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PLANKTONIC FORAMINIFERAL ECOLOGY OF THE EASTERN EQUATORIAL PACIFIC OCEAN: INCLUDING A PALEOCEANOGRAPHIC RECONSTRUCTION OF THE PANAMA BASIN FOR THE LAST 320,000 YEARS

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PLANKTONIC FORAMINIFERAL ECOLOGY OF THE EASTERN EQUATORIAL PACIFIC OCEAN: INCLUDING A PALEOCEANOGRAPHIC RECONSTRUCTION OF THE PANAMA BASIN FOR THE LAST 320,000 YEARS

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by

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I hereby recommend that the thesis prepared under my supervision by MARC SELIG SVERDLOVE

entitled PLANKTONIC FORAMINIFERAL ECOLOGY OF THE EASTERN EQUATORIAL PACIFIC OCEAN: INCLUDING A PALEOCEANOGRAPHIC RECONSTRUCTION OF THE PANAMA BASIN FOR THE LAST 320,000 YEARS

be accepted as fulfilling this part of the requirements for the degree of DOCTOR OF PHILOSOPHY

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

It is recognized that the ecology of planktonic foraminiferal assemblages provides information about the chemical and physical properties of the water in which they live. Their areal and vertical distributions in the water column and in deep-sea sediments may be used to derive oceanographic and climatic models of Recent and past oceans.

A seasonal study of surface and vertical plankton tows in the eastern equatorial Pacific and the Panama Basin indicates that the distribution of various species reflect their affinity for distinct water masses, currents and thermoclinal depths. One species, Globorotalia inflata is almost totaly absent in the Panama Basin and is restricted to the region of convergence between the North Eqautorial and California Currents.

Calcium carbonate corrosive waters selectively filter out more susceptable species, favoring the accumulation of more resistant species on the ocean-floor. This distortion of the sedimentary record does not permit total accuracy of the ecological-paleocecological model. However, a significant amount of paleoecological information was derived using the 11 most resistant species.

A Q-mode factor analysis of 52 trigger weight core top samples yielded 5 planktonic foraminiferal assemblages: 1) *Neogloboquadrina dutertrei* (5 or more chambers), 2) *Globorotalia menardii-tumida* complex, 3) *Neogloboquadrina pachyderma*, 4) *Globorotalia inflata*, and 5) *Neogloboquadrina dutertrei* (4 - 4 1/2 chambers). Using multivariate stepwise regression these faunal assemblages were calibrated to observed seasonal surface temperatures and temperatures and depths of the thermoclinal layers. Eight transfer functions were used to estimate Late Pleistocene and Holocene seasonal temperatures at the surface and within the thermocline.

Application of these paleoecologic equations to cores V19-29 (3° 35' S.;83° 56' W.), V21-29 (0° 57' N.;89° 21' W.) and V21-212 (2° 50' N.;85° 8' W.) results in a paleoecologic model. For the last 320,000 years, at site V19-29, oceanic conditions were much like the Recent except between 36,000 - 18,000 B.P. *G. inflata* became a significant faunal constituent, although its abundance remained low in the other two cores. This suggests a cooling of the surface and a depression of the thermal structure between the Galapagos Islands and Ecuador, and is interpreted to reflect the development of a sharp convergence between an intensified and surfaced Equatorial Undercurrent and the increased flow of the Peru and South Equatorial Currents.

I. INTRODUCTION

Since Schott's (1935) pioneering study of deep-sea cores (from the Meteor Expedition) describing differences between Recent and glacial planktonic foraminiferal assemblages, micropaleontologists have used marine microfossils to decipher Pleistocene paleoceanography. Imbrie and Kipp (1971) developed the factor analysis/regression analysis, transfer function method for estimating Pleistocene sea-surface temperatures and salinities from microplankton data obtained from deep-sea cores. Their technique has been used to develop ecologic models for the Recent world's oceans, and derive global reconstructions of Pleistocene sea-surface temperature 18,000 years before present (B.P.) (CLIMAP project members, 1976). Previous investigations by the CLIMAP group inferred sea-surface temperatures for the last ice age based on the ecologic relations between various marine microplanktonic organisms and the waters of the Pacific (Moore et al., 1980) For the most part, CLIMAP investigated major oceanic regions and the marginal seas and basins were left for later inquiry. To date, the planktonic foraminifera from the eastern equatorial Pacific Ocean, and the Panama Basin in particular, have only been cursorily investigated. The Panama Basin is nearly oceanographically isolated from the rest of the Pacific as the North and South Pacific anticyclonic gyres skirt the region. Upwelling along the Central and South American coasts, due to the prevailing trade winds, brings nutrient rich waters to the surface and induces high productivity levels. This, in turn, indirectly increases the dissolution rates of planktonic foraminifera within the sea-floor sediments, which are already high in the Pacific.

The main goals of this dissertation are to study the ecology of planktonic foraminifera within the region from 140° W. longitude to the American coastline between 30° N. and 10° S. latitude. and to attempt a reconstruction of the Panama Basin oceanic circulation during the Late Pleistocene and Holocene. Therefore, this study endeavors to decipher the mutual relationships between living planktonic foraminifera and the surface physical oceanography of the study area, and to derive a paleoceanographic model based on fossil foraminiferal data from deep-sea cores.

To achieve these goals a multi-faceted approach is needed. At the outset, it is necessary to describe the Recent physical oceanography of the region in sufficient detail in order to appreciate the complexity and seasonal variability of the distribution of its ocean currents and variations of its thermal structure (ie., vertical temperature distribution).

For the purpose of examining the ecology of living planktonic foraminifera, a series of near surface plankton tows from several ship tracks may be examined. The distributions of assemblages of foraminifera are considered in the context of the characteristics of the various oceanic water masses in which they live. In addition foraminiferal populations from known depths may be compared to in situ conditions of temperature in order to determine the relationships between the fauna and the thermal structure. This can be accomplished in the Panama Basin, so that for this region it is possible to describe the relationships between foraminiferal assemblages and the ecologic conditions which control their distributions.

In order to determine the biogeographies of the foraminiferal species and investigate the relationships to these oceanic variations it is necessary to examine an array of living populations collected from the upper water column and from the Recent death assemblages recoverd from sea-floor sediments. One must reconcile the differences between these two data sources. Living planktonic foraminifera in the water column represent the instantaneous standing stock, whereas, specimens within the sediment are ideally a result of the seasonal average production of foraminifera over many years. Can an effective comparison be made between living plankton and fossil specimens? A method of "buffering" paleoecologic signals against selective dissolution distortion must be derived. The post-mortem effects upon "normal" assemblages of living planktonic foraminifera may be obtained by sampling the water column at selected depths with plankton nets and sediment traps and subsequently comparing these data to sea-floor sediment sample data.

Using an approach (similar to that of Imbrie and Kipp, 1971), a three-dimensional model of the physical oceanography of the eastern equatorial Pacific Ocean may be derived by calibrating the foraminiferal biogeographies based on Recent sea-floor sediment assemblages to observed values of sea-surface temperatures and depths and temperatures of the thermocline. Regression analysis comparing down-core faunal assemblages from the Panama Basin, and the surface assemblages can estimate a Late Pleistocene to Holocene thermal structure history for this region. As in other oceanic regions, we may expect to find evidence of climatic variations and associated advances and retreats of ice sheets during the last 320,000 years B. P.

II. PHYSICAL OCEANOGRAPHY OF THE EASTERN EQUATORIAL PACIFIC

GENERALIZED CIRCULATION

In his study of surface current trajectories, Wyrtki (1966) divided the equatorial Pacific into eastern, central and western sectors. In the east, the zonal circulation of the central region is gradually developed by the equatorward flow of the eastern boundary currents. This zonal flow dissipates when the western boundary currents turn towards the poles. The shape of the ocean basin and the prevailing Trade Winds combine to divert the flow of the southerly California Current and the northerly Peru Current from the extreme eastern equatorial Pacific (Figure II.1). Figure II.2 illustrates the seasonal variations in the surface oceanic currents of the eastern equatorial Pacific.

The California Current encompasses the bulk southerly flow along the North American coastline. In the spring and early summer, prevailing northwest winds induce coastal upwelling thus maintaining a near-shore component of the southerly flow to approximately 15°N. latitude. There the current divides: most of the water turns westward into the North Equatorial Current, but a minor amount flows southeastward into the tropical Pacific to approximately

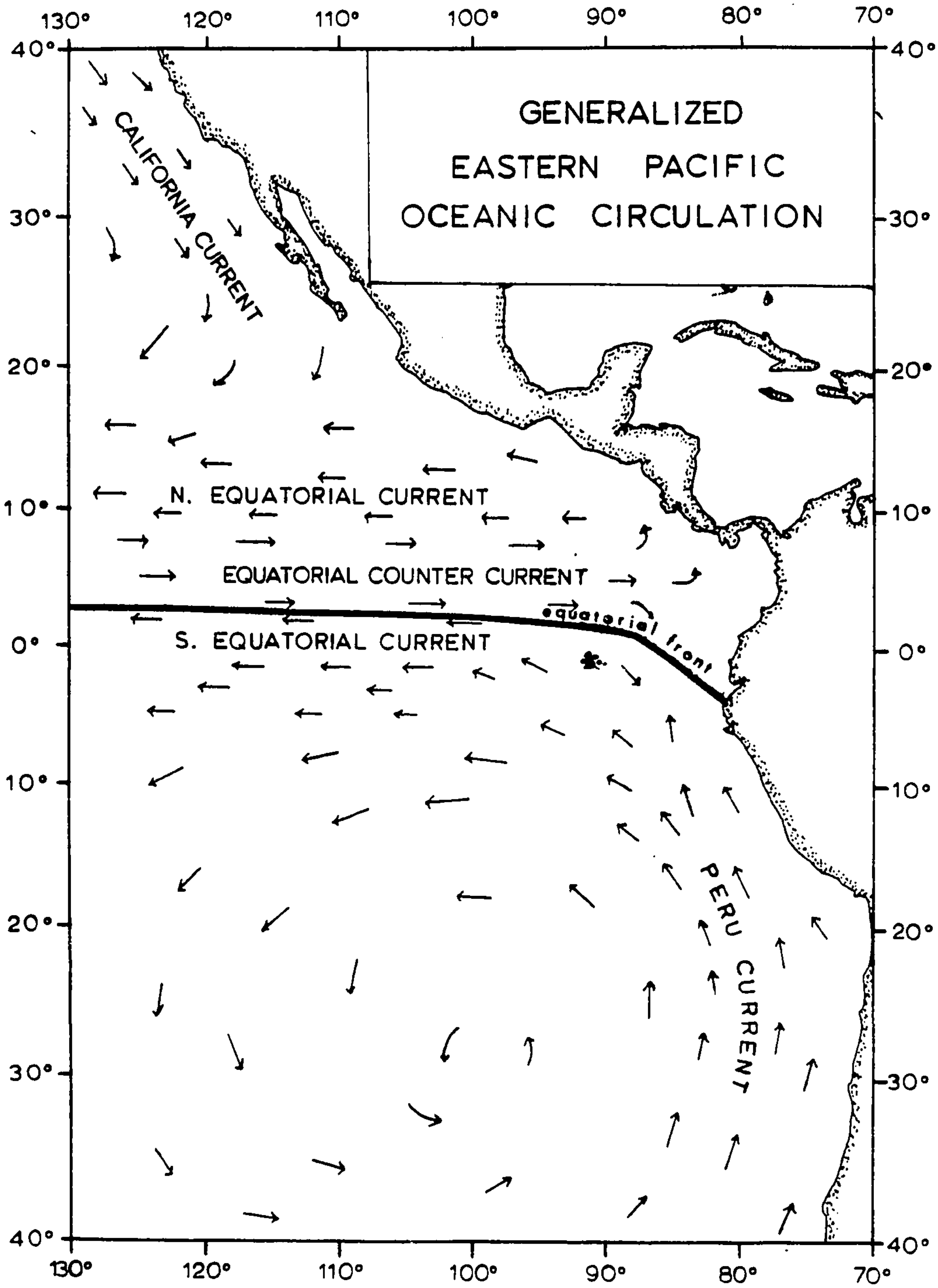


Figure II.1 Generalized sea-surface circulation of the eastern Pacific Ocean.

a.

b.

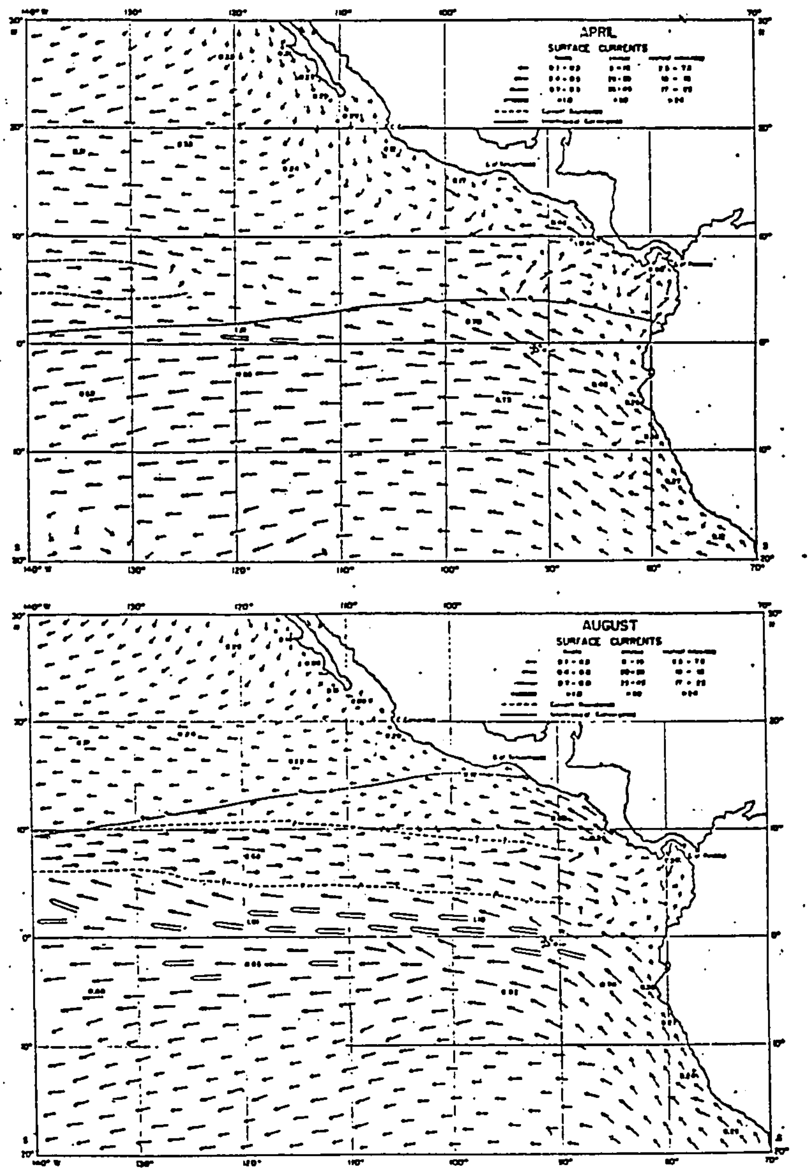


Figure II.2 Eastern equatorial Pacific surface currents. In April (a) the Equatorial Counter Current is absent east of 120° W. longitued. Figure (b) illustrates August Circulation. After Wyrtki (1964b).

100° W. longitude. Between August and December, southwest winds prevail over the west coast of the United States thus inhibiting coastal upwelling. During this season the northerly flowing California Undercurrent intersects the surface. This near-shore northerly flow, commonly referred to as the Davidson Current, displaces the California Current westward. The result is that only the off-shore flank of the California Current reaches the North Equatorial Current (Wyrtki, 1965).

In the southern hemisphere the Peru Current flows from the Antarctic Convergence northward along the South American coastline to approximately 5° N. latitude where it diverges westward to join the South Equatorial Current. Unlike the Davidson Current in the northern hemisphere, the Peru Undercurrent never surfaces because the effects of seasonal changes are minimal upon the pattern of upwelling off Peru and Ecuador.

Throughout the year, in the western and central Pacific, the Equatorial Counter Current flows towards the east between 4° N. latitude and 10° N. latitude. To the east of 120° W. longitude, the characteristics of this current vary greatly on a seasonal basis, depending on the position of the Intertropical Convergence Zone (ITCZ) which separates the north and south Trade Wind systems. From May to

December when the ITCZ is at or near its maximum northerly position (10° N. latitude), the Equatorial Counter Current is well developed. However, by April when the ITCZ has migrated to its maximum southerly location (3° N. latitude), the Equatorial Counter Current vanishes to the east of 120° W. longitude (Wyrtki, 1965).

Two oceanic gyres mark the eastern terminus of the Equatorial Counter Current. Most of the water approaching the Central American coastline circulates around the northern of these gyres known as the Costa Rica Dome (centered at 9° N.; 89° W.). These waters turn west into the North Equatorial Current. The southerly deflected waters are returned to the western Pacific by the South Equatorial Current.

The flow within the North Equatorial Current is induced by the northern Trade Wind system. In the eastern equatorial Pacific, flow is greatest in this current between July and December when transport around the Costa Rica Dome is intensified, and the California Current is weak and off-shore. Between March and July, the California Current extends further to the south and east. It becomes the major source of the North Equatorial Current to the west of 100° W. longitude. During this season, further to the east, the North Equatorial Current is weak because flow around the

Costa Rica Dome is diminished (Wyrtki, 1965).

The southern Trade Wind Belt extends into the northern hemisphere and forces the South Equatorial Current to straddle the equator. Wyrtki (1966) and Pak and Zaneveld (1974) have shown that this current is not a simple extension of the Peru Current and that a major source of its water arises from the Equatorial Undercurrent in the zone of equatorial divergence.

The Equatorial Undercurrent is a major easterly flowing subsurface current which is approximately 200 m thick and 300 km wide; it attains maximal velocities of 150 cm/sec. Its pattern of flow is symmetric about the equator at an average depth of 100 m (Cromwell et al., 1954; King et al., 1958; Knauss, 1960). Above the Equatorial Undercurrent, a thin surface layer flows westward as part of the South Equatorial Current (Figure II.3).

As the Equatorial Undercurrent approaches 90° W. longitude it divides into several branches prior to reaching the Galapagos Islands. A southern branch, identified by White (1969), extends eastward towards Ecuador and Peru where it supplies much of the water which wells up in that region (Wyrtki, 1963, 1966). However, most of the Equatorial Undercurrent waters are diverted to the north of the

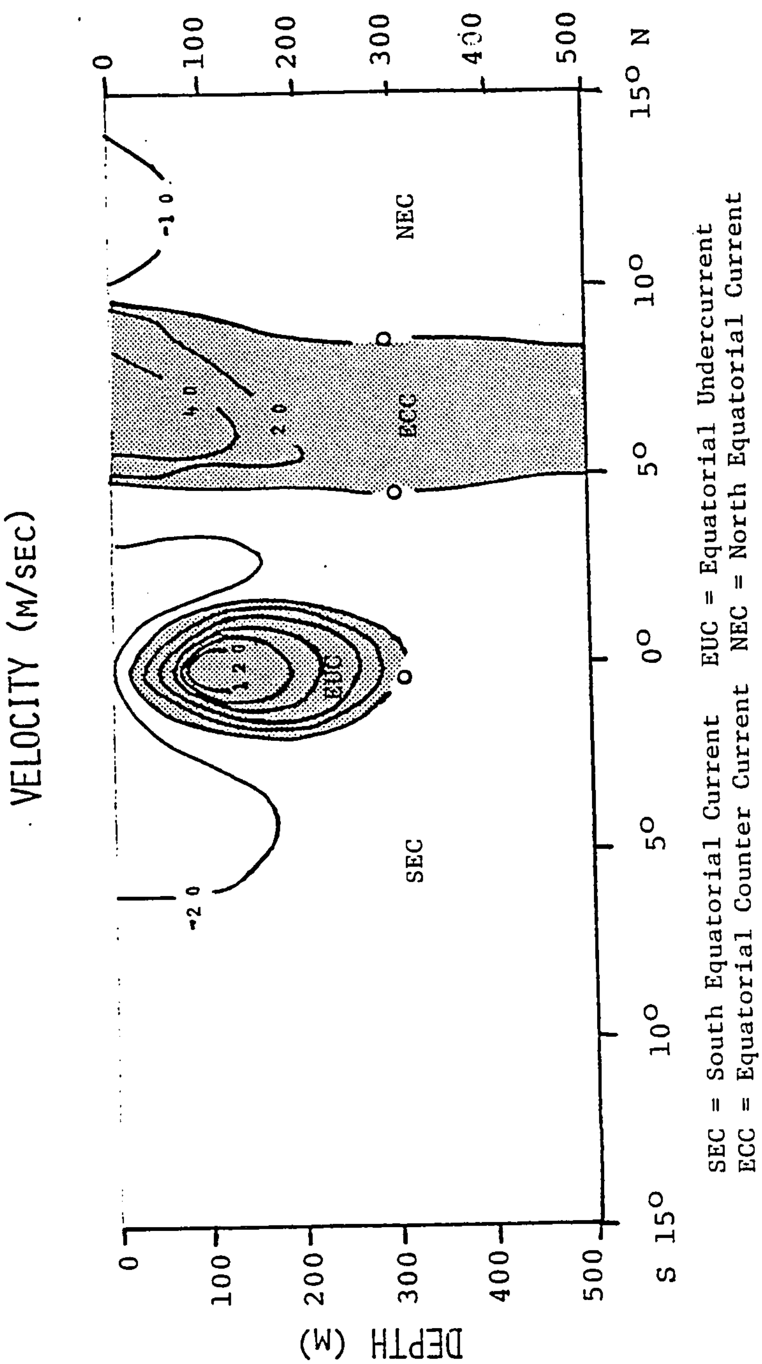


Figure II.3 Generalized cross-section along 140° W. longitude from 15° N. to 15° S. latitude illustrating the relationships between the Equatorial Undercurrent and the surface currents of the equatorial Pacific Ocean (After Knauss, 1960).

Galapagos Islands. These waters continue eastward near the equator (Pak and Zaneveld, 1973) where they subsequently well up to become integrated with surficial waters in a complex fashion (Pak and Zaneveld, 1974).

WATER MASSES

Between 4° N. and 15° N. latitude, in the eastern equatorial Pacific, rainfall exceeds evaporation by more than 50 cm per year (Wyrtki, 1966). This condition results in the formation of Tropical Surface Water which has a high temperature (above 26° C). and a low salinity (below 34 ‰). This water circulates in the Equatorial Counter Current and the North Equatorial Current. Subtropical Surface Water, which flows in the South Equatorial Current and the northern Peru Current, forms in regions where evaporation exceeds precipitation. Consequently this water's salinity is always greater than 35 ‰, although its temperature is variable (15°C to 28°C). In the vicinity of the Galapagos Islands, Subtropical Surface Water, seasonally advected by the Peru Current, mixes with upwelling waters from the Equatorial Undercurrent and with Tropical Surface Water from the northern hemisphere to form a variable, complex mixture termed Equatorial Surface Water by Wyrtki (1966).

During the southern winter, the well-mixed surface layer in the South Pacific Anticyclone becomes very deep. The deeper layers of the Subtropical Surface Water in this region extend northward as a subsurface salinity maximum. This water, referred to as Subtropical Subsurface Water, flows northwestward towards the equator until it encounters the Equatorial Undercurrent where transport becomes eastward.

In most regions of the ocean, the physical property gradients of the water are extremely gradual, and only in the localized areas of oceanic fronts do abrupt changes occur. The Equatorial Pacific Front, which extends east-west between 2°N. and 4°N. latitude, separates the colder, normally saline Subtropical Surface Water in the South Equatorial Current from the warmer, less saline Tropical Surface Water of the northern hemisphere (Cromwell and Reid, 1956; Knauss, 1957; Wyrtki, 1966). To the east of Galapagos Islands, the Equatorial Pacific front curves towards the southeast and extends to approximately 4°S. latitude off the coast of Ecuador (Wyrtki, 1966; Wooster, 1969). Pak and Zaneveld (1974) demonstrated that the front, in this region, is maintained by seasonal advection of Peru Current waters and the almost continuous supply of upwelling water from the Equatorial Undercurrent.

The Pacific Equatorial Front is a quasi-stable feature in the region to the east of the Galapagos Islands. Its position is controlled by advection of water masses on either flank due to the influence of the prevailing winds, and pressure and/or density gradients (Bjerkness, 1961). Normally, during February and March, warm surface waters extend only a few degrees south of the equator. However, on occasion the front is displaced southwards so that warm surface temperatures prevail as far south as 12°S. latitude. This condition is known as El Niño.

Bjerkness (1961) suggested that a reduction in the strength of the southern Trade Winds would result in the displacement of the Pacific Equatorial Front, thus causing El Niño. A modified explanation for El Niño was postulated by Wyrtki et al., (1976). Their model proposes a period of increased Trade Winds lasting more than one year. This is thought to cause an intensification of the South Pacific Anticyclone, and a build up of an east-west sea level slope in the equatorial Pacific due to the accumulation of seawater in the western Pacific. When the winds return to normal, the accumulated water will return to the eastern Pacific with the Equatorial Counter Current and the Equatorial Undercurrent thus accumulating excess water off the coasts of Peru and Ecuador, causing El Niño. During El

Niño the excess surface waters cause a depression of the thermocline (Wyrtki et al., 1976).

THERMAL STRUCTURE

Thermoclinal Layers

The thermal structure of tropical oceanic regions is characterized by three layers. A mixed layer, due to wind-induced turbulence, exists near the surface. In this layer temperature remains relatively constant with depth. Below the mixed layer is the thermocline where temperature decreases rapidly over a short depth interval. Beneath the thermocline, in the subsurface layer, temperature decreases by less than 0.2°C/10 m depth (Defant, 1936). The depth of the thermocline is controlled by the intensity of the incident radient energy received from the sun and the rate of vertical mixing of the ocean. One generally finds stronger, shallow thermoclinal structures in the tropics where the sea-surface is heated more thoroughly, and deeper thermoclines in the mid-latitudes where less heating occurs and greater seasonal atmospheric temperatures produce stronger winds for mixing.

Wyrtki (1964b) illustrated the topography of the thermal structure layers in the eastern equatorial Pacific on a seaonal basis with a series of maps. The boundaries of the various surface currents are delineated on these maps as parallel ridges and troughs (Figure II.4). Zones of divergence along the equator and the northern boundary of the Equatorial Counter Current are clearly indicated as ridges, and the southern boundary of this current (a zone of convergence) is depicted as a trough in the thermocline topography.

The thermocline in the Panama Basin, to the north and east of the Galpagos Islands averages only 50 m in depth (Figure II.4). The development of this shallow thermocline is enhanced by the unusually low seasonal surface salinity, of 22 ‰ (Reid, 1969). Figure II.5 illustrates the vertical distributions of temperature and salinity within the water column of the Panama Basin at 5°20' N.; 81° 50' W. during July of 1979. The presence of a warm, low salinity cap above denser, cooler, normally saline waters produces a highly stable condition. Only limited overturn of the upper water column can occur, thus favoring the development of the strong, shallow thermocline. The depth of the thermocline increases dramatically beyond the eastern boundary currents, within the central water masses of the Pacific anticyclonic

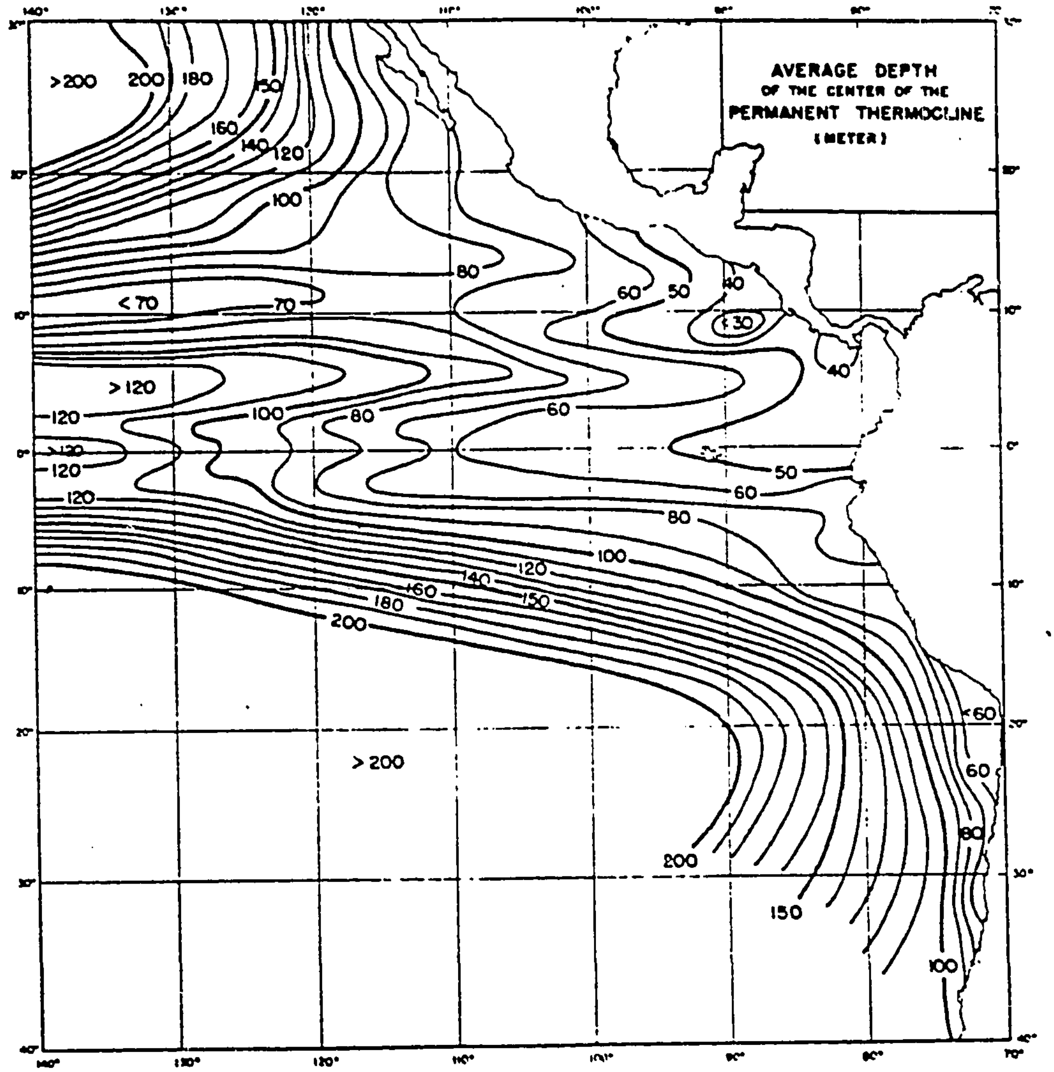


Figure II.4 Topography of the center of the permanent thermocline. Troughs and ridges occur at the margins of the various currents in this region (After Wyrtki, 1964b).

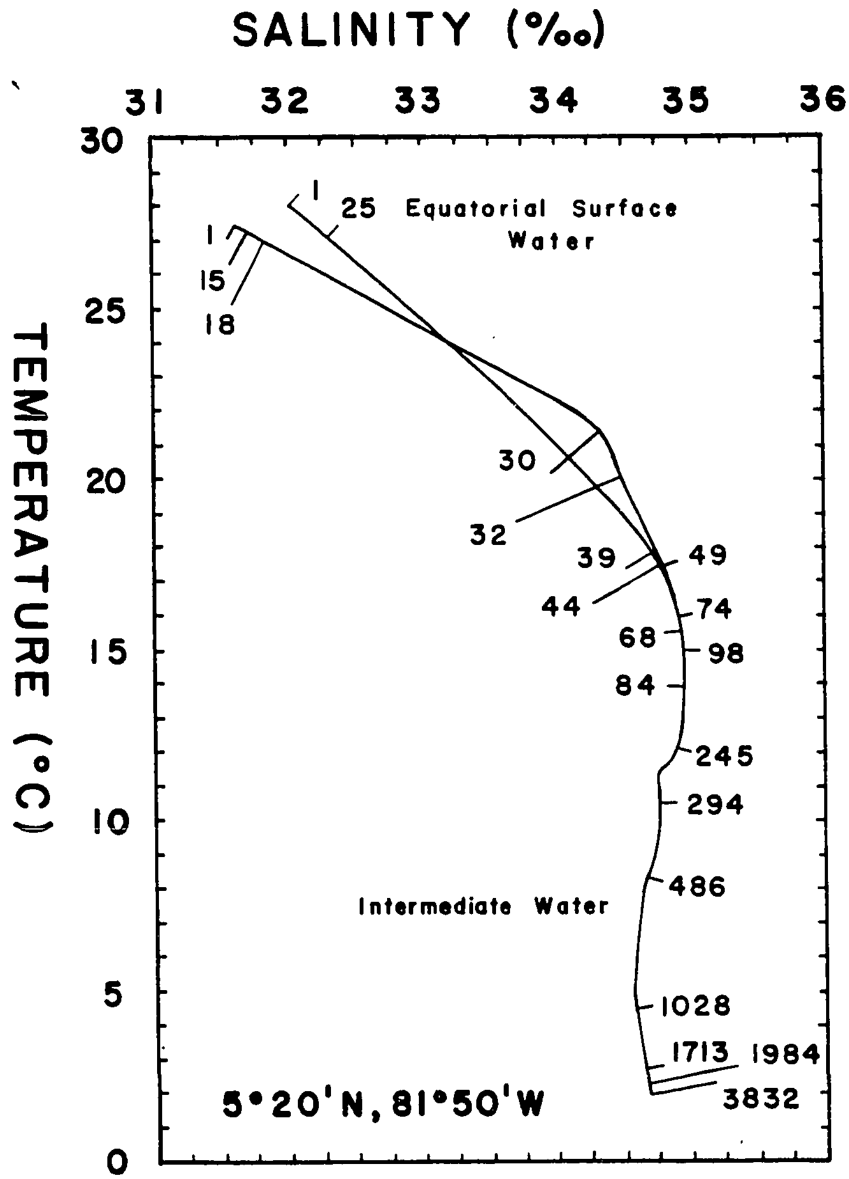


Figure II.5 Temperature - Salinity diagram for the Panama Basin showing oceanic conditions prevailing between July 27 and August 8, 1979 at 5° 20' N.; 81° 50' W. Figures along curves denote depth in m. A shallow, steep thermocline exists between 25 and 35 m.

gyres (Figure II.4). In these areas deep mixed layers are present, especially during the winter months.

Cross-section representations of the seasonal variations in the thermal structure of the eastern equatorial Pacific (Figure II.6) have been prepared as follows. An unpublished computer listing of seasonal sea-surface temperatures, at two degree intervals of latitude and longitude, for the Pacific Ocean was provided by D. Hahn of the Geophysical Fluid Dynamics Laboratory, Princeton University. Data values for locations between these points were interpolated from the listing. Depths of the base of the mixed layer, and of the center of the thermocline, as well as values for the average thermal gradient within the themocline, were obtained from Wyrtki's (1964b) monthly data maps. Using the assumption that the temperature at the base of the mixed layer (Tm) is equivalent to the overlying sea-surface temperature, temperatures at the center of the thermocline (Tth) were calculated:

$$Tth = Tm - \langle G\ (Dth - Dm) \rangle,$$

where G = the thermal gradient within the thermocline, Dth = the depth of the center of the thermocline, and Dm = the depth of the base of the mixed layer.

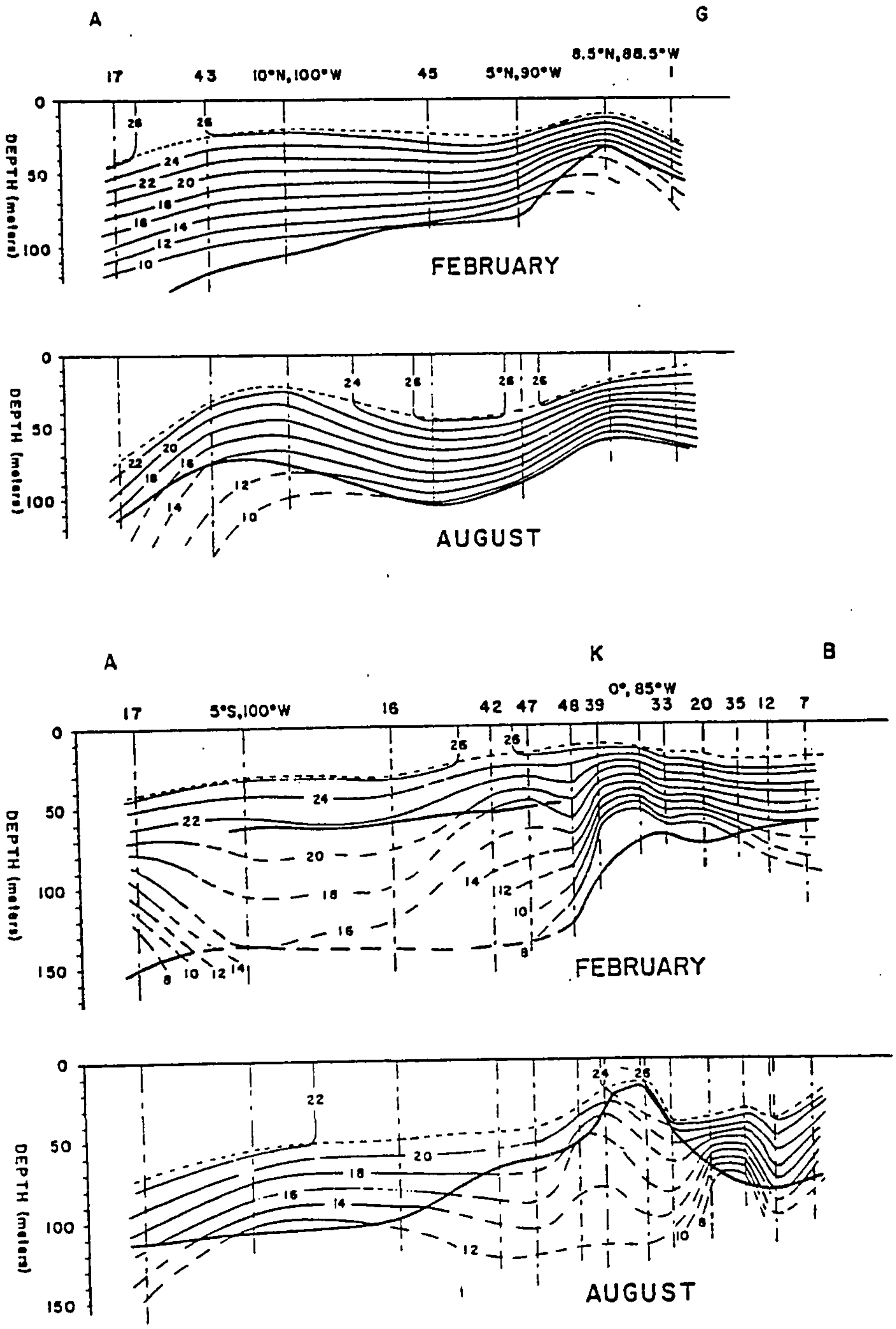


Figure II.6a, 6b Seasonal temperature (°C) profiles for the eastern sector of the study area. Locations of sections are shown in Figure II.7 with capital letters A-K. Stations identified by latitude; longitude or plankton station numbers in Figure III.1. Data derived, as described in text, from Wyrtki (1964b) and Hahn (unpublished).

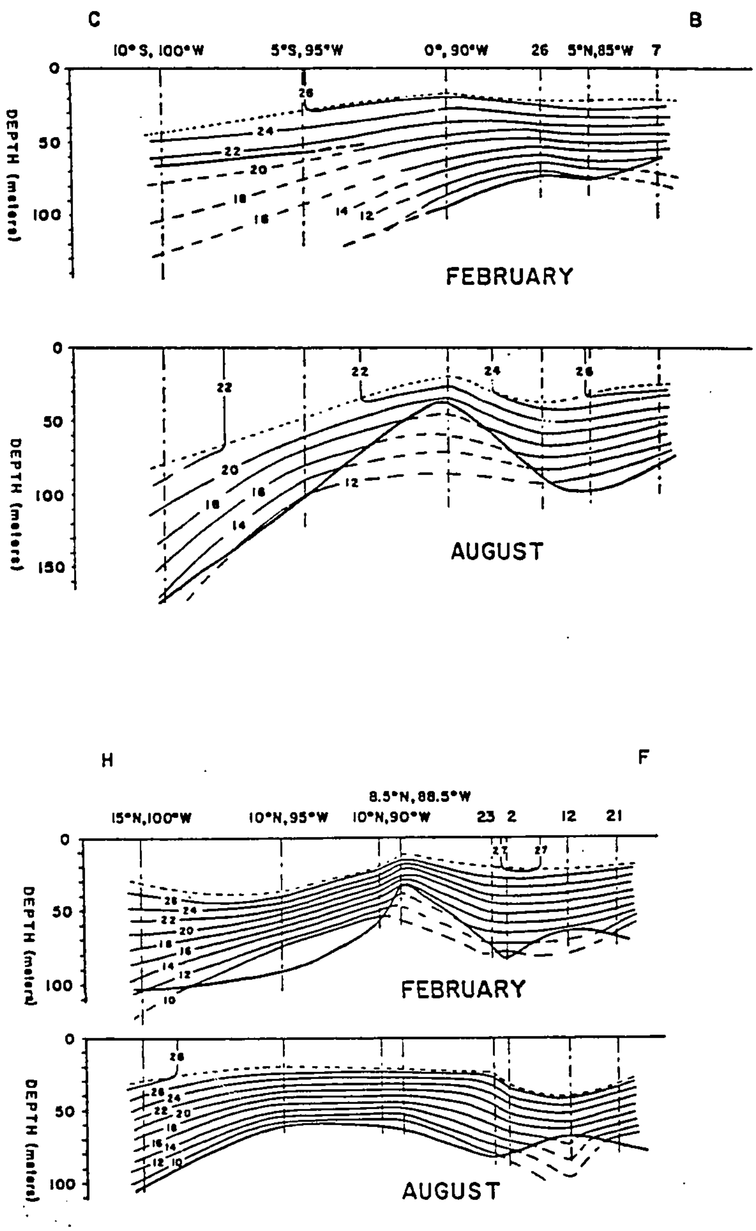


Figure II.6c, 6d Seasonal temperature profiles as in Figure II.6a.

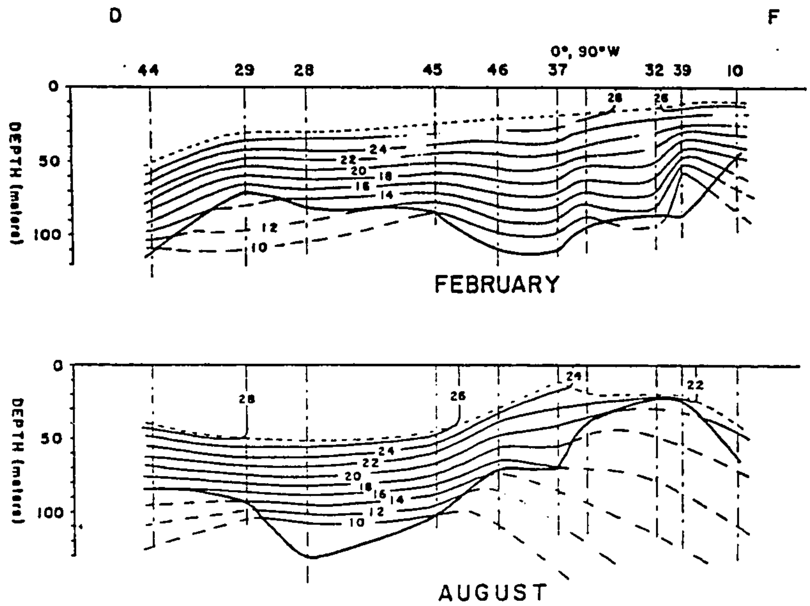


Figure II.6e Seasonal temperature profiles as in Figure II.6a

The locations of the traverses (Figures II.6a-e), identified by the letters "A" to "K" are shown in Figure II.7. In the individual profiles, the base of the mixed layer is presented as a thin dashed line. In constructing these cross-sections, the depth of the base of the thermocline (solid bold line) was estimated by doubling the depth to the thermocline center. Wyrtki (1964b) reports that during February (southern hemisphere summer) a significant "summer thermocline" (solid line) develops above the "permanent themocline" (dashed).

Figures II.7a and II.7b are similar to the fence diagrams used by stratigraphers. The upper parts of each panel (stipled) represent the mixed layer, and the lower parts (cross hatched) the thermocline. During February, the thermal structure is generally shallower than in August. In the southern region the summer thermocline develops above the permanent thermocline. A deep mixed layer is present in August (winter) when the thermocline descends, especially in the south where the summer thermocline no longer exists.

In February (Figure II.7a), off the coast of Central America, the thermal structure rises in the water column due to wind induced upwelling. As described by Stumph (1975) northern hemisphere winter storms force strong winds through a major break in the Sierra Madre Mountains of southern

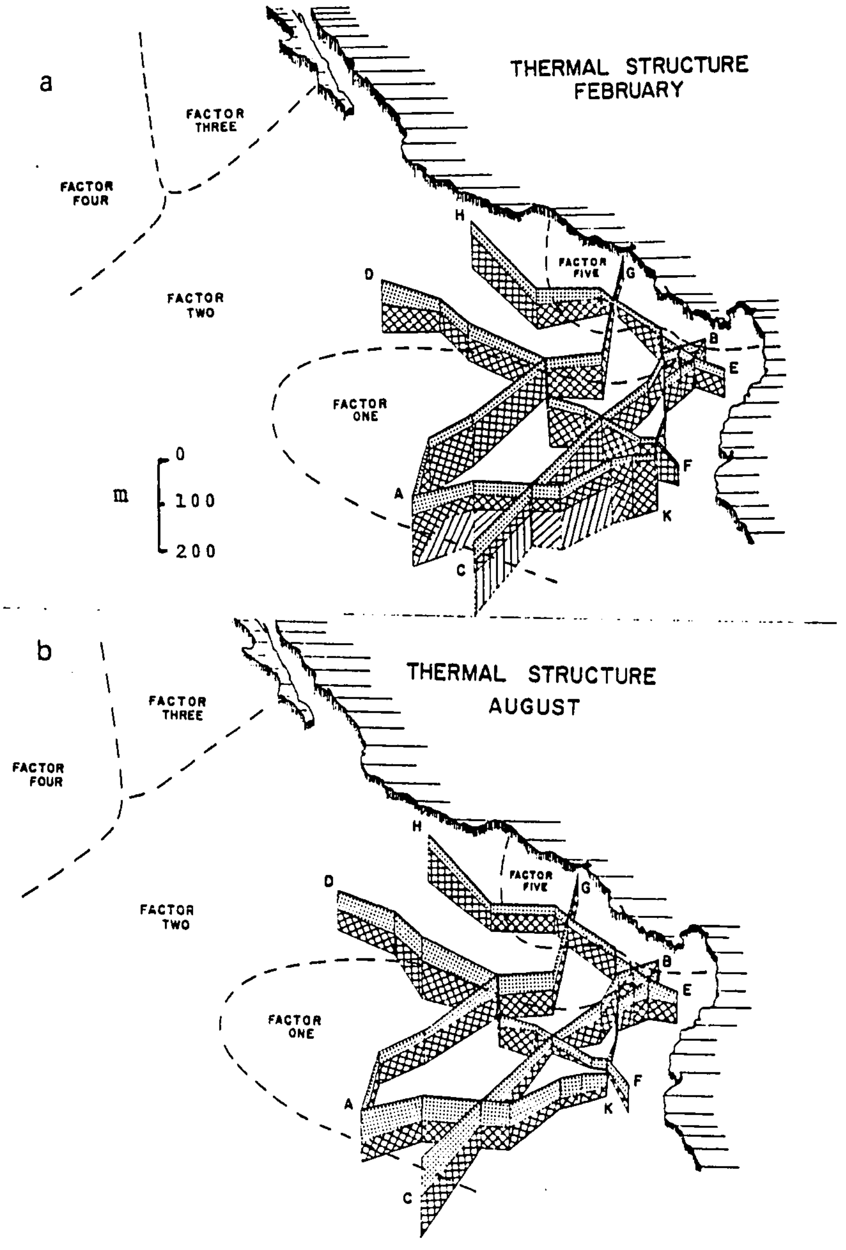


Figure II.7 Seasonal three dimensional representations of the thermal structure of the extreme eastern equatorial Pacific. Shaded panels schematically represent the data of Figure II.6. Stiples, mixed layer; cross hatched, thermocline. Wyrtki's (1964b) permanent thermocline (diagonal lines) is differentiated from the summer thermocline in February. In August a deep mixed layer replaces the summer thermocline. Also shown are relations betweer the thermal structure and planktonic foraminiferal assemblages (factors) described in a later section.

Mexico. These winds, known as Tehuantepecers, cause episodes of coastal upwelling in the tropical Pacific. The upwelled waters form into localized anticyclonic gyres which are detectable by satellite infrared imagery.

Euphotic Thermoclinal Layers

Near the base of the euphotic zone (approximately 80 m depth), in response to the development of a density gradient maxima (the pycnocline), the concentration of organic material increases (Ortner, 1978). This organic concentration, a major food source for many marine organisms, is known as the deep chlorophyll maximum (DCM). In the open ocean, water density is largely controlled by temperature, and therefore, the location of the pycnocline and the DCM may be approximated by the depth of the thermocline. In this dissertation, the relationships between planktonic foraminifera and the environmental conditions in the upper water column are examined. Since most of these organisms live within the DCM the discussion will concern the euphotic thermoclinal layers which extends from the base of the mixed layer (regardless of the presence of a summer thermocline). The base of the thermocline, is defined as the depth where the temperature gradient falls below 0.3°C/10 m (after Wyrtki, 1964b).

Seasonal temperatures at the center of the euphotic thermoclinal layer, for the study area, have been calculated from the unpublished sea-surface temperatures of D. Hahn and the thermal structure data of Wyrtki (1964b). These data for February and August are presented in Figure II.8. The maximum difference in seasonal temperatures at the center of the euphotic portion of the thermocline occurs to the east of the Galapagos Islands. In August (winter) the flow of the Equatorial Undercurrent is intensified which causes increased upwelling in this region. Accordingly, the thermocline rises in the water column, the thermocline temperature increases although the sea-surface temperature decreases (see Figures II.6 b,c,e and II.7). In the summer (February) when the Equatorial Undercurrent is less active the thermocline is deeper in the water column.

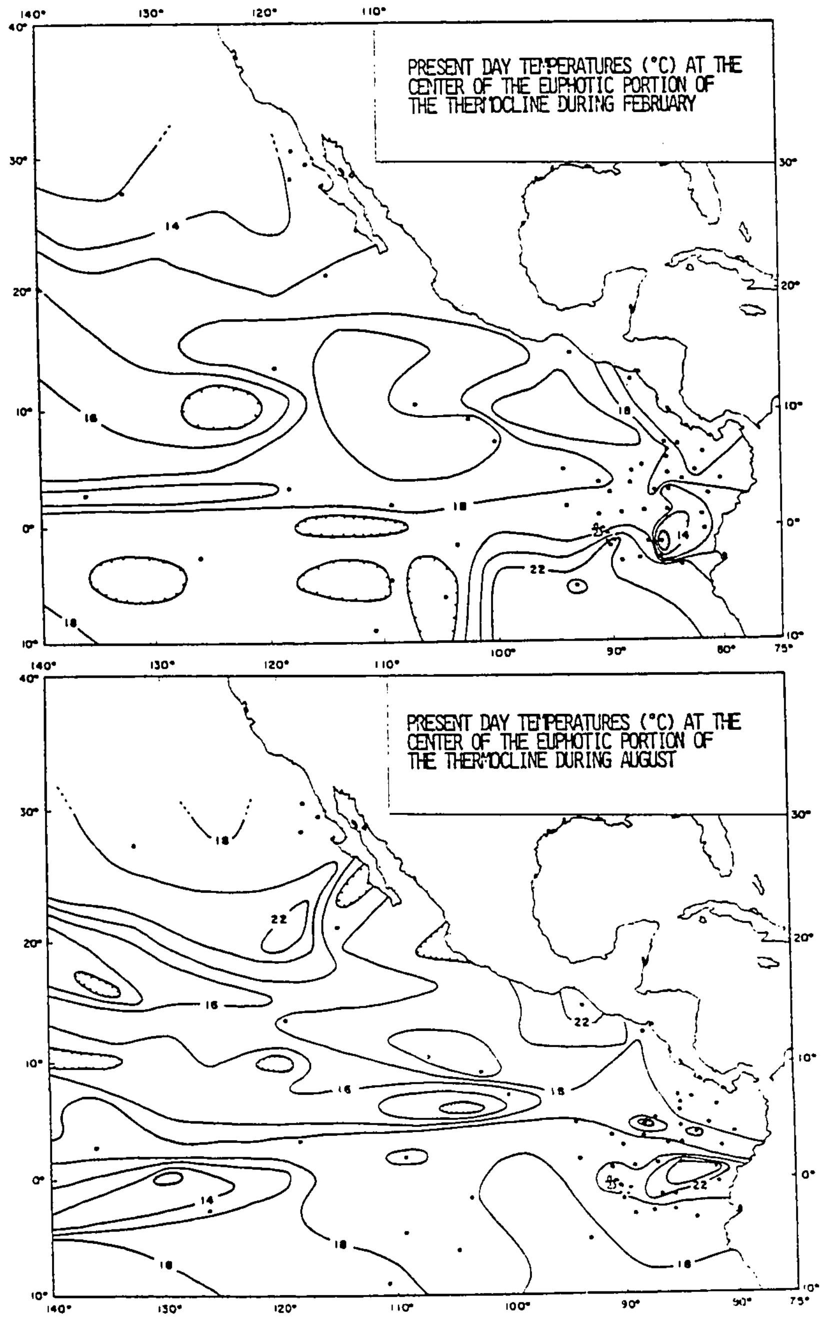


Figure II.8 Seasonal temperatures (°C) at the center of the euphotic thermoclinal layer; (a) February, (b) August. Values calculated from data in Wyrtki (1964b) and Hahn (unpublished).

III. LIVING PLANKTONIC FORAMINIFERA OF THE EASTERN EQUATORIAL PACIFIC OCEAN

PLANKTON ECOLOGY

Planktonic foraminifera are marine protozoans which are adapted to the chemistry and temperature regimes of particular water masses. Geographic differences and seasonal changes influence their areal and vertical distributions in the water column (Bé and Tolderlund, 1971; Bé, 1977) Living populations, collected with plankton nets, and death assemblage populations, recovered from Recent sea-floor sediments, have been used to describe the geographic ranges of the various species.

Samples Used For Areal Distribution Analysis

Forty-nine plankton tows were used to study living populations of planktonic foraminifera from the eastern equatorial Pacific Ocean. The plankton nets used to collect the specimens were constructed using Nitex mesh with 202 µm openings supported on a rectangular 50 cm X 50 cm frame. The net was either towed horizontally within the upper 10 m of the water column, or vertically through a known depth interval. A flow meter suspended in front of the net permits the investigator to analyze the faunal populations in relation to the volume of water filtered. The samples, once washed from the net, were preserved in 5% formalin buffered to a pH of 7 with hexamine ($C_6H_{12}N_4$). The locations, depth ranges and dates of collection for each sample are shown in Appendix A, Table 1, and in Figure III.1. Some of these samples were previously examined by Bé (unpublished), the others were presently examined to supplement the data. The examiner is indicated for each sample listed in the appendix.

Samples Used For Vertical Distribution Analysis

The vertical distribution of living planktonic foraminifera in the Panama Basin was investigated in conjunction with two Office of Naval Research projects: 1) the Sediment Trap Intercomparison Experiment (STIE), and 2) the Composition Flux And Transfer Experiments (CFATE). These investigations were conducted via two oceanographic cruises: Knorr 73, Leg 17, between July 27, 1979 and August 8, 1979; and Gillis 7904/3, between November 24, 1979 and December 3, 1979. The first cruise deployed various experimental apparatus at 5°2Ø' N.; 81°5Ø' W. (Figure III.2), and the second cruise recovered this equipment and

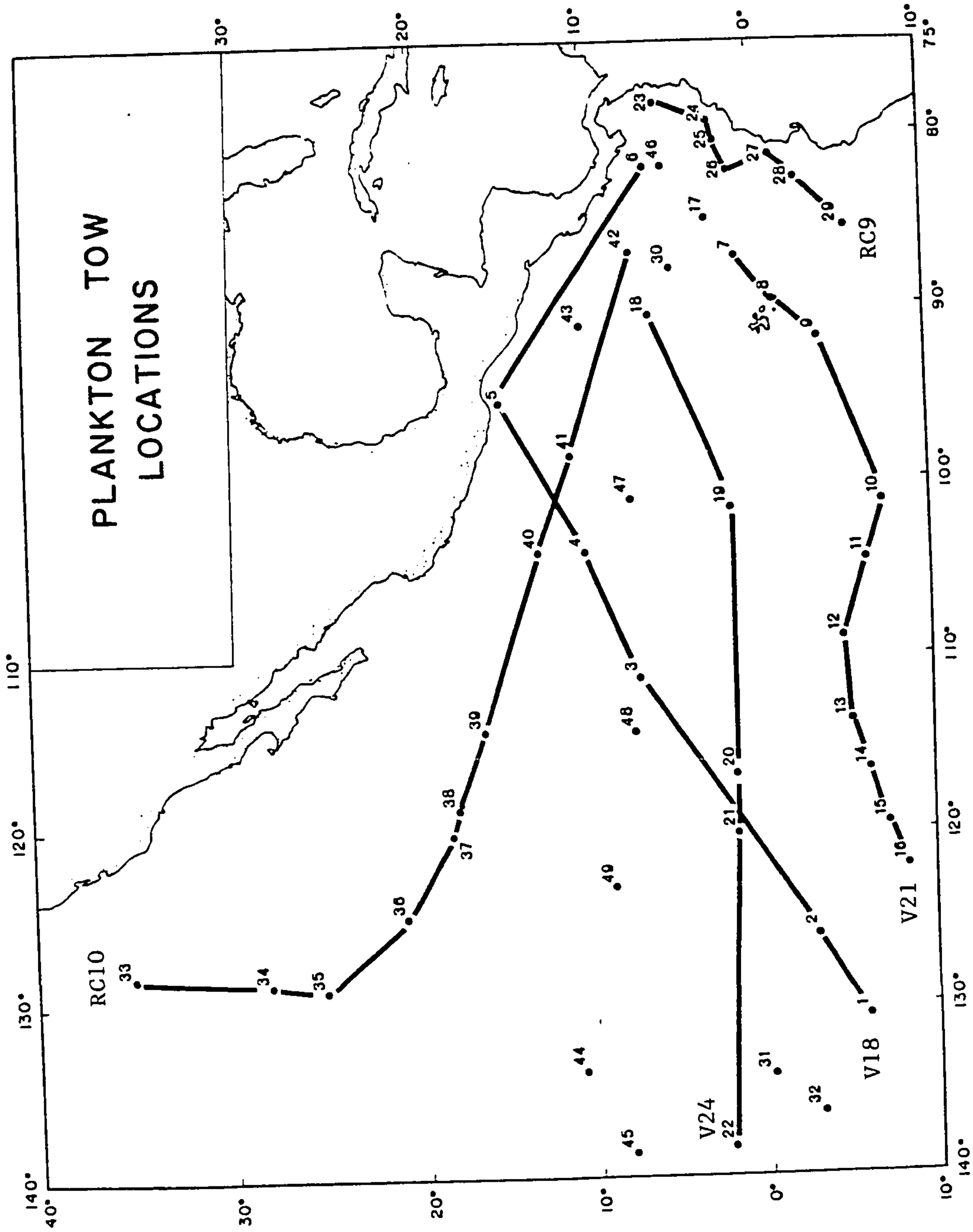


Figure III.1 Locations of plankton stations along various tracks of RV *Vema* and RV *Robert Conrad*. See Appendix A, Table 1.

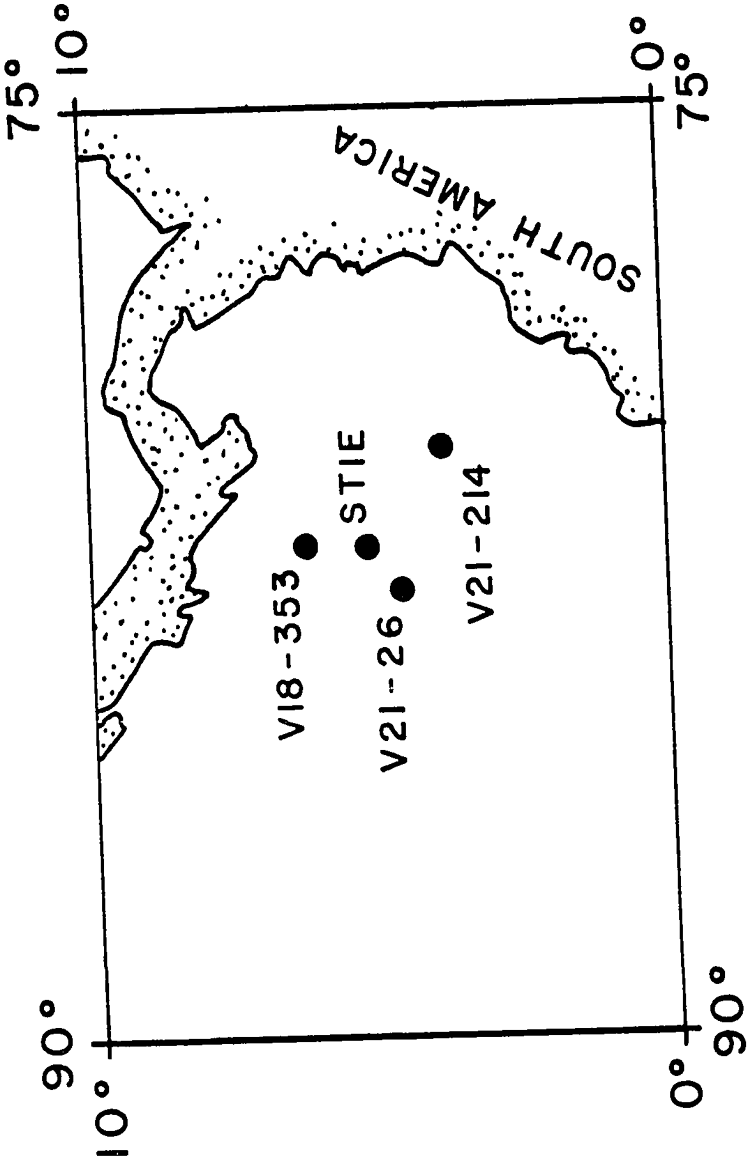


Figure III.2 Location (5° 20' N.; 81° 50' W.) of the STIE/CFATE site. Also show are three nearby core top samples used for faunal comparisons.

made repeat observations. Ten vertical haul plankton tows, from Ø to 2ØØ m depth, obtained during the two cruises, have been examined for their foraminiferal content. In addition, a more sophisticated plankton sampling device was used during the July cruise. A Multiple Opening and Closing Net and Environmental Sensing System (MOCNESS), developed by Wiebe et al., (1976), was outfitted with eight plankton nets that sequentially opened and closed, via ship-board remote control. This enabled sampling at selected depth intervals during four oblique hauls from: Ø to 1ØØ, Ø to 2ØØ, Ø to 1ØØØ and Ø to 2ØØØ meters. The precise sample depths are listed in Appendix B, Table 4. All of the STIE/CFATE plankton tow samples were collected with 333 µm Nitex mesh and preserved aboard ship with buffered formalin.

The relatively large mesh size used for the plankton nets did not permit the sampling of juvenile foraminiferal specimens. Planktonic foraminifera ranging in size from 1Ø um (single chamber, proloculus stage) to over 2ØØ um were collected via a Large Volume Filtration System (LVFS). This is a pump, developed by Bishop and Edmond (1976), outfitted with 53 µm Nitex, and Ø.4 µm glass fiber filters. Sub-samples of the 12" diameter Nitex material recovered from deployments at the various depths listed in Table 4 of Appendix B, were examined for juvenile foraminifera.

Sample Preparation Techniques

All but one of the plankton tow samples that were examined by this author (not those previously examined by Bé) in order to investigate the areal distributions of planktonic foraminifera in the eastern equatorial Pacific, were prepared as follows. The samples were removed from formalin solution by rinsing them through a 63 µm sieve. This was followed by a tap water rinse. Next, the samples were either placed in a 450° C. furnace for 2 hours or in a Low Temperature Asher (LTA) set at 300 watts for 1 hour. In each instance, the intense heat, or the radio-frequency radiation was adequate to destroy soft protoplasmic material in the samples. The foraminiferal tests were then separated from the residue of biomineralogic components of planktonic organisms. The samples were split and the specimens were identified and mounted using gum tragacnath on 60 square micropaleontologic slides. The remaining sample (number 46, Figure III.1) was obtained from the STIE/CFATE project. Consequently it was processed as described below.

All but one of the STIE/CFATE plankton samples were observed while still in formalin. The material was carefully examined with a microscope and teased apart with fine needles in order not to damage the microplankton to be studied by the other CFATE researchers. The foraminifera, as they were found, were removed with a transfer pipet, identified and stored in two dram vials of buffered formalin. These specimens were classified as either "living" (full of protoplasm) or empty ("dead"). The remaining sample (RT 13) contained large quantities of massive colonial radiolaria, making wet examination all but impossible. Rather, a one fourth split of this sample was rinsed of formalin and placed in the LTA (at 300 watts) for an hour and examined in the same manner as the areal distribution plankton samples.

Representative portions of the 53 μm Nitex filters from the LVFS pump were placed on glass slides. The filters were dissolved with phenol and toluene and the remaining material was sealed under cover slips with silicone cement.

The data presented in this dissertation is listed in a series of appendicies. Appendix A contains the locations of the various samples employed in this study. Appendix B contains the faunal data. The relative percentages (of the total planktonic foraminiferal population) for each species, or counting group, was then calculated for all of the samples.

Taxonomy

The taxonomy used in this study is based on the work of several authors: Parker (1962), Bé (1966, 1977) and Saito, Thompson and Breger (1976, 1981). In the sections describing the biogeographic distributions of the individual species, a condensed synonomy of each is presented. Several noteworthy nomenclatural considerations are discussed here.

In this study no taxonomic significance is attributed to the pink variety of *Globigerinoides ruber* although this form is frequently counted separately. Pink *G. ruber* is not currently living in the Pacific Ocean, but is present in sediments older than 120,000 B. P. (Thompson *et al.*, 1981). The data in the appendicies reflect combined counts for both white and pink individuals. Also, the data for Globigerinoides sacculifer with and without a terminal "sac-like" chamber have been combined.

In the eastern equatorial Pacific, various forms of the species *Globorotalia menardii* and *Globorotalia tumida* were observed. Adelseck (1975) discussed several varieties of these species from this region. These include specimens attributable to *G. menardii gibberula* Bé (1977) and *G. menardii neoflexuosa* Srinivasan *et al.*, (1974). For counting purposes these species have all been combined as the *G. menardii-tumida* complex.

Kipp (1976) proposed a "P-D intergrade" category for specimens that appear to be intermediate morphologically between *Neogloboquadrina pachyderma* and *Neogloboquadrina dutertrei*. This system classifies *all* left coiling individuals with less than four and one half chambers visible in umbilical view as *N. pachyderma*, and only right coiling specimens are considered to be P-D intergrades. Because, in the Panama Basin, 1 - 2% of the planktonic foraminifera are left coiling individuals with morphologies between *N. pachyderma* and *N. dutertrei*, for this study it was necessary to restrict the sense of *N. pachyderma* to include only those specimens with four chambers visible in umbilical view, regardless of coiling direction. In this orientation, these specimens are quadrate in outline, have a straight slit-like aperture, often with a lip, between the closely appressed final (F) and F-3 chambers (Figure III.3c). Specimens of *N. dutertrei* tend not to coil as tightly as *N. pachyderma*, and at least a portion of their F-4 chamber is visible through a curved aperture (a result of the recurved edge of the chamber wall). An umbilical "tooth" may or may not be present in *N. dutertrei*. Two counting groups of *N. dutertrei* have been recognized. They are based on the number of chambers visible in the final whorl, independant of coiling direction. Figure III.3b illustrates a specimen with four to four and one half chambers visible in the final whorl. This morphotype is similar to specimens described by Cifelli as _N. incompta_. Figure III.3a is representative of more typical specimens with 5 or more chambers visible in the final whorl.

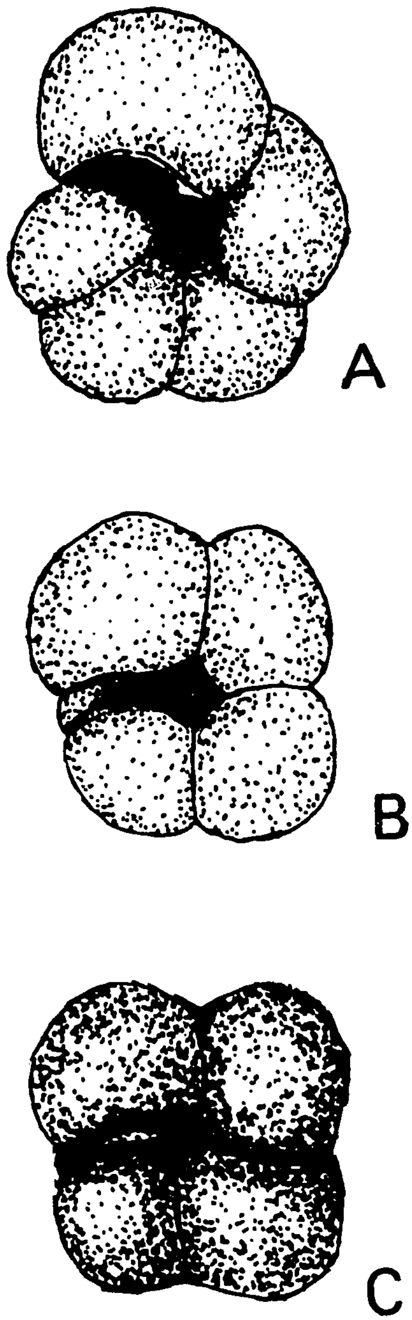


Figure III.3 Schematic illustrations of (a) Neogloboquadrina dutertrei var. 5+ chambers, (b) N. dutertrei var. 4 1/2 chambers, and (c) a right coiling specimen of N. pachyderma. See text for descriptions.

Foraminiferal Distributions

Eastern Equatorial Pacific Ocean

The ecology of planktonic foraminifera in the eastern equatorial Pacific Ocean may be described by examining the abundances of the species at each ship station. Figure III.1 illustrates the locations of the plankton stations along several ship tracks of the RV Vema and the RV Robert Conrad. The percentage data for the eleven most abundant species presented in Appendix B, Table 1 has been plotted in Figures III.4 a and b. The station numbers agree with Figure III.1. The following letter codes apply in these diagrams: A, Globigerinoides ruber; B, Globigerinoides sacculifer; C, Globigerinita glutinata; D, Globigerina bulloides; E, Neogloboquadrina dutertrei; F, the Globorotalia menardii-tumida complex; G, Globigerinella aequilateralis; H, Globigerinoides conglobatus; I, Pulleniatina obliquiloculata; J, Globorotalia theyeri; K, Globoquadrina hexagona; and O, others. The species are illustrated in their approximate depth relations to one another, ie., those shown at the top of the panels generally are found in the surface waters, whereas, the species at the bottom of the figures generally are deep dwelling organisms.

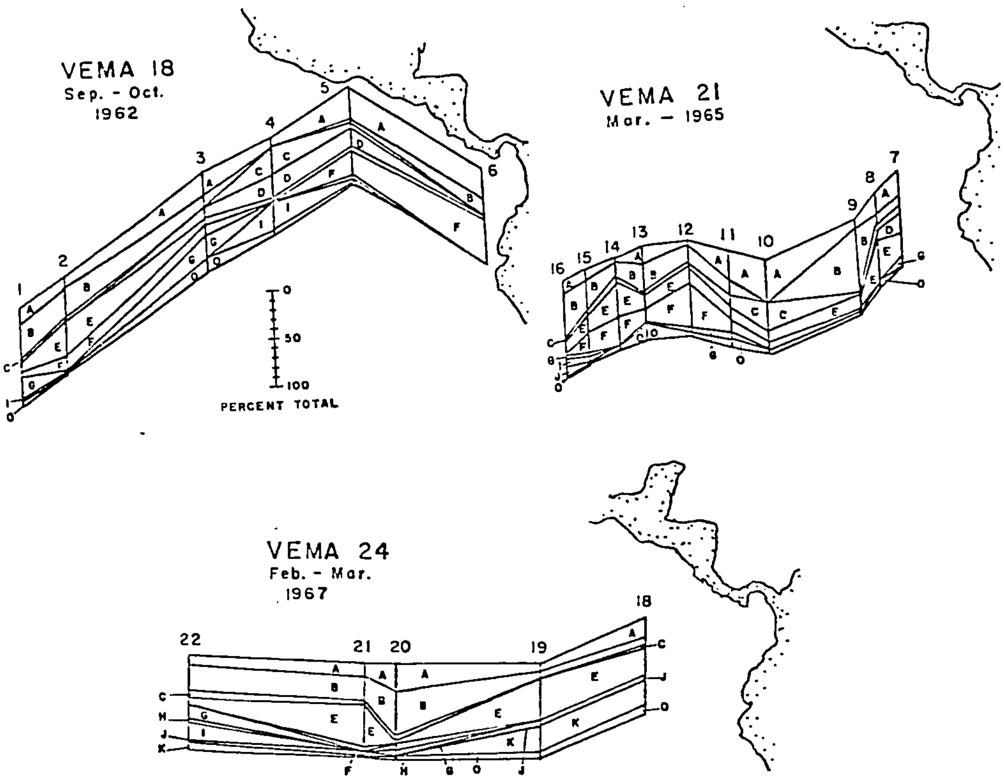


Figure III.4a Planktonic foraminiferal populations at individual plankton stations of 3 ship tracks of the RV Vema. See Figure III.1 for locations of ship tracks. Species ID: A, G. ruber; B, G. sacculifer; C, G. glutinata; D, G. bulloides; E, N. dutertrei; F. the G. menardii-tumida complex; G, Globigerinella aequilateralis; H, G. conglobatus; I, P. obliquiloculata; J, G. theyeri; K, G. hexagona; and O, others.

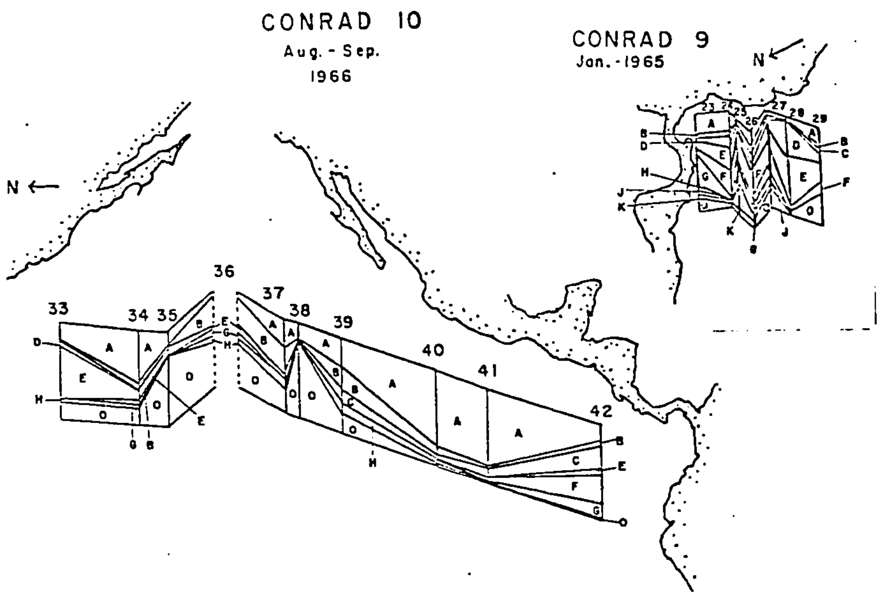


Figure III.4b Planktonic foraminiferal populations at individual plankton stations of 2 ship tracks of the RV Robert Conrad. Species and scale as in Figure III.4a Note the non-standard orientation of track Conrad 9 and the meridional part of track Conrad 10. Locations of tracks are shown in Figure III.1.

The vertical scale (percent of total planktonic foraminifera) is shown in Figure III.4a.

Globigerinoides ruber and/or Globigerinoides sacculifer are present in all of the samples. However, their abundance varies from location to location. Some of the extremely high percentages, found in localized areas, are likely due to random sampling of an unusually large standing stock. In other regions specific oceanic environments appear to control the faunal populations. Sixty-five percent of the sample from site 9 in ship track Vema 21 is composed of G. sacculifer, but neighboring stations 8 and 10 only contain 9 and 0%, respectively, of this species. In ship track Conrad 10, at site 34, 58% of the planktonic foraminifera were G. ruber. However, the large percentages of this species at stations along the Mexican coast probably reflect the warm waters of the North Equatorial Current.

In the southern sector of the study area, along ship track Vema 21, at sites 11-15, there appears to be a relative increase of G. menardii-tumida and a corresponding decrease in G. ruber and G. sacculifer. However, at nearby site 16 and at sites 1 and 2 of track Vema 18 this species comprises only a small part of the foraminiferal population. These differences may be attributed to the depths of collection of the samples. Samples 11-15 were obtained from depths ranging to 1000 m while the other tows were taken in the the upper 10 m. The southern part of track _Vema_ 18 illustrates an abundance of _N. dutertrei_ within the flow of the South Equatorial Current. _Vema_ 21 sampled the deeper waters of this region where the _Globorotalia_ species are more abundant. At sites 7 and 8 of _Vema 21_, surface tows illustrate the abundance of _N. dutertrei_ and the presence of _G. bulloides_ in response to upwelling to the east of the Galapagos Islands. _Globigerina bulloides_ is also an important faunal constituent at sites 4 and 5 of _Vema_ 18 where upwelling in the Gulf of Tehuantepec brings cool water to the surface. At site 6, the _G. menardii-tumida_ complex dominates in the warm water of the Equatorial Counter Current.

Ship track _Conrad_ 9 illustrates a sharp contrast in the foraminiferal faunas between the Panama Basin and the Peru and South Equatorial Currents. To the north of the equator at station 23 and 24 many species are present in the water column. They include both warm and cool water species. However, over a short latitudinal range, encompassing stations 25-27 the population changes drastically. To the east of the Galapagos Islands (station 28) two species, _G. bulloides_, and _N. dutertrei_ dominate the foraminiferal assemblage. In the Peru Current (station 29) the species grouped as "others" become significant. These species include *Orbulina universa* and *Hastigerina pelagica*. Together they comprise 10 to 20 percent of the planktonic foraminifera. They are also an important constituents of the fauna in the California Current. In ship track *Conrad* 10, stations 35, 36, and 38, they range from about 40 to 80 percent of the foraminiferal population.

Panama Basin

In order to refine our knowledge of the individual species vertical distributions, four series of MOCNESS plankton tows from the Panama Basin STIE/CFATE site (5°20' N.; 81° 50' W.) have been examined for their foraminiferal content. The absolute abundances, at 12.5 m depth intervals between 0 and 100 m and 25 m intervals between 0 and 200 m, of living (ie., protoplasm filled) specimens of planktonic foraminifera are presented in Figure III.5. These data were collected jointly by the present author and by Rosemary Free (Lamont-Doherty). The majority of the species have their maximal abundance within the upper 100 m (ie., the euphotic zone). The individual species plots illustrate that each species occupies a restricted depth range. *Globigerinoides ruber* and *Globigerinoides sacculifer* are most dominant near

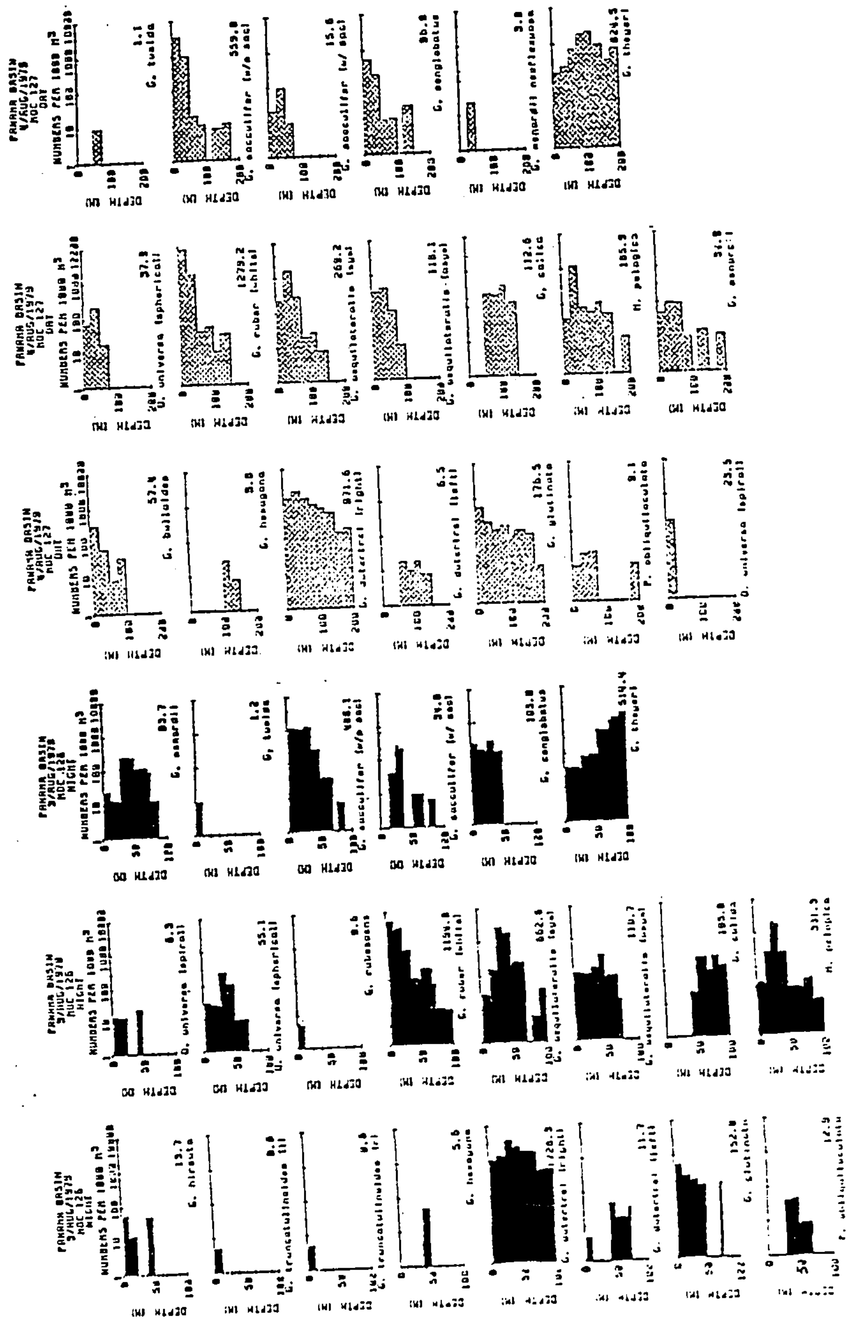


Figure III.5 Vertical distributions of the 14 most abundant species of planktonic foraminifera in the Panama Basin at 5° 20' N.; 81° 50' W. during July 1979. A majority of the species have their maximal abundances at 25 - 50 m, ie. within the deep chlorophyl maximum and the thermocline (After Fairbanks, et al., 1982).

the sea-surface (0 - 25 m). This depth interval corresponds to the mixed layer and upper portions of the thermocline. *Globigerinella aequilateralis*, *Neogloboquadrina dutertrei*, *Hastigerina pelagica* and the *Globorotalia menardii-tumida* complex are all most dominant between 25 and 75 m. This interval encompasses the entire thermocline. *Globigerina calida* and especially *Globorotalia theyeri* have their maximal abundances below the thermocline. In fact *G. theyeri* specimens containing green protoplasm, an indication of recent ingestion of phytoplankton, were found abundantly between 200 and 1000 meters, well below the euphotic zone. This would suggest that these specimens were rapidly sinking through the water column.

Two species, *Orbulina universa* and *G. sacculifer* normally produce distinctive terminal chambers. *Orbulina universa* encloses all of its earlier trochospirally arranged chambers within a final spherical chamber. *Globigerinoides sacculifer* tends to form a flattened, pointed, "sac-like" final chamber. The juvenile stages of these species were most abundant in the upper 25 m, within the mixed layer. Specimens with the special chambers were most often found between 25 and 37.5 m, within the thermocline.

Evidence that protoplasm filled tests below the euphotic zone are passively settling without adding new chambers was obtained by weighing and measuring the maximum diameter of randomly selected "living" specimens of Neogloboquadrina dutertrei from the 0 - 100 m, 100 - 200 m and 400 - 550 m depth samples of MOC 128. The specimens were cleaned in a Low Temperature Asher (set at 300 watts) for a half hour in order to remove the protoplasm from the shells. The precision of the Perkin Elmer microbalance used for this study permitted the specimens to be weighed to the nearest 0.1 µg. The maximum diameters of the shells was determined to within 5 µm via an ocular micrometer. The data is presented in Table 3.1 and illustrated in Figure III.6

When comparing specimens of equal size, differences in weight may mostly be ascribed to differences in test wall thickness. Planktonic foraminifera thicken their exposed test walls with the addition of each new chamber. The secondary cortex of calcite which is common in specimens collected from sea-floor sediments, but is generally absent in living plankton specimens, is now known to be added, in at least one species (G. sacculifer), just prior to or during gametogenesis (Bé, 1980). Bé reported that laboratory cultured specimens of this species increased in weight by as much as 28% due to gametogenic calcification.

TABLE 3.1
LENGTHS AND WEIGHTS OF N. DUTERTREI SPECIMENS

MOC-1-128, 0 - 100 m

Maximum Diameter (μm)	Weight (μg)
522	13.5
467	14.3
458	17.8
522	7.9
480	11.2
536	26.1
462	7.8
517	32.4
476	8.4
412	10.9
448	12.2
563	25.9
622	19.5
540	9.7
403	3.8
499	8.9
563	44.4
416	3.3
512	30.9
549	19.5

MOC-1-128, 100 - 200 m

Maximum Diameter (μm)	Weight (μg)
549	46.5
476	30.4
485	34.6
490	31.7
508	37.9
613	55.5
549	45.2
371	18.7
444	27.3
471	32.1
540	45.2
508	43.8
462	26.4
503	37.0
485	36.2
471	30.3
526	43.0
485	33.7
494	31.6
567	43.5

MOC-1-128, 400 - 450 m

480	15.4
494	25.8
398	4.8
421	16.3
499	24.2
549	37.4
604	40.1
287	12.5
512	27.6
508	30.2
490	25.0
549	30.0
462	25.4
444	16.3
512	25.3
458	28.0

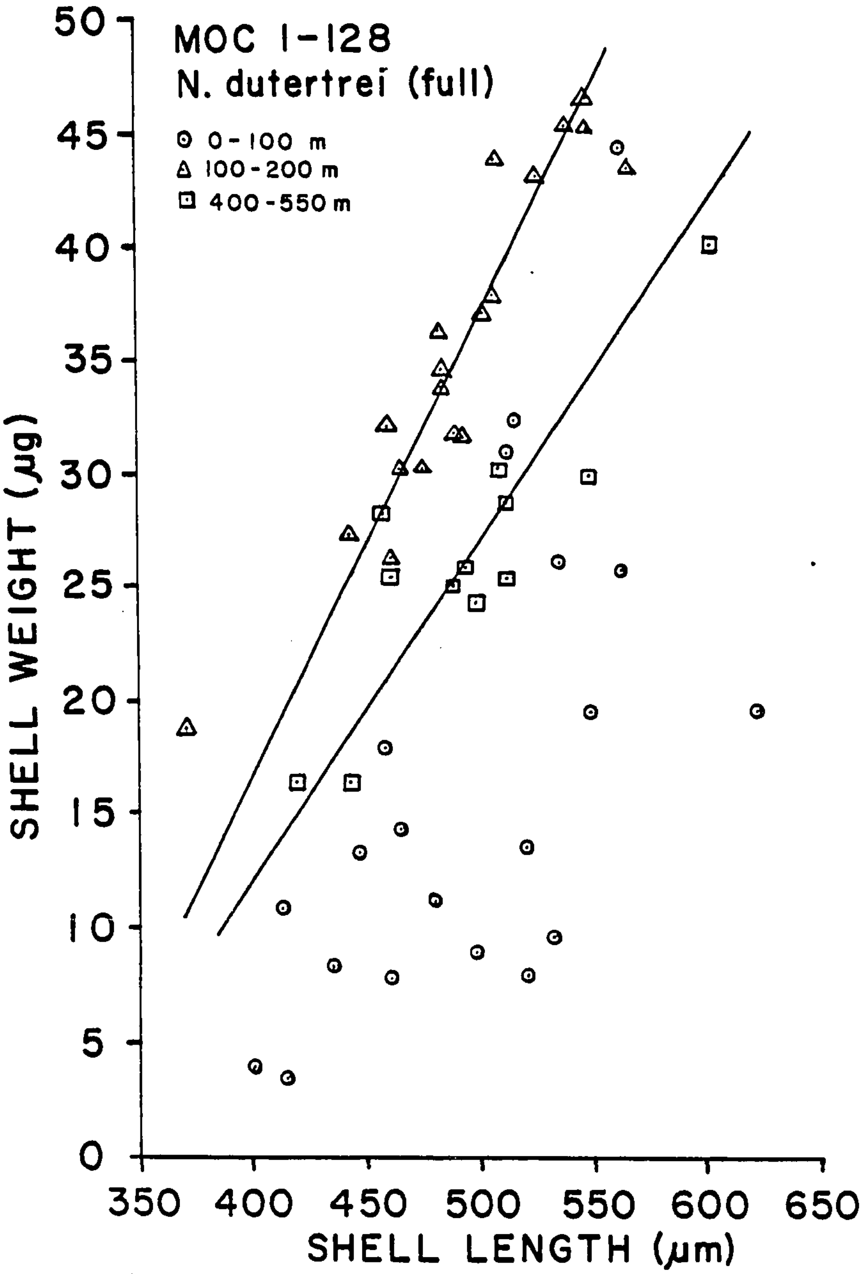


Figure III.6 Length vs. weight of randomly selected specimens of N. dutertrei from 3 depth intervals in MOC-128. Active chamber formation in shallow specimens produces scatter in the data. Linearity of deep specimen data indicates no chambers are forming. For any given size heavier shells must have thicker test walls: 0-100 m tests thicken shells while starting gametogenesis; 400-500 m tests may represent shells that aborted the reproductive processes and are passively setling.

The N. dutertrei specimens from the MOC 128, 0 - 100 m sample (circles in Figure III.6) are, in general, for any given size lighter in weight than those from the deeper tows. The heavier 0 - 100 m specimens may represent specimens in an early stage of gametogenic calcification, though no specimens in this comparison have completed gametogenisis as this would leave the shells empty. The large amount of scatter in the data for these specimens may be related to their collection at different stages of chamber formation. Some specimens in a random population would have just formed a new chamber which would be thin walled. Other specimens would be expected to have thickened, fully developed final chambers.

The specimens from the 100 - 200 m sample (triangles) are for any given size heavier than the shallower collected specimens. This indicates greater shell wall thickening. These data tend to plot in a straight line, which indicates that no new chambers are forming. The increased thickness is most probably due to a more advanced stage of gametogenic calcification than most of the 0 - 100 m specimens.

The linearity of the data for the 400 - 500 m specimens indicates that no new chambers are forming. However, the similarity of their weights to the heavier 0 - 100 m specimens rather than the 100 - 200 m specimens indicates that they are not continuing gametogenic calcification. These specimens must represent individuals which have descended passively through the water column from near sea-surface waters after aborting the process of gametogenesis.

Fairbanks et al. (1982) have performed oxygen isotope measurements on sea-water samples, and several size ranges of "living" planktonic foraminifera from the STIE/CFATE site. As each species calcifies new chambers, the ratio of ^{18}O to ^{16}O (δ O) incorporated in the calcite of their tests is largely controlled by the temperature of the ambient sea-water. The spinose species (which generally have algal symbionts) were found to be isotopically 0.5 per mil to light, while the symbiont free, non spinose species appeared to be calcifying in equilibrium with sea-water. For each oblique MOCNESS haul the individaul foraminiferal species $\delta^{18}O$ values paralleled the $\delta^{18}O$ for sea water down to species dependant depths. Below these depths, the foraminiferal $\delta^{18}O$ diverges from the sea-water $\delta^{18}O$ values, indicating simple passive descent through the water column, without additional calcification. Therefore, actual growth of planktonic foraminifera occurs in ranges much reduced from the overall vertical range of occurence of protoplasmic filled tests. The data indicate that shell growth (associated with actively living specimens) is restricted to the upper 100 m of the water column. The green protoplasm filled tests of G. theyeri and N. dutertrei found below 200 m are for all intensive purposes not growing because they are below the food supply of the euphotic zone. There is probably little chance for succesful maturation and gametogenesis in these specimens.

The mesh size of the plankton nets (333 µm) has effectively limited the previous discussion to mature planktonic foraminifera. Juvnile specimens, collected with the LVFS pump at the STIE/CFATE site, have also been examined. These samples generally contain specimens which only have their initial whorl of chambers. Even individual proluculi (initial chambers) were measured and found to range in size from 10 to 40 µm. The juvenile specimens were easily grouped, via transmitted light microscopy, into: living (full) and empty (dead) tests. Figure III.7 illustrates the relationships between depth in the water column, percentage of living juvenile foraminifera and the thermal structure of the STIE/CFATE site. At a depth of 12 m (within the mixed layer) nearly 90% of the specimens contain protoplasm. At the base of the thermocline roughly 90% of the tests are empty. Bishop et al., (1980) reported a similar distribution at another LVFS site in the Panama

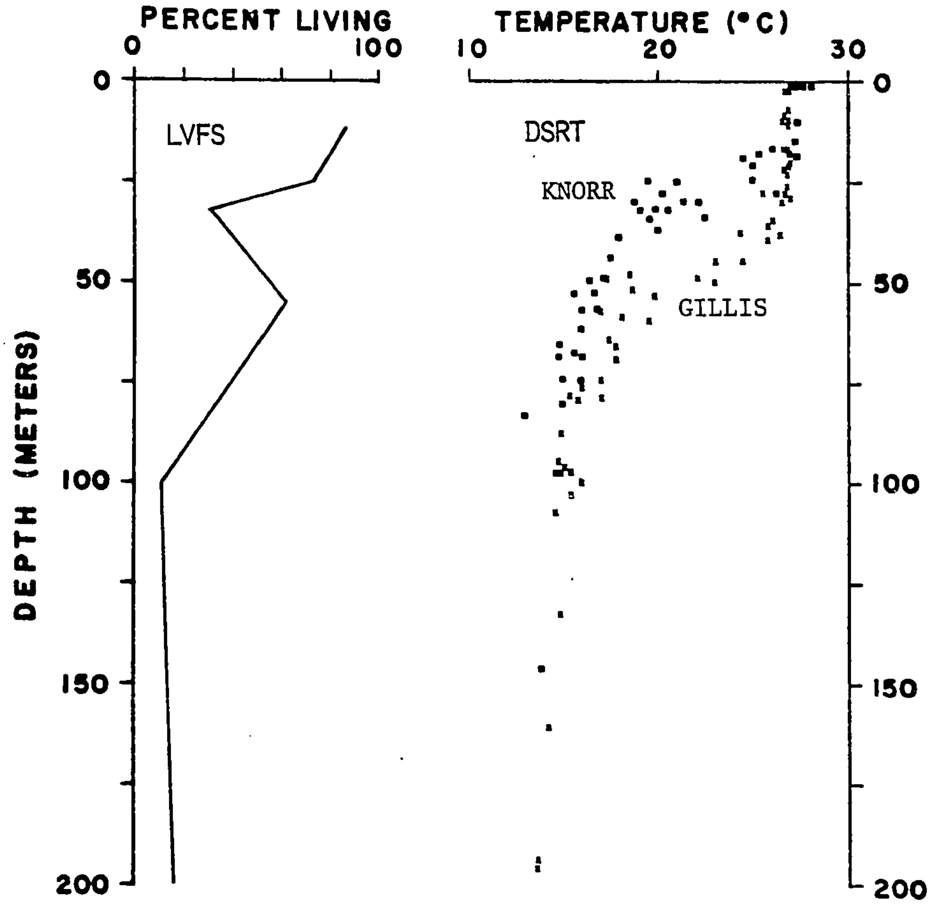


Figure III.7 Relationships between (A) living juvenile planktonic foraminifera and (B) the thermal structure of the Panama Basin at 5° 20' N.; 81° 50' W. Most juvenile foraminifera caught by the LVFS pump live in the mixed layer. Their numbers decrease with depth until the base of the thermocline as determined by Deep Sea Reversing Thermometer (DSRT) readings. Data plotted from RV Knorr in July-August, 1979 and RV Gillis in November-December, 1979.

Basin.

At this time not enough data has been compiled to permit the identification of the juvenile specimens. Although all of the initial whorls are quite similar to each other, preliminary investigations suggest the future possibility of using shape analysis to group these individuals into categories which may reflect the generic level of classification of mature specimens. Before this is possible further comparisons with dissected mature specimens is needed. Huang (1981), has presented an excellent description of this technique.

Variations in Planktonic Foraminiferal Populations of the Panama Basin Between July-August and November-December, 1979

It was not possible to study the vertical distributions of planktonic foraminifera during the STIE/CFATE recovery cruise because the MOCNESS apparatus was not available aboard the RV Gillis in November and December. However, comparisons of the overall faunal composition, of the upper water column, with the July - August cruise of the RV Knorr was possible because a series of 0 - 200 m oblique hauls was taken during both cruises. This data is illustrated in Figure III.8

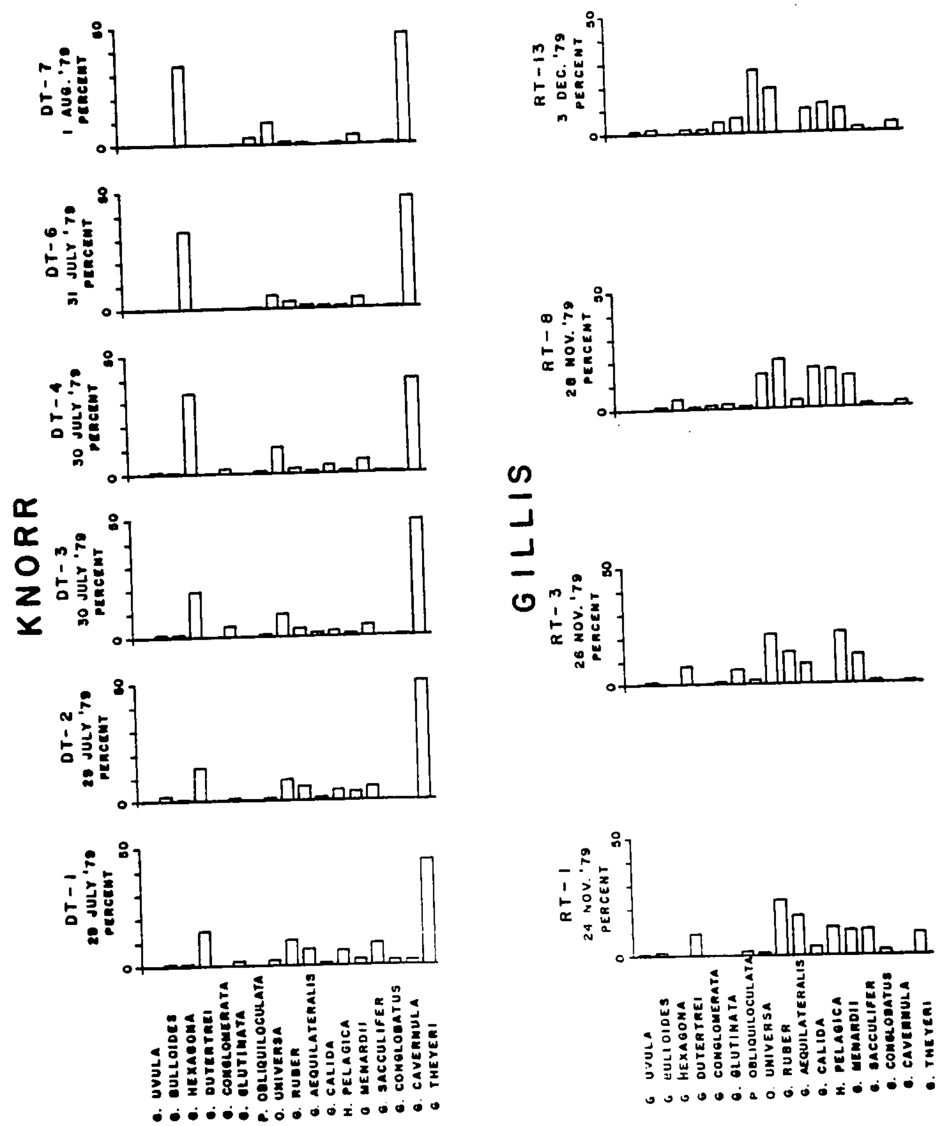


Figure III.8 Variation in planktonic foraminiferal species composition in the Panama Basin at 5° 20' N.; 81° 20' W. between July-August and November-December, 1979 based on 0-200 m oblique plankton tows. In July the cool water N. dutertrei and deep water G. theyeri are dominant. In August warm water, shallow to intermediate depth species (ie. G. ruber, G. sacculifer, G. menardii-tumida) prevail.

In July and August of 1979 the dominant species were *Neogloboquadrina dutertrei* and *Globorotalia theyeri*. In November and December the species dominance was drastically different. The warm water fauna, including: the *Globorotalