL NUMBERS IDENTIFIED

SPECIES	1967												1968				Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May					
<u>Anticoma</u> sp.		1	3	1						1					4		
<u>A. sp.</u> (l.o.)															1		
<u>A. trichura</u>				1							1				1		
<u>Halaelaimus</u> sp.															3		
<u>H. Cletcheri</u>															1		
<u>Phanodermopsis longisetas</u>				4	1	1	2	2	1	2	3	2			10		
<u>P. sp.</u>															15		
<u>enoplolaimid</u>															3		
<u>Mesacanthion</u> sp.									1	1					4		
<u>Epacanthion</u> sp.									1	1					1		
<u>Rhabdodemanis</u> sp.		1							1	1					3		
<u>Meyersia minor</u>		1							1	1					1		
<u>Viscoxia</u> sp.									2	1	5	3			11		
<u>Filoncholaimus prolatus</u>		4													4		
<u>F. sp.</u>												1			1		
<u>Proncholaimus</u> sp.												1			1		
<u>Paracryptosina</u> n. sp.			1			1				1					3		
<u>Polygastrophora</u> sp.					1										1		
<u>Euchromadora gaulica</u>		1									3	1			2		
<u>E. (nec. g.)</u>															3		
<u>Spilophorella - Hynd. ?</u>															11		
<u>Chromadorella (t.)</u>											1				2		
<u>Hypodontolaimus (Pty.)</u>															1		
<u>Chromadorid</u>															1		
<u>Comesoma</u> sp.		1	4	5	4	9	9	3	8	15		13			50		
<u>C. sp. 2</u>		2	2	5	5	1	6	5	5	26					73		
<u>Paracomesoma</u> sp.				1	2		2								10		
<u>P. sp. 2</u>		2		1	1				9	11	11	22			56		
<u>P. n. sp.</u>												1			1		

APPENDIX B2. NEMATODES, CHD - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967						1968					Tot.	
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr		May
<u>Actarhania</u> sp.			1										1
<u>Dorylaimopsis metatypicus</u>		1		1		1	2				3	4	12
<u>Mesonchius</u> sp.		1					1					5	7
<u>Sabateria</u> sp.					1		2						3
<u>Laimella longicaudata</u>							1						1
<u>Longicyatholaimus</u> sp. # 5			1										1
<u>L.</u> sp. (B # 3)									1				1
<u>L.</u> sp.		1											1
<u>Pomponema</u> sp.			1										1
<u>P. tessellatum</u>						3							3
<u>Numocephalus</u> -like											2		2
<u>Phyllolaimus</u> sp.									2				2
<u>Paracyatholaimus</u> sp.										1			1
<u>Gomphonema typicum</u>					1			1					2
<u>G.</u> sp.							2			5		13	20
choanolaimid						2							2
<u>Halichoanolaimus</u> n. sp.	1	2										3	6
<u>H. quattuordecimpapillatus</u>									1	1			2
<u>H.</u> sp.				3	2		2		1				8
<u>Latronema</u> sp.					1			1				1	4
<u>Cheironchus vorax</u>						3							3
<u>C.</u> sp.	2						1	1	4			1	7
<u>Microlaimus</u> sp.													1
<u>Chromaspirina</u> sp.			1									1	1
<u>Pseudometachromadora</u> sp.				1	1		1	1	1	4	4	5	18
<u>Metachromadora</u> sp.			1		1				2	2	4	1	11
<u>Laxonema majum</u>			3										3
<u>Eubostrichus parasitiferus</u>				2				3		2	3	2	12
<u>E.</u> # 3 n. sp.			1							10	20	9	40
<u>E.</u> sp. (b.o.)			1	4					2				7

