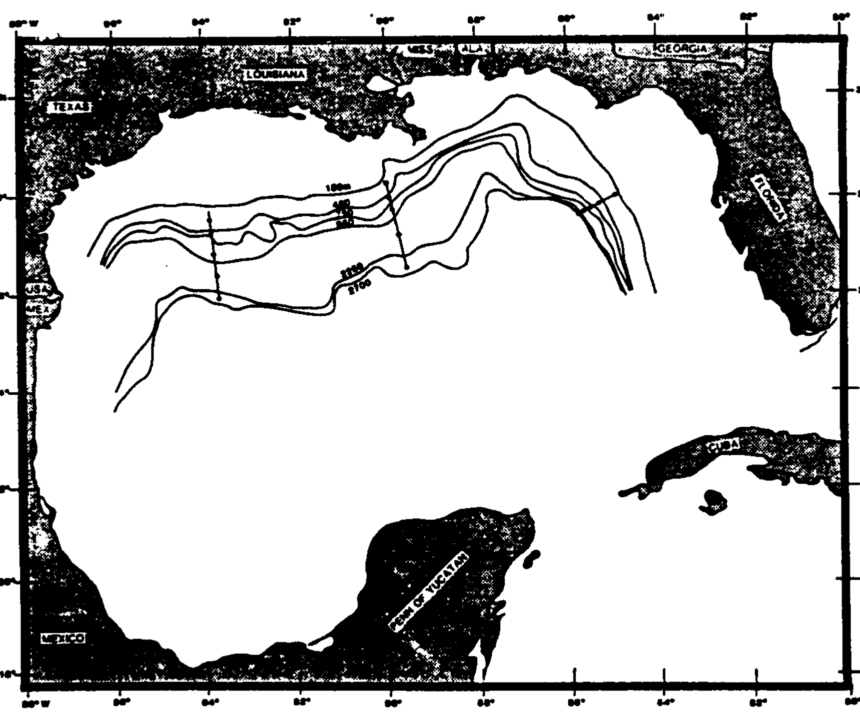
OCS STUDY
MMS 85-0058

EXECUTIVE SUMMARY OF THE ANNUAL REPORT FOR NORTHERN GULF OF MEXICO CONTINENTAL SLOPE STUDY



C.6 U.S. DEPARTMENT OF THE INTERIOR / MINERALS MANAGEMENT SERVICE

OCS STUDY
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EXECUTIVE SUMMARY

NORTHERN GULF OF MEXICO CONTINENTAL SLOPE STUDY

by

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for

Minerals Management Service
Gulf of Mexico OCS Regional Office
3301 N. Causeway Boulevard
Metairie, Louisiana 70002

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DISCLAIMER

INTRODUCTION

The continental slope of the Gulf of Mexico is poorly known from an ecological standpoint, but is a habitat into which oil and gas exploration and development activity is proceeding at an accelerating rate. In response to its mandate to obtain environmental data on the impacts of petroleum development on the outer continental shelf (OCS) and provide the relevant information to decision makers, Minerals Management Service (MMS) contracted in late 1983 a four-year research program to investigate the slope habitat across the Gulf of Mexico waters north of 25°N and from 200 to 2600 m in depth. This study is being conducted by LGL Ecological Research Associates, Inc. (LGL) in cooperation with Texas A&M University (TAMU). The first year of the program has been completed and is reported herein.

PROGRAM OBJECTIVES

The overall objectives of the program are:

(1) To determine the abundance, structure, and distribution of animal communities in the deep sea in the Gulf of Mexico.

(2) To determine the hydrographic structure of the water column and bottom conditions at selected sites within the study area.

(3) To determine and compare sedimentary characteristics at selected sites within the study area.

(4) To relate differences in biological communities to hydrographic, sedimentary, and geographic variables.

(5) To assess seasonal changes in deep sea biological communities in terms of abundance, structure, animal size, and reproductive state.

(6) To measure present levels of hydrocarbon contamination in the deep-sea sediments and selected animals prior to, and

in anticipation of, petroleum resource development beyond the shelf-slope break.

(7) To compare the biological and non-biological characteristics of the deep Gulf of Mexico with that of other temperate and subtropical deep-sea regions.

(8) To assemble together and synthesize appropriate published and unpublished data with the results of this study, summarizing on a seasonal and spatial basis all biological, habitat, and other environmental observations and parameters.

(9) To conduct an effective quality assurance and quality control program which insures that all data acquired are accurate and repeatable within standards normally required for each type of observation, measurement, or determination.

(10) To critically review, interpret, and analyze all observations and data acquired to redefine as necessary the research program in such a way as to avoid or minimize redundancy and to optimize the efficiency of all field, labortory, and data management operations for future deep-sea studies sponsored by MMS in the Gulf of Mexico.

(11) To assess the need for and determine the type of studies to be conducted in future program efforts.

The data for meeting these objectives have been gathered on five cruises of which two were conducted during this first year of the program.

STUDY AREA AND METHODS

During Year One, three transects of five stations each were sampled, with one transect located in each of the Western, Central, and Eastern Gulf of Mexico Lease Planning Areas (Fig. 1). Average sampling depths along each transect were 348, 657, 839, 1341, and 2530 m which corresponded to the approximate bathymetric centers of previously hypothesized faunal zones: Shelf/Slope Transition (150-450 m);

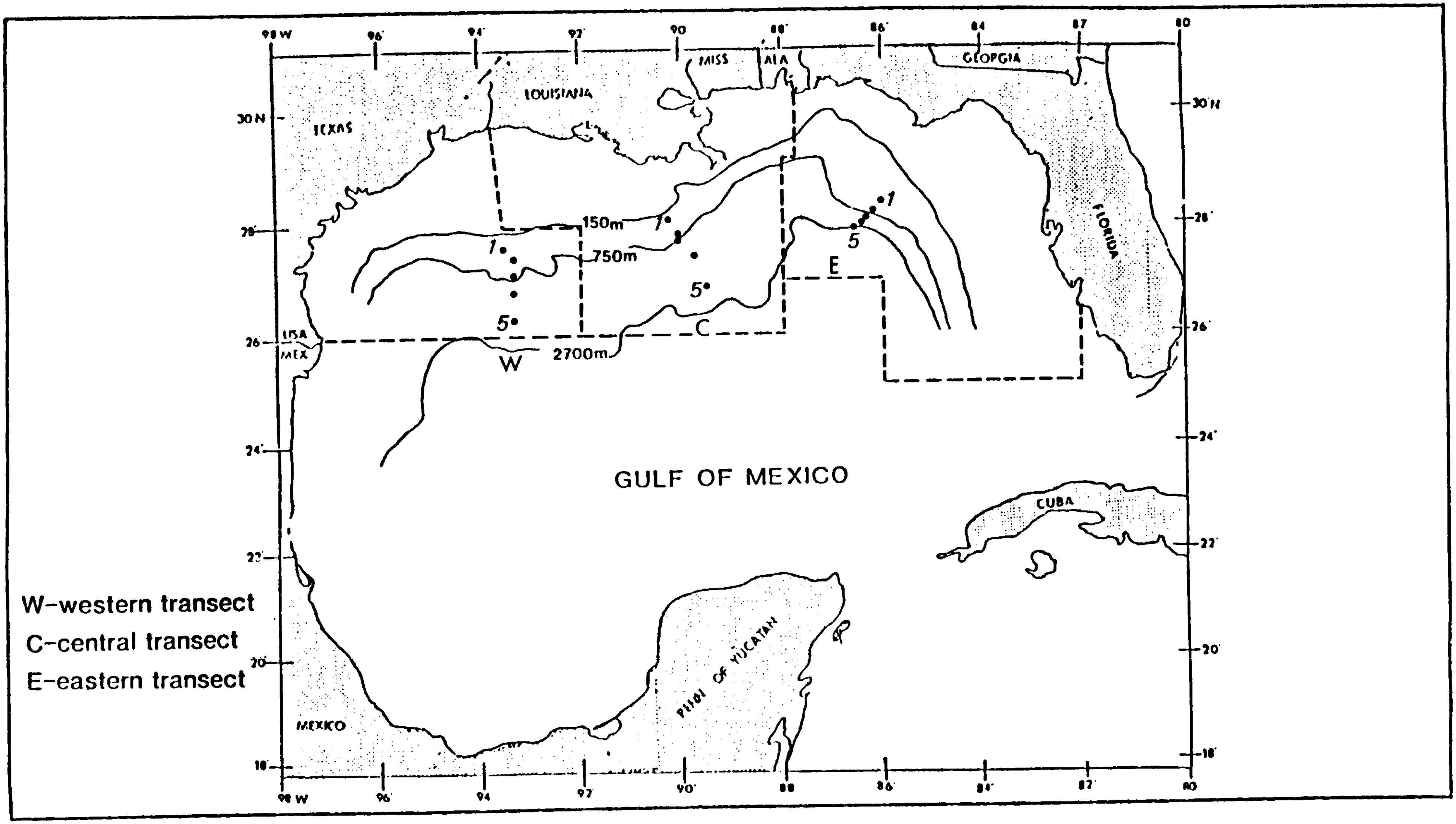

Figure 1. Location of transects and stations, within Western (W), Central (C) and Eastern (E) Gulf of Mexico lease planning areas.

Archibenthal, Horizon A (475-750 m); Archibenthal, Horizon B (775-950 m); the Upper Abyssal (975-2250); and the Mesoabyssal, Horizon C (2275-2700 m).

The types and numbers of samples taken at each station included 800 bottom photographs; a hydrocast and supportive water column sampling, either six (Central Transect) or three (East and West Transects) box cores; and a trawl sample. Box core samples were split for biological (macroinfauna, meiofauna) and physical (sediment grain size and chemistry) analyses. In November 1983, only the Central Transect was sampled whereas in April 1984, all three transects were sampled. All samples planned to be taken were obtained.

The laboratory analyses are proceeding on schedule using standard protocols for each type of physical, chemical, and biological analysis. The results which were available are reported below and in the main report volume.

ENVIRONMENTAL FEATURES

The water column over each transect was characterized by the presence of distinctive water masses (Fig. 2) that showed little seasonal or geographic variation. From top to bottom, these water masses included a shallow mixed layer of Gulf Water (usually present from the surface to 250 m); Tropical Atlantic Central Water (~300 to 500 m); Antarctic Intermediate Water (~500 to 1000 m); and Gulf Deep Water, a mixture of North Atlantic Deep and Caribbean Mid-water. The Shelf/Slope Transition Faunal Zone roughly corresponds in depth to the Tropical Atlantic Central Water mass, the Archibenthal Faunal Zone to the Antarctic Intermediate Water mass, and both the Upper Abyssal and Mesoabyssal faunal zones occur in Gulf Deep Water. Gulf Deep Water is distinctly colder than the water masses above, and temperature is undoubtably one of the important factors controlling depth distributions of organisms.

Bottom sediments at stations in the Central Transect in November 1983 (Fig. 3) were predominantly clay-sized at Stations C1, C2, and C3, with deeper stations containing higher proportions of either silt (C5) or silt- and sand-sized particles (C4). The same stations on the Central Transect during Cruise II (April 1984) typically had a higher proportion of silt-

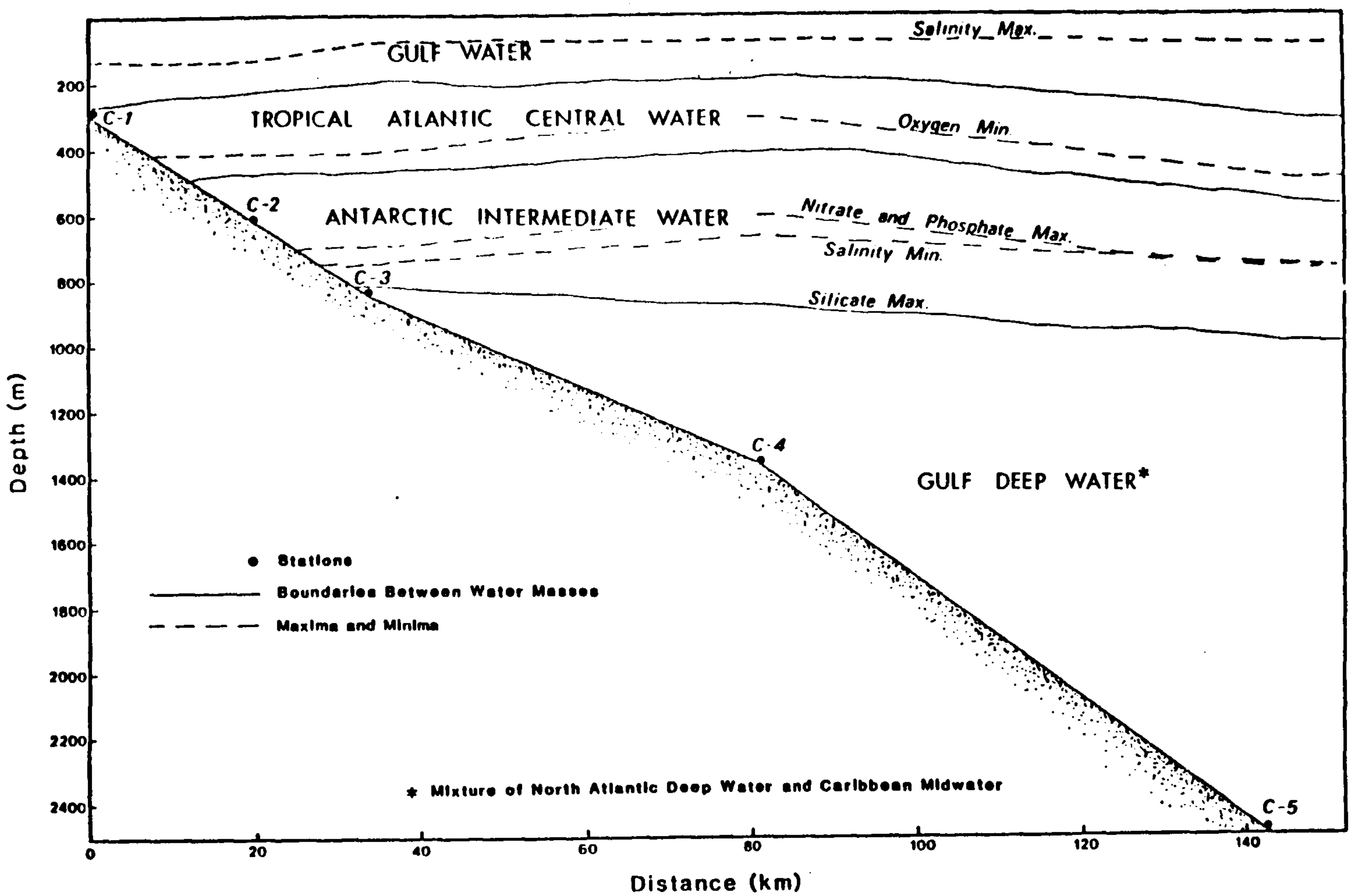

Figure 2. Water masses along the Central Transect during Cruise I. A similar distribution was observed for Cruise II.

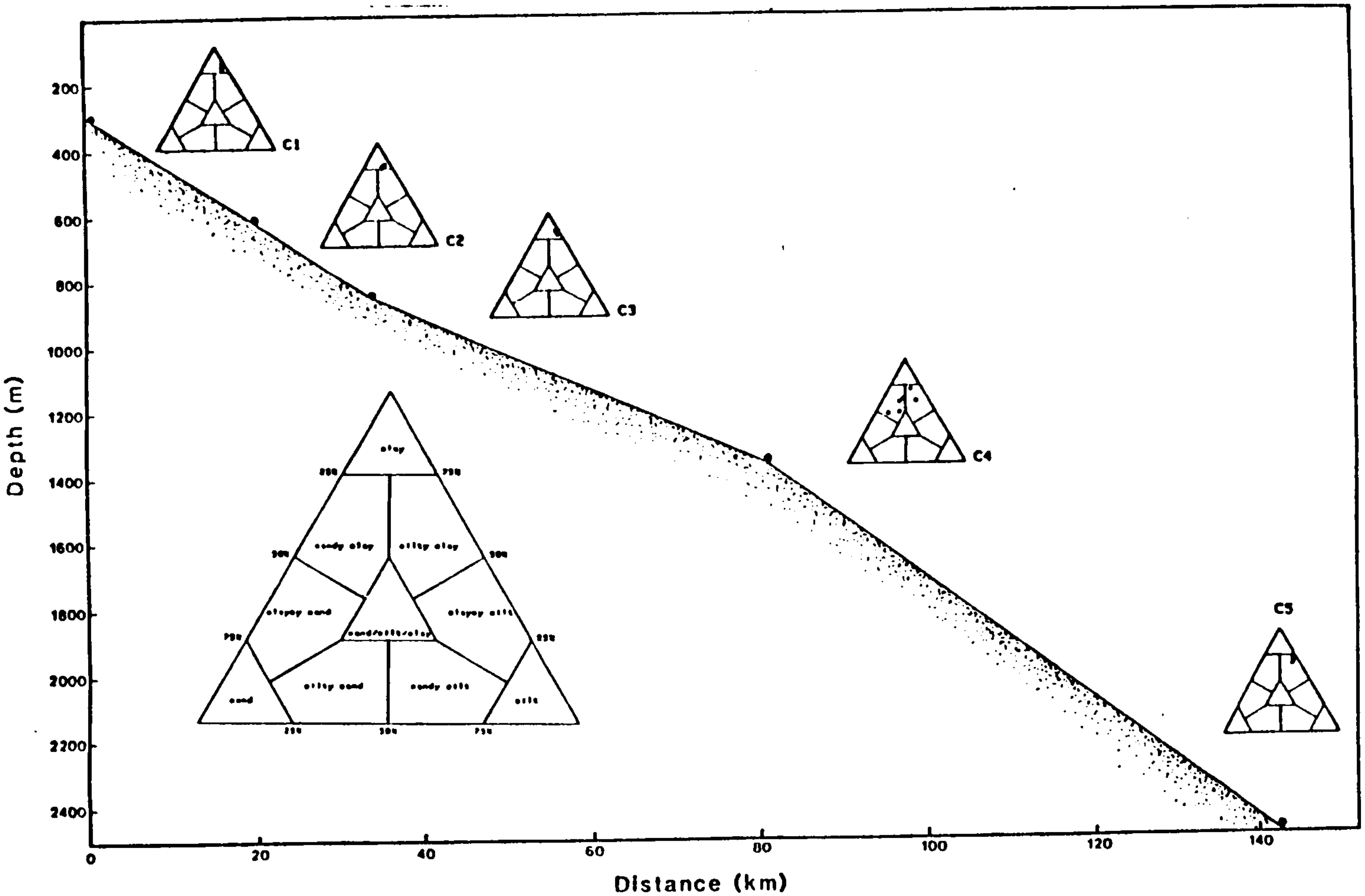

Figure 3. Sediment grain sizes at Cruise I sampling stations.

sized particles than had been observed in November of the previous fall (Fig. 3 and Fig. 4). Sediment levels of organic carbon (Fig. 5) and calcium carbonate (Fig. 6) were also higher in samples taken on Cruise II than in samples taken on Cruise I. Results of the sediment hydrocarbon levels also suggested that an influx of terrigenous material (bulk organic matter and plant biowaxes) to the bottom occurred between the two samplings.

On a geographic basis, bottom sediments at stations on the Eastern Transect contained considerably more sand and silt than sediments on the other transects, even though all stations were predominantly clay. Calcium carbonate levels were highest in sediments from the Eastern Transect, and higher in Western Transect samples than in Central Transect samples. The pattern of organic carbon levels in the sediments indicated levels to have been highest on the Central Transect, and then generally higher for sediments from the Western Transect than for sediments from the Eastern Transect. An exception was noted for the deepest station; i.e., organic carbon levels at Station E5 were higher than levels at Station W5. Organic carbon levels exhibited a trend of decrease with depth. At the Central Transect, sediment organic carbon in November 1983 was characteristic of carbon provided by marine phytoplankton, based upon carbon isotopic analyses.

With one exception, results from carbon isotopic analyses for benthic organisms not collected in the vicinity of gas seeps in April 1983 suggested that the slope biota derive their energy from sinking photosynthetic carbon (marine phytoplankton). The exception (a crab, Geryon quinquedens) had a carbon isotopic value suggesting a food source other than marine phytoplankton alone. Animals collected from around seeps had carbon isotope levels suggesting chemosynthesis, as opposed to photosynthesis, provided the primary production at the base of the seep-community food chain.

Sediments at all three transects had a mixture of thermogenic, terrigenous, and planktonic hydrocarbons. The two samplings at the Central Transect suggested an influx of low UCM terrigenous material occurred between Cruises I and II. This terrigenous material consisted primarily of bulk organic matter and plant biowaxes. The material being transported to this area appeared to be compositionally constant with

84-G-4 Grain Size

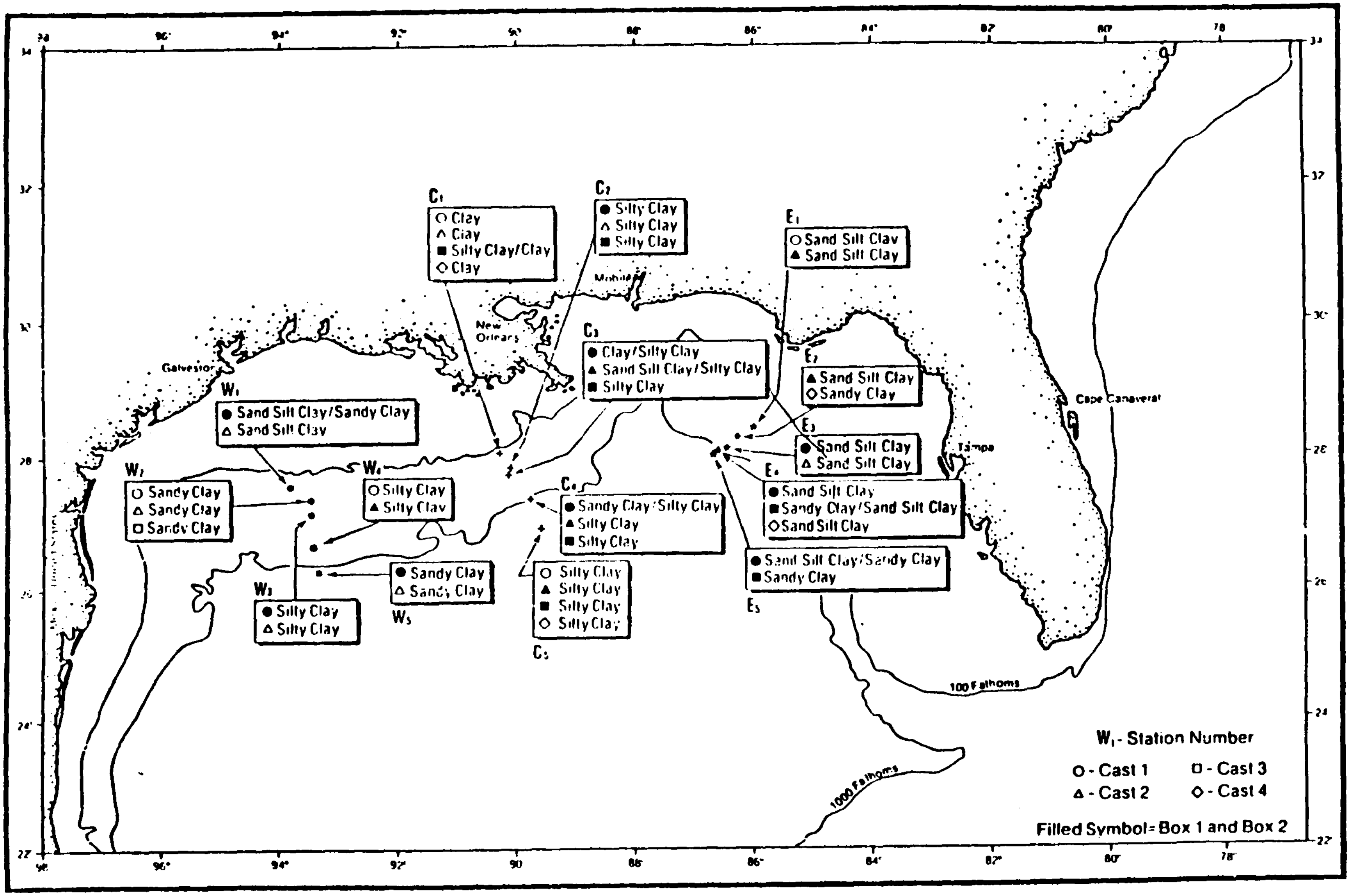

Figure 4. Grain size types (after Folk, 1974) at Cruise II stations.

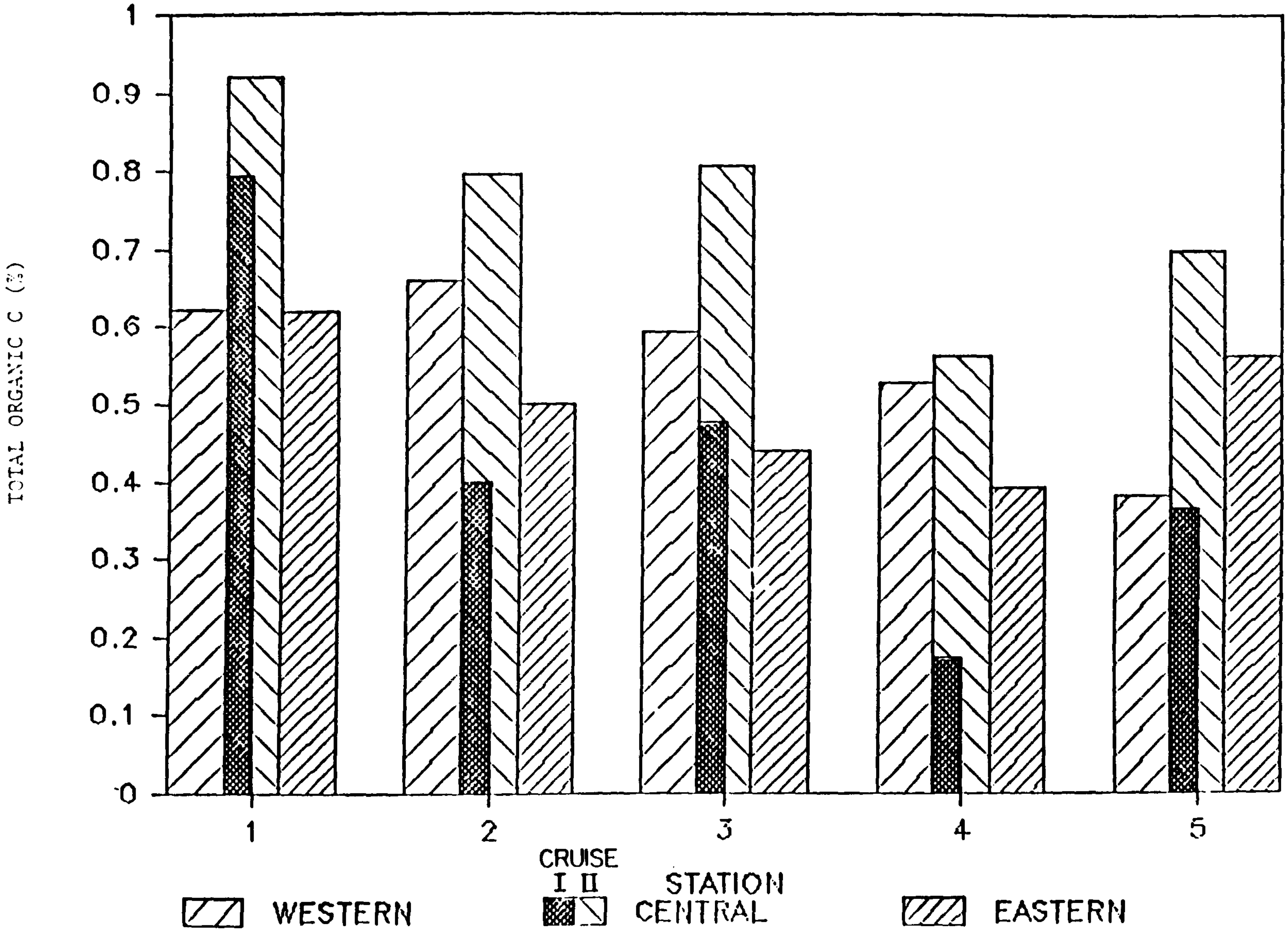

Figure 5. Average percent benthic total organic carbon for stations along the West, Central and East Transects, Cruises I and II.

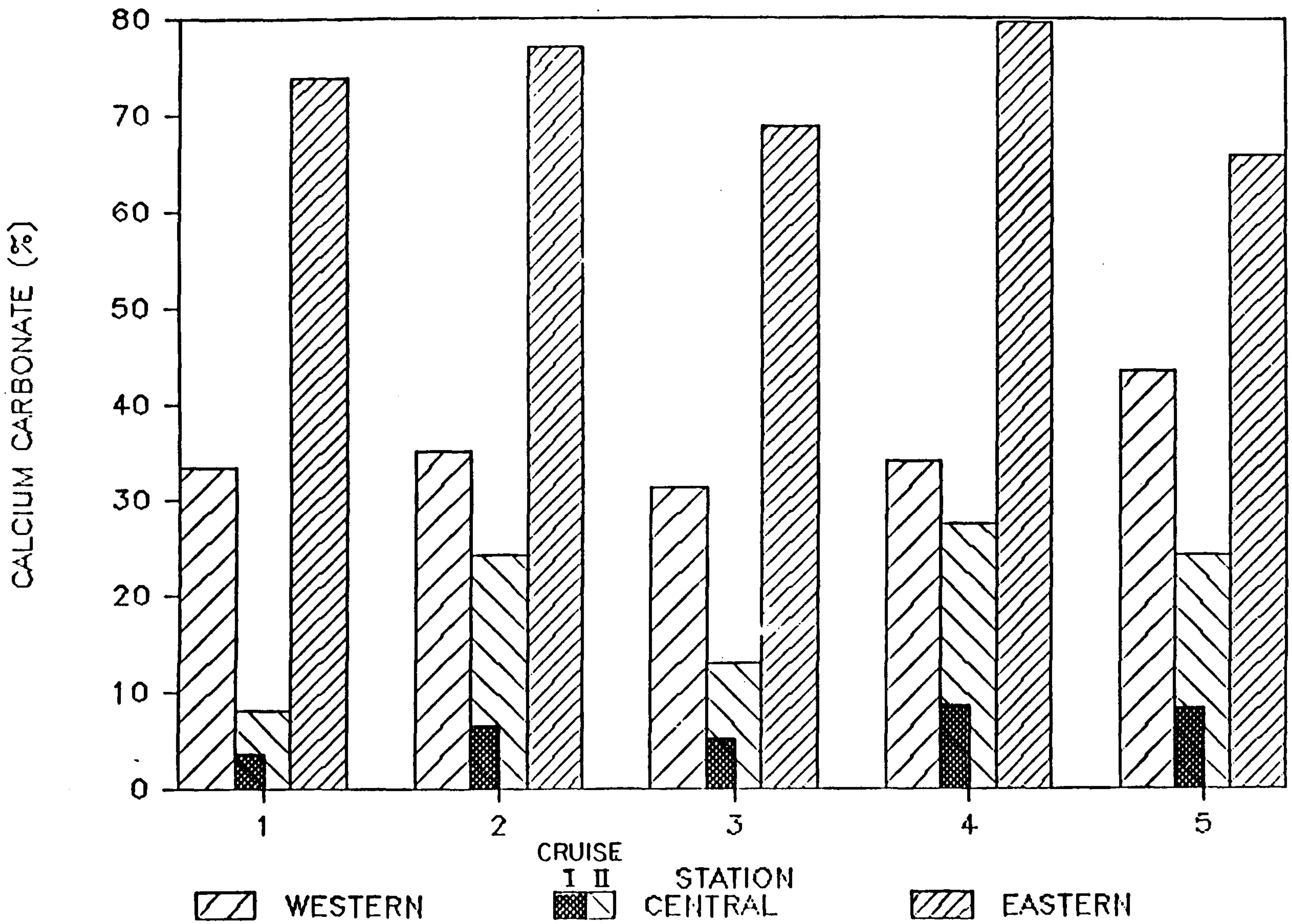

Figure 6. Average percent calcium carbonate for stations along the West, Central, and East Transects.

time. The biowaxes were accompanied by a low molecular weight UCM and by $n-C_{15}$ to $n-C_{19}$ compounds. The higher molecular weight UCM appeared to accumulate in place and was much more highly degraded than the terrigenous material. Piston coring in the Gulf of Mexico intraslope has demonstrated that the Central Transect is in an area of active natural oil seepage. Piston cores sampled at these sites generally showed an increase in hydrocarbons with depth. This suggests that the source of the high molecular weight UCM in the sediments is upward migration, though transport of anthropogenic hydrocarbons to the sediment by water column particulates cannot be ruled out.

The influence of riverborne material in the sediments decreased from the Central to the West to the East Transect. The reduced hydrocarbon levels in the East Transect were primarily due to smaller terrigenous and thermogenic inputs. Planktonic and algal inputs were difficult to discern in the West and Central Transects, but were readily apparent in the East Transect as shown by the numerous alkenes detected. This may be due to more rapid sedimentation rates at the Central and West Transects and/or the large input of riverine material causing rapid dilution of oceanic detritus. Elevated microbial activity in the sediments and/or in the water column may also assist in removing the more labile marine debris.

In general, hydrocarbons were only present in low concentrations in the sediments, especially at the East Transect. Aliphatic hydrocarbon levels ranged from ~10 to 50 ppm. Aliphatic hydrocarbon levels recorded in the literature range from 1 to 3000 ppm. The low concentrations generally occur in very sandy areas, whereas the high concentrations occur in polluted, shallow waters. In areas of pervasive seepage on the Gulf of Mexico slope, aliphatic hydrocarbons have been measured in excess of 100,000 ppm.

With one exception, all organisms surveyed for hydrocarbon contamination appeared to be pristine. The exception was a pooled sample of shrimp (*Nematocarcinus rotundus*, five individuals) from Station E3. A complete suite of alkanes and the unresolved complex mixture present in this sample strongly suggested petroleum contamination. However, bottom tars were also collected in this trawl. The shrimp may have become contaminated in the trawl, but one would expect that contamination during sampling would have been confined to the exterior hard parts.

BIOLOGICAL FEATURES

Biological studies include investigations of the meiofauna (organisms passing through a 0.30 mm screen but retained on a 62 micron screen), the macroinfauna (organisms retained on a 0.30 mm screen) and the megafauna which were sampled by trawling. The meiofaunal collections from the Central Transect for Cruises I and II indicated a substantial increase in density occurred in April 1984 as compared to levels observed in November 1983, particularly at the shallowest station (Fig. 7). There was also a marked change in the relative abundance of major taxa, namely the increased relative abundance of Foraminifera. The density data for the Central Transect suggested a trend of decreasing abundance of meiofauna with depth.

Comparisons of the three geographic regions in terms of meiofauna density and composition showed the Central Transect to have had the highest levels as well as a higher proportion of Foraminifera than was present in collections from the other two transects (Fig. 8). Whereas the collections from the Western Transect exhibited a moderate decline in abundance with depth, no such trend was observed for samples from the Eastern Transect.

The meiofaunal collections are yielding good numbers of a newly described phylum, the Loricifera, and the poorly-known kinorhynchs. Both groups contain at least genera and species new to science. It is now known that the Loricifera are not restricted to shallow, sandy substrates, given that collections have been taken as deep as 2530 m on clay bottoms.

Density levels of macroinfauna from the slope taken during this study are markedly higher (range was from 2435 to 8628 organisms/m^2) than levels previously reported from the Gulf of Mexico slope and abyss (25 to 1095 organisms/m^2). Our samples were screened with a seive having 0.30 mm mesh whereas the previous study used a 0.42 mm mesh. The typical macroinfauna we are seeing from the samples are minute, making weighing impractical without destroying the samples. The size feature probably also accounts, in large part, for the disparity between our and previous measurements of macroinfaunal density from deep-Gulf habitats.

The seasonal data for the macroinfauna from the Central Transect also suggested an increase in density in April 1984 as compared to November

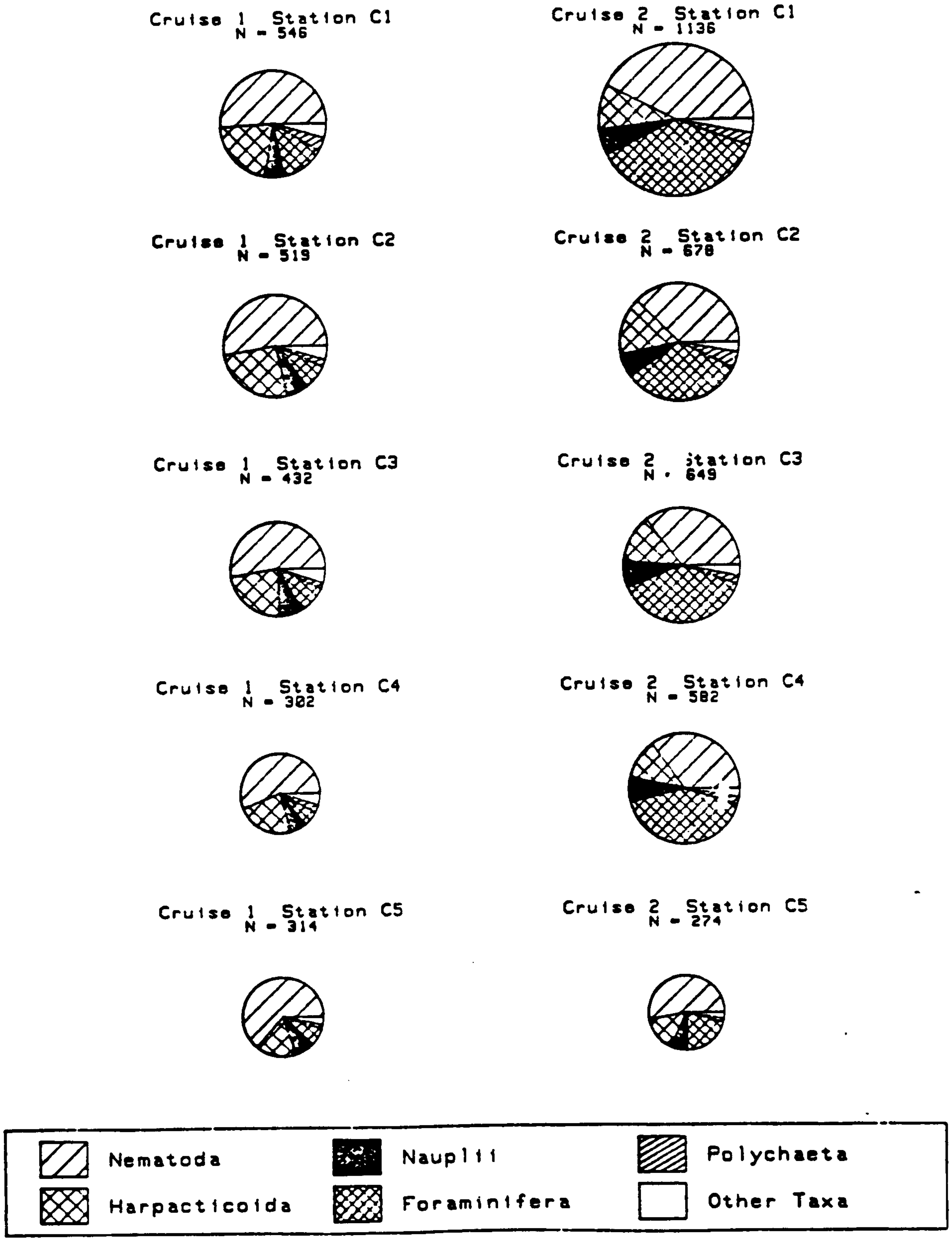

Figure 7. Comparison of meiofauna densities (no./10 cm^2) between Cruises I (November 1983) and II (April 1984) on the Central Transect. Note the large increase of forams in Cruise II diagrams. Comparisons can be made on both axes.

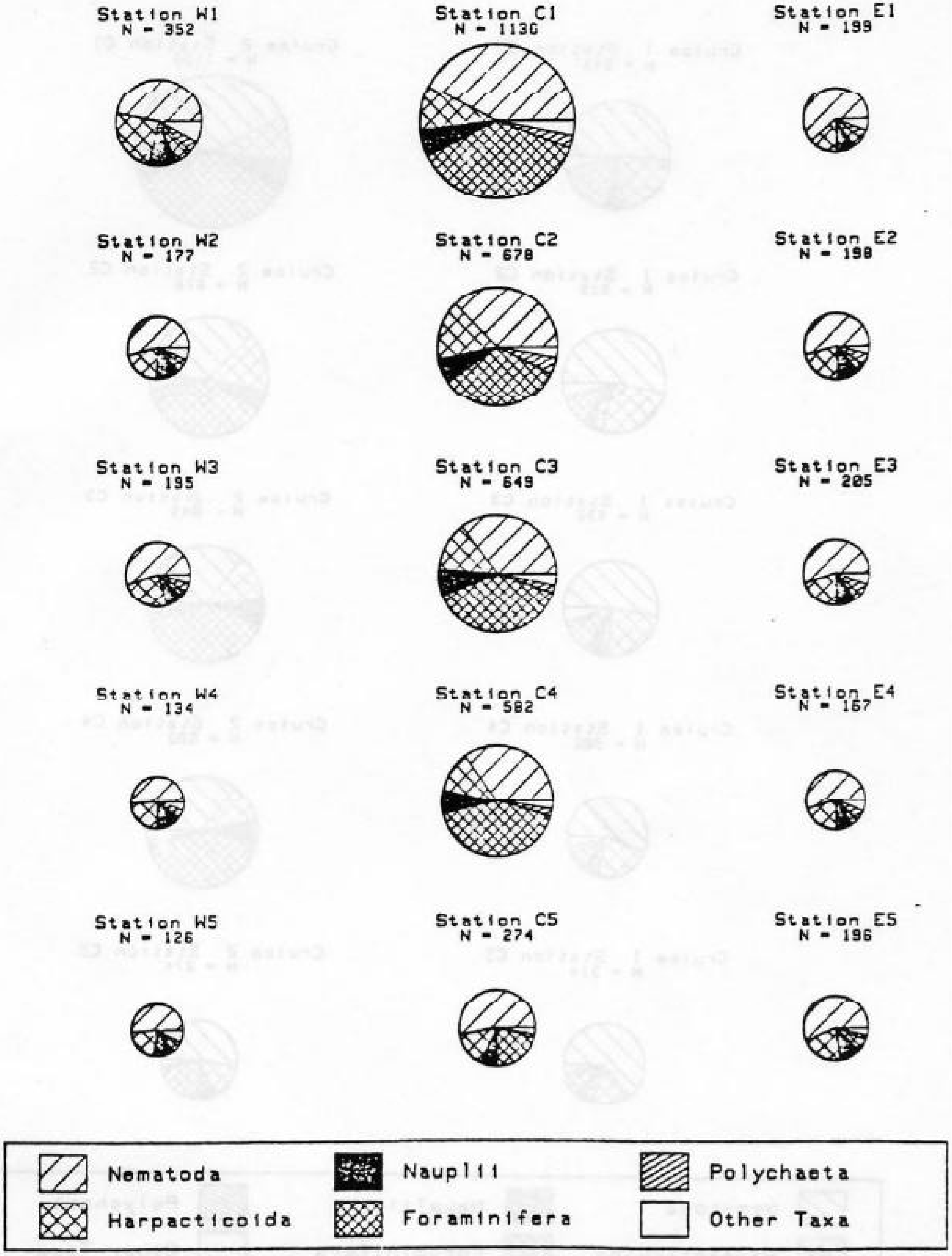

Figure 8 . Comparison of meiofauna densities (no./cm^2) obtained during Cruise II (April 1984). Comparisons can be made on both axes.

1984, but the increase was not nearly as pronounced as the change observed for meiofauna (Fig. 9). On the Central Transect, density of macroinfauna did not exhibit a pronounced decrease with depth, but there was an obvious decline in abundance at 2530 m (Station C5). Polychaetes were the numerical dominants at all depths on the Central Transect except at 2530 m where nematodes of a macroinfaunal size equalled or exceeded the relative numbers of polychaetes.

Macroinfaunal densities on the Eastern and Central Transects were higher than the density of organisms found on the Western Transect (Fig. 10). The Western Transect also differed in that macroinfaunal density exhibited a decline with depth. On both Central and Eastern Transects, density levels were rather consistent from 348 to 1341 m, dropping sharply at 2530 m.

The macroinfaunal groups which have been sorted to the species level are exceedingly diverse and contain many new species and genera. The taxonomist for the tanaidacean collections has indicated that once all the specimens from Cruise II are described, it will increase the number of known species, world-wide, by 20%.

Of the megafauna collected to date, the decapod crustaceans, echinoderms and demersal fish collections have been identified to the species level. There were 78 species of decapods (led in variety by the anomurans, including the galatheids), 33 species of echinoderms (not including the brittle stars) and 94 species of fish representing 42 families. Bathymetric distributional patterns of the megafauna collected to date agree very closely with previous work, providing credence to historical faunal zonation and assemblage characterization schemes based upon the megafauna.

The benthic photography aspect of the program to date has been mainly devoted to the development of quantitative analytical procedures which have now been finalized. Preliminary results of photographic analysis for Stations W1, C1, and E1 from Cruise II indicate Station C1 was characterized by a greater density of both biota and Lebensspuren than the other two stations.

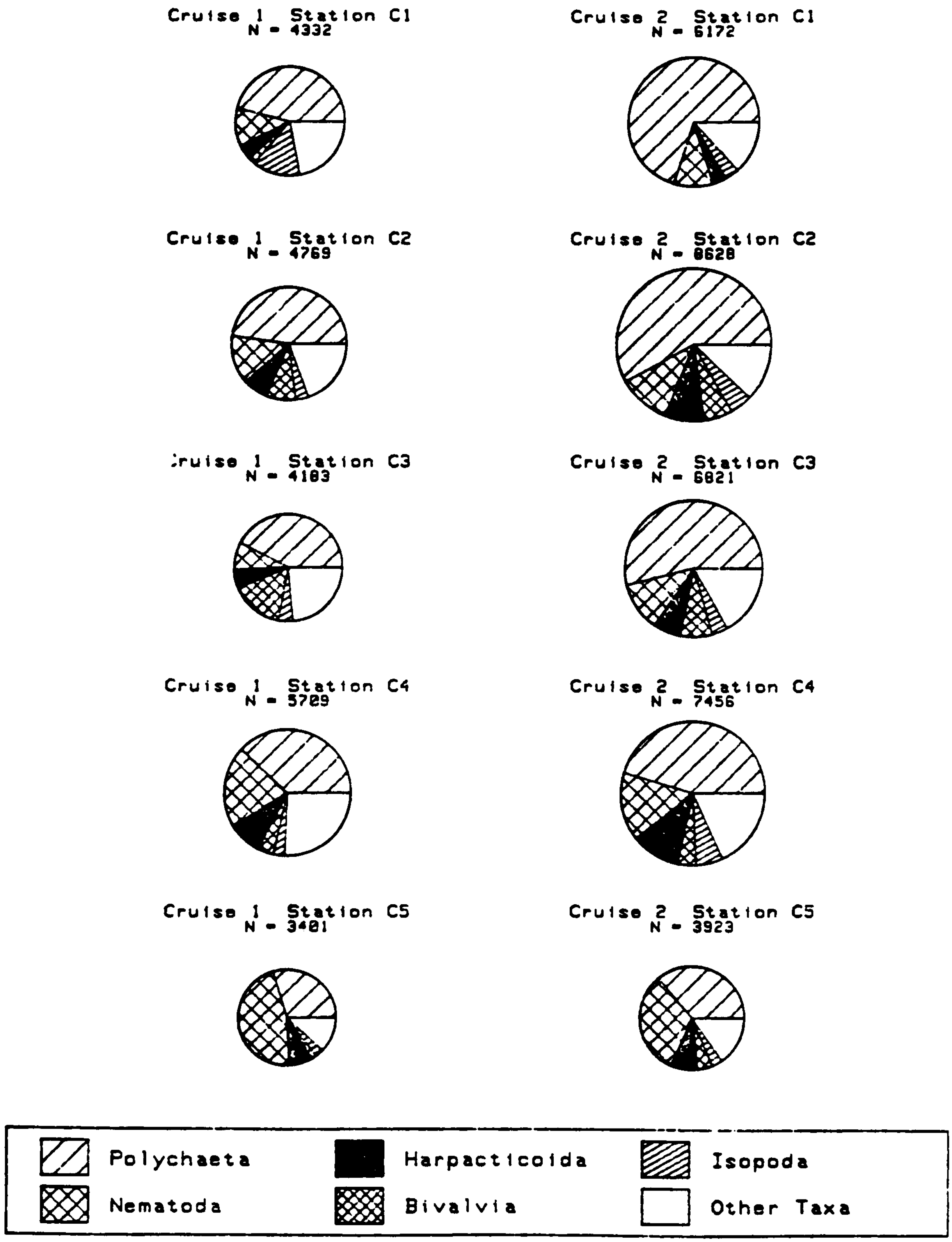

Figure 9. Comparison of macroinfauna densities (no./m^2) between Cruise I (November 1983) and Cruise II (April 1984) stations.

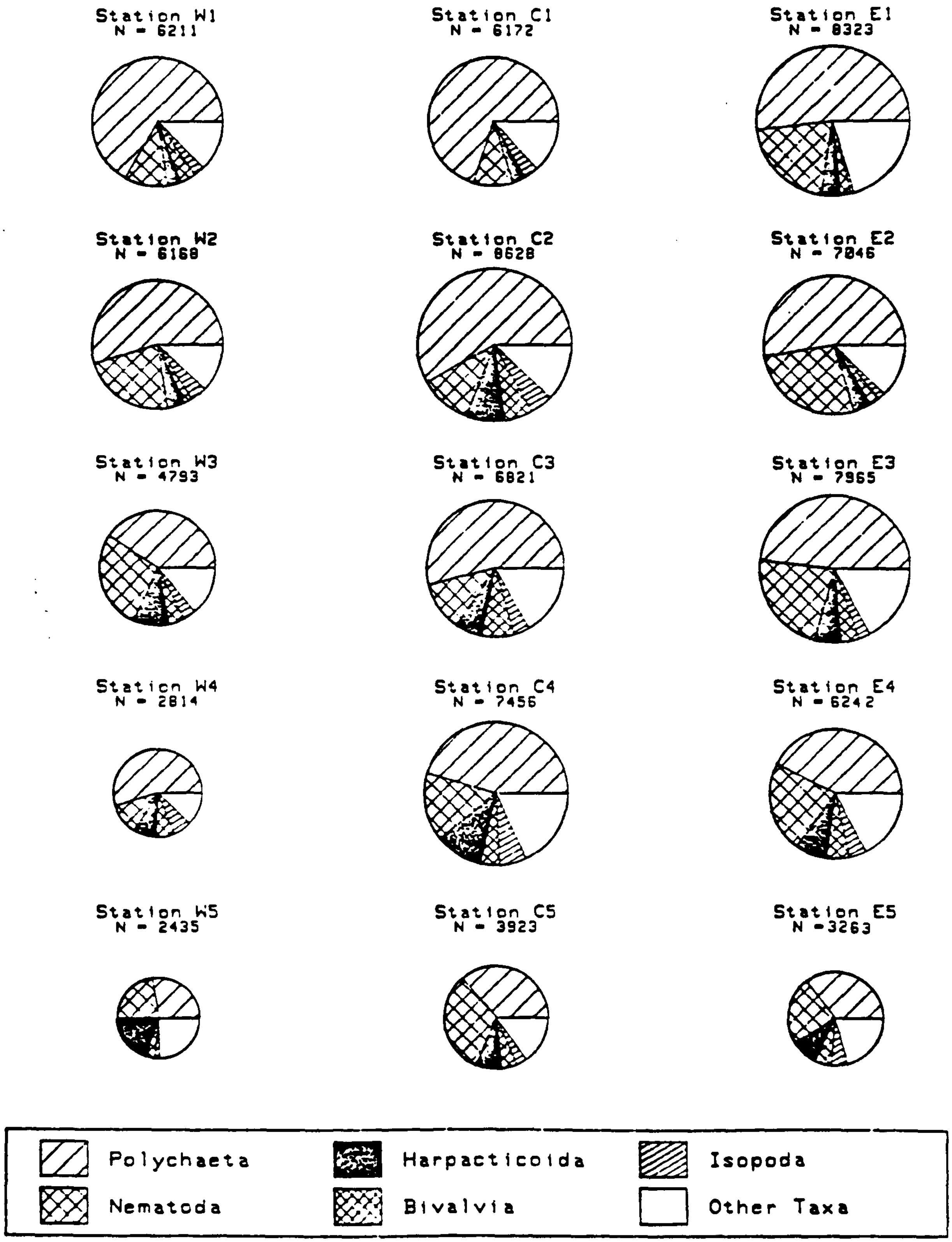

Figure 10 . Comparison of macroinfaunal densities (no./m^2) obtained during Cruise II (April 1984).

CONCLUSIONS

Few conclusions can, or should, be made at this early point in the program. However, it would appear that there are marked regional differences in the slope environment and biota, as well as seasonal changes. The latter may prove to be related, in large part, to the influence of river discharge.

From the standpoint of hydrocarbon contamination, the slope environment and biota have thus far appeared pristine, or nearly so. Natural seeps are prevalent in the vicinity of the Central Transect and may, in fact, provide an additional source of energy to newly discovered chemosynthetic communities in this region. Data from Cruise III suggest this to be the case. The results of that cruise will be described in subsequent reports.

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.