APPENDIX B2. NEMATODES, CHD - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967						1968					Tot.	
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr		May
<u>Stilbonema brevicolle</u>													2
<u>Catanema sp.</u>			2					2					2
<u>Paradesmodera sp.</u>				2				1				1	2
<u>P. (nec. 1)</u>													2
<u>P. sp. 3</u>													2
<u>Desmodorella cephalata</u>									1	2	3	1	6
<u>Metadesmodera sp.</u>						1						4	5
<u>Zalonema sp.</u>										1		1	1
<u>Monopesthia sp.</u>									1			1	2
<u>Tricoma sp.</u>													1
<u>Desmocolax sp.</u>					1					2	1	1	2
<u>Paradesmocolax-like</u>													3
<u>Odontophora sp.</u>						1						1	1
<u>Paradontophora sp.</u>			2								1		3
<u>Dedelta maculatus</u>		1											1
<u>Pandolella sp.</u>									1				2
<u>Siphenolaimus sp.</u>									7	2		4	13
<u>Anticyathus tenuicaudatus</u>								1					1
<u>A.-like</u>													1
<u>Paralinhomoeus sp (b.t.)</u>										1			2
<u>linhomoeid (l.e.)</u>													3
<u>linhomoeid</u>			4	18	5		1	32	53	119	29	32	305
<u>Terrichellingia sp.</u>		5		1									14
<u>T. longicaudata</u>		1			1								3
<u>Synonema sp.</u>					1								3
<u>Sphaerolaimus sp.</u>			1									2	1
<u>Theristus sp.</u>		1	3									2	2
<u>T. fistulatus</u>												5	5
<u>T. sp. # 4 or 5</u>			2										4
<u>Paramonohystera canicula</u>			1			2							1

APPENDIX B2. NEMATODES, CHD - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967							1968					Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Paramonohystera</u> sp. 2								1					1
<u>E.</u> sp.							1						1
<u>E.</u> sp. # 3			2										2
<u>Sphaerolaimus</u> -like									2	2		8	12
<u>Trissonchulus</u> ?				1									1
Total # species	4	17	23	16	15	12	17	12	21	22	18	36	94
Total # individuals	6	36	43	51	28	26	54	53	104	187	121	167	877

APPENDIX B3. NEMATODES, BBC - ACTUAL NUMBERS IDENTIFIED

SPECIES	1967					1968					Tot.		
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar		Apr	May
<u>Anticoma</u> n. sp.	2	1							5	5			13
<u>A.</u> sp.	3		1			2	1	1					8
<u>A. trichura</u>			1					5	1				5
<u>leptosomatid</u>										1			2
<u>Trefusia</u> sp. 1 (s.t.)											1		1
<u>Halalaimus</u> sp.			3			5	15	2	9	4	1		40
<u>Tripylodas</u> sp.	1					1						2	1
<u>Phanoderma</u> sp.			1			1						1	2
<u>Phanodermopsis longisetae</u>													2
<u>P.</u> sp.													2
<u>enoplid-genus</u>										1	4	1	5
<u>enoplolaimid</u>	2		2			5	1	8	5	6	3		28
<u>Mesacanthlon</u> sp.			1			5	1	2				4	9
<u>Epacanthlon</u> sp. 1 (l.o.)					3			13	1	15	8		27
<u>E.</u> sp.													17
<u>Oxvorchus</u> -like				1									1
<u>Chaetoneus</u> sp.													1
<u>Thalassironus</u> n. sp.								8			1		1
<u>Meyeria minor</u>	4		1					2		10	24	11	67
<u>Viscozia</u> sp.	1				1					4	3	3	14
<u>Oxcholaemus</u> sp.										1			1
<u>Ellencholeimus prolatus</u>		1											1
<u>Menoncholeimus</u> sp.													1
<u>Metencholeimus anolus</u>			3	6	2	1			2				16
<u>Paracrystomina</u> n. sp.	1		2						1				1
<u>Symplecositona</u> sp.													1
<u>Euchromadora</u> (nec. g.)											1	1	4
<u>E. gaulica</u>											5		8
<u>E. pect-like</u>								1					1
<u>Prechromaderella</u> sp. (5)				1		1			12	14	9	1	36

APPENDIX B3. NEMATODES, BBC - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967						1968						Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Prochromadorella</u> sp. (6)							1	2	13	1		8	22
<u>P.</u> -like													1
<u>P.</u> sp.						1							2
<u>Chromadora macrolaimoides</u>							1			1			2
<u>C.</u> (3 supps.)													1
<u>Spilophorella paradoxa</u>										1	2		1
<u>Atrochomadora denticulata</u>										1	3		5
<u>Chromodoralla</u> vm.			1										1
<u>Chromadorita</u> sp.								2	1	1	2		14
<u>Nyctationchus</u> -like							2		5				7
<u>Comesoma</u> sp.	2	1	1			3		4	1	3			15
<u>C.</u> sp. 2											6		3
<u>Paracosoma</u> n. sp.						3		3					11
<u>Longicyatholaimus</u> sp. #5	1	5				1						2	1
<u>L. maldivarum</u>													1
<u>Choniolaimus</u> sp.	1					5						5	26
<u>Pomponema tessellatum</u>								1	1		14		5
<u>Nummacephalus</u> sp.						3							2
<u>Nannolaimus</u> (<u>Neotonchus</u> -like)													5
<u>Paracyatholaimus</u> sp.						4						1	5
<u>Acanthonchus</u> sp.								2	1	1		2	1
cyatholaimid									2				5
<u>Halichoanolaimus</u> n. sp.	1						2	1	2				3
<u>H.</u> sp.									1				1
<u>H.</u> sp. 2													1
<u>H.</u> sp. 3													1
<u>Neotonchus</u> n. sp.								1					1
<u>Latronema</u> sp.													1
<u>Kosswigonema</u> sp.													1
<u>Microilaimus</u> sp.													1
<u>Spirinia</u> (<u>setae</u>) sp.	1				4				1	3	1		9

APPENDIX B3. NEMATODES, BBC - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967						1968						Tot.
	Jun	Jul	Aug	Sep	Oct*	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Spirinia</u> sp.								2					2
<u>Spirinia</u> (sss) sp.				1	1						4	3	9
<u>Chromaspirinia</u> sp.				1	2			4		1	1	10	19
<u>Metachromadora</u> sp.			2	2	4	1		2	4	2	2	10	27
<u>M.</u> (nee. p.)												1	1
<u>M.</u> (pul.)	1												1
<u>M.</u> (diplo-head)								1	1			6	8
<u>M?</u> <u>Chromaspirinia</u> sp. ?									2	3			5
<u>Laxonema</u> <u>majum</u>		1	2							2	1		6
<u>Eubostrichus</u> <u>parasitiferus</u>			2					1	1	1	2	4	11
<u>E.</u> sp. (b.e.)											2	4	6
<u>E.</u> sp.	1												1
<u>E.</u> # 3 n. sp.				1									1
<u>Leptonemella</u> sp.			2			2			1	1		2	8
<u>Stilbonema</u> <u>brevicolle</u>			2					1			1	1	5
<u>stilbonematid</u>								1					1
<u>Catanema</u> sp.									1			1	2
<u>Paradesmodora</u> sp. 1											3	7	10
<u>Desmodorella</u> <u>cephalata</u>									1		2		3
<u>Xenodesmodora</u> sp.						1							1
<u>Acanthopharynx</u> sp.										1			1
<u>Dasynemella</u> sp.											1		1
<u>Ceramonema</u> <u>reticulatum</u>								2			2		4
<u>Monoposthia</u> sp.						1				1			2
<u>Tricoma</u> sp.												6	6
<u>Axonolaimus</u> sp.						2		1			1	1	5
<u>Odontophora</u> sp.						1			1		2	3	14
<u>Didelta</u> <u>maculatum</u>	1												1
<u>Anticyathus</u> <u>tenuicaudatus</u>			2										2
<u>Paralinhomoeus</u> sp. (b.t.)	2												2
<u>linhomoeid</u> (l.e.)				1				5			3	8	17

APPENDIX B3. NEMATODES, BBC - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967							1968					Tot.
	Jun	Jul	Aug	Sep	Oct*	Nov	Dec	Jan	Feb	Mar	Apr	May	
linhomoeid			3					1					4
<u>Metalinhomoeus setosus</u>												1	1
<u>Theristus floridanus</u>					1	1		2	6	2	1	3	16
T. sp. # 4 or 5					1		2	9	1	1	2	6	22
T. sp.			1	1									2
<u>Paramonohystera canicula</u>								2	10				12
P. sp. # 2			5	1				5	3				14
P. sp. # 3						2						1	3
<u>Nyala striata</u>								1					1
others ?									2				2
Total # species	16	5	21	11	12	20	11	33	33	29	35	34	101
Total # individuals	25	9	39	17	30	41	30	98	100	89	130	123	731

* BBC-BBF combined

APPENDIX B4. NEMATODES, BEF - ACTUAL NUMBERS IDENTIFIED

SPECIES	1967							1968					Tot.
	Jun	Jul	Aug	Sep	Oct*	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Anticoma</u> sp.				1				1					2
<u>A. n.</u> sp.									6	1	1	1	9
<u>A. trichura</u>												2	2
<u>Leptosomatid</u>	1											1	2
leptosomatid p/2										1			1
<u>Trefusia</u> sp.									1				1
<u>Halalaimus fletcheri</u>						2		1	1	1			5
<u>Tripyleides</u> sp.						2			2			1	5
<u>Phanodermopsis longisetae</u>								1					1
enoplid-genus			1								3		4
enoplolaimid			1	5			2	3	12	1		2	26
<u>Mesacanthion</u> sp.												1	1
<u>Epacanthion</u> sp.				2	3				3				8
<u>E. sp. 1</u> (l.o.)											2		2
<u>E. sp. 2</u>										1			1
<u>Thalassironus n.</u> sp.									1				1
<u>Meyersia minor</u>				1	7								8
<u>Viscosia</u> sp.		1		1	1		3	3	2		2	1	14
<u>Oncholaimellus</u> sp.			1									1	2
<u>Mononcholaimus</u> sp.				1		1							2
<u>Metoncholaimus amplus</u>					2					1			3
<u>Pareurystomina</u> sp. (b.t.)				1									1
<u>Euchromadora</u> sp. (neg. g.)									1	1	1		3
<u>E. gaulica</u>				1								1	2
<u>E. sp.</u>							1						1
<u>Prechromadorella</u> sp (5)									4		2	1	7
<u>P. sp.</u>						4		1					3
<u>Chromadorella</u> va.								4	2		3	6	15
<u>C. sp.</u>				13		1	3		11				28
<u>C. sp. (t)</u>				1									1
<u>Actinonema</u> sp.						1					2		3

APPENDIX B4. NEMATODES, BEF - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967						1968						Tot.
	Jun	Jul	Aug	Sep.	Oct.*	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Neochromadora</u> sp. # 1								7		1	3		11
<u>Graphonema</u> sp.									2				2
<u>Nygmatochus</u> -like							1	2	2	3	1	3	12
<u>Comesoma</u> sp.				1			2						3
<u>C.</u> sp. 2						1		1	8	1	1	2	14
<u>Longicyatholaimus</u> sp.			1						1		3	6	11
<u>L.</u> sp. # 5				9			1				4	1	15
<u>Pomponema tessellatum</u>				1	1		1				3	5	11
<u>P.</u> sp. # 2				1					5	5			11
<u>Nannocephalus</u> sp.				3	3			5					11
<u>cyatholaimid</u>				1			1						2
<u>Neotonchus</u> -like								1					1
<u>Halichoanolaimus</u> sp.				1					1				2
<u>Latronema</u> sp.				2									2
<u>Cheironchus vorax</u>											1	3	4
<u>Microlaimus</u> sp.									2				2
<u>Spirinia</u> (setae) sp.					4	1			1				6
<u>Spirinia</u> (sss) sp.				3	1								4
<u>Chromaspirinia</u> sp.				2	2	1		1				3	7
<u>Metachromadora</u> sp.		2	1	2	4	1	2	1	7	4	1	1	26
<u>M.</u> (Diplo-head)								1					1
<u>M?</u> <u>Chromaspirinia</u> sp. ?										1			1
<u>Laxonema majum</u>	2	1		1				1			3	2	10
<u>Eubostrichus parasiteferus</u>				2					1	1			4
<u>E.</u> # 3 n. sp.				4									4
<u>E.</u> sp. (b.o.)											3	2	5
<u>Leptonomella</u> sp.			1							3		1	5
<u>Stilbonema brevicolle</u>										4		2	6
<u>Catanema</u> sp.												1	1
<u>Paradesmodora</u> sp. # 1		1									5	3	9
<u>Desmodorella cephalata</u>									2				2

APPENDIX B4. NEMATODES, BBF - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967						1968					Tot.	
	Jun	Jul	Aug	Sep	Oct*	Nov	Dec	Jan	Feb	Mar	Apr		May
<u>Desmodorella</u> sp.				1									1
desmodorid				1									1
<u>Xenodesmodora</u> sp.						1			1				2
<u>Ceramonema reticulatum</u>								1			1		2
ceramonematid				1									1
<u>Monoposthia</u> sp.									2	1		1	4
<u>Tricoma</u> sp.				1						2	2	3	8
<u>Axonolaimus</u> sp.									2				2
<u>Odontophora</u> sp.				2		1			4	3		3	13
<u>Anticyathus</u> sp.	2												2
<u>Paralinhomoeus</u> sp. (b.t.)	1			2			1						4
linhomoeid (l.o.)							1				1		2
<u>Theristus floridanus</u>					1	2	5	4	14	2	12	6	46
T. sp. # 4 or 5		1		1	1		3	4				1	11
T. sp.			1				1			1			3
<u>Paramonchystera canicula</u>								1					1
P. sp. # 2								1					1
<u>Xyala striata</u>									1				1
<u>Xenolaimus</u> sp.				2							3	1	6
monohysterid p/2										1			1
others									2	2			4
Total # species	4	5	7	31	12	13	15	21	28	23	24	31	83
Total # individuals	6	6	7	69	30	17	28	45	104	42	63	68	485

* BBF-BBC combined

APPENDIX B5. NEMATODES, T1 - ACTUAL NUMBERS IDENTIFIED

SPECIES	1967						1968						Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Anticoma</u> sp.				1								1	1
<u>A. n.</u> sp.												1	1
<u>Trefusia</u> sp. # 1											1		1
<u>Wieseria pica</u>						3	1					1	5
<u>Halalaimus fletcheri</u>						1							1
<u>Tripyloides</u> sp.						7		5	1	3			16
enoplid-genus				6		2		3			1		12
<u>Metenoploides</u> sp.				1									1
enoplolaimid	1	1						2					4
<u>Mesacanthion</u> sp.	2	2										1	5
<u>Epacanthion</u> sp. # 1(1.o.)										4	1	3	8
<u>E.</u> sp.								2	2				4
<u>Oxvonchus</u> sp.								1	1		1		3
<u>Oxvonchus-like</u>						1							1
<u>Thalassironus</u> n. sp.								2					2
<u>Meyersia minor</u>							1		2				3
<u>Viscosia</u> sp.		1		1		2		3		1	5	11	24
<u>Oncholaimellus</u> sp.	3				3						2	4	12
<u>Filoncholaimus</u> sp.											1		1
<u>Metoncholaimus amplus</u>						1							1
<u>Pareurystomina</u> n. sp.												1	1
<u>Euchromadora gaulica</u>											1	1	2
<u>Prochromadorella</u> sp.								3					3
<u>P.</u> sp. (5)									1	1		4	6
<u>P.</u> sp. (6)											2	1	3
<u>Chromadora macrolaimoides</u>				1									1
<u>Chromadorella</u> sp.						2		2					4
<u>Actinonema</u> sp.						1	1						2
<u>Hypodontolaimus</u> sp. (ss)												1	1
<u>Graphonema</u> sp.											1		1
<u>Comasoma</u> sp.	9	13		2	13	24	2						63

NO SAMPLES

APPENDIX B5. NEMATODES, FI -- ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967					1968					Tot.		
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar		Apr	May
<u>Comesoma</u> sp. # 2		1		2	8	38	1	29	31	32	39	28	198
<u>Paracomosoma</u> sp.				1		5	1	1		1	4	1	2
<u>E. n. sp.</u>				4				7					1
<u>Sabatieria</u> sp.							1						23
<u>Choniolaimus</u> sp.		2		2		2				1	1	13	1
<u>Pomponema tessellatum</u>						2							21
<u>E. sp.</u>				1					2			1	3
<u>E. sp. # 2</u>							1						3
<u>E.-like (vast stoma)</u>												1	1
<u>Paracaryatholaimus</u> sp.					1	4						1	2
<u>Acanthonchus</u> sp.							1						4
<u>cyatholaimid</u>													1
<u>Latronema</u> sp.										1			1
<u>Gamanema</u> sp.										1			1
<u>Kosswigonema</u> sp.											1		1
<u>Microilaimus</u> sp.													1
<u>Spirinia (setae)</u> sp.				1	1	8	1	3	1	9	10	6	40
<u>Spirinia (ass)</u> sp.						1					1		1
<u>S. sp.</u>						1							1
<u>Chromaspirinia</u> sp.								2					2
<u>Metachromadora</u> sp.					1		1	3	6	6	5	10	33
<u>M. (nec. p.)</u>										1			1
<u>M? Chromospirinia</u> sp. ?								3		1	1	2	1
"desmo-v-long ridges"								1		2	1	2	8
<u>Laxonema majus</u>								1					4
<u>Subostrichus parasiteferus</u>				3	2	5	3	1		1	4		9
<u>E. # 3 n. sp.</u>						3							10
<u>E. sp. (b.o.)</u>						3							3
<u>E. sp. (b.p. w/ s.c.)</u>						3							1
<u>Leptonemella</u> sp.						3					2		5

NO SAMPLES

APPENDIX B5. NEMATODES, FI - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967						1968						Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Stilbonema brevicolle</u>						2						1	3
stilbonematid									1				1
<u>Squanema</u> sp.						1	1			1			3
<u>Robbea</u> sp.	1	1				2			1			2	7
<u>Catanema</u> sp.								10		1		5	16
<u>Paradesmodora</u> sp. # 1	1				3	4		13	1	6	16	22	66
<u>P.</u> sp. # 2												3	3
<u>P.</u> sp. (nec. # 1)						18							18
<u>Desmodorella cephalata</u>										1	1		2
<u>Dasynemella</u> sp.								2		1	2	1	6
<u>Dasynemoides</u> sp.						2							2
<u>Ceramonema reticulatum</u>					1			5		2			8
<u>C.</u> sp.						1							1
<u>C.</u> sp. # 2											1	3	4
<u>Monoposthia</u> sp.	1				2		2	1				4	10
<u>Tricoma</u> sp.							1				3	3	7
<u>Axonolaimus</u> sp.	1	3				1		1		2		6	14
<u>Odontophora</u> sp.		2				2	1	2	4	2		5	19
<u>Paraodontophora</u> sp.				1								1	1
<u>Tarvaia</u> n. sp.								1				2	3
<u>Canacolaimus</u> sp.					1			1					2
<u>Procanacolaimus</u> n. sp.								15			1	4	20
<u>Paralinhomoeus</u> sp. (b.t.)				1	1								2
linhomoeid									1				1
<u>Metalinhomoeus</u> sp.								1	1				2
<u>Theristus floridanus</u>		2			1			1	5		12	6	27
<u>T.</u> sp.								5					5
<u>T.</u> sp. # 3						1		1	2		1	5	10
<u>T.</u> sp. # 4 or 5		3				24	2	9		2	6	2	48
<u>T.</u> xyaliformis-like								1					1

NO SAMPLES

APPENDIX B5. NEMATODES, TI - ACTUAL NUMBERS IDENTIFIED (Cont.)

SPECIES	1967						1968					Tot.	
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr		May
<u>Theristus</u> sp. (heterospiculum group)								1					1
<u>T. fistulatus</u> -like			N. S.			1							1
<u>Paramonohystera</u> sp. 2								1					1
others						1							1
Total # species	11	11		16	12	34	13	39	16	27	28	37	95
Total # individuals	22	31		29	37	176	18	147	62	76	126	168	892

APPENDIX B6. NEMATODES, DH - ACTUAL NUMBERS IDENTIFIED

SPECIES	1967							1968					Tot.
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
<u>Anticoma trichura</u>											1		1
<u>Viscosia sp.</u>											4		4
<u>Euchromadora gaulica</u>											1		1
<u>Prochromadorella sp.</u> 8											7		7
<u>Graphonema sp.</u>												1	1
<u>Sabateria sp.</u> # 2											2		2
<u>Microlaimus sp.</u>											1		1
<u>Spirinia (setae) sp.</u>											1		1
<u>Laxonema majum</u>											1		1
<u>Pseudochromadora sp.</u>											14	8	22
<u>Tarschallingia-like</u>											1		1
<u>Spaerolaimus-like</u>											1		1
<u>Theristus sp.</u>											6	11	17
Total # species											12	3	13
Total # individuals											40	20	60

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VITA

The author, Bruce Charles Coull, son of Charles Jr. and the late Louise Lind Coull, was born September 16, 1942 in New York, New York. He attended West Paterson (N.J.) public schools and graduated from Passaic Valley Regional High School, Little Falls, New Jersey in 1960.

He matriculated at Moravian College, Bethlehem, Pennsylvania in 1960 and received a B.S. degree in Biology in 1964. He entered Lehigh University in September 1964 and was awarded the M.S. degree in Biology in 1966.

He was a graduate teaching assistant during the academic year 1964-1965 and a research assistant to Dr. Sidney S. Herman from September 1965 to June 1968. He was also an assistant to the Organism-Sediment Interrelationships course at the Bermuda Biological Station during the 1966 summer.

On June 3, 1967 he married the former Judith Mapletoft of Verona, New Jersey.

He was awarded special research grants from the Society of the Sigma Xi and the Bermuda Biological Station for Research, Inc. in the summer of 1967.

He is a member of AAAS, AIRS, American Society of Limnology and Oceanography, Marine Biological Association of the United Kingdom, American Society of Meiobenthologists, Tau Kappa Epsilon International Social Fraternity and an associate member of Sigma Xi.

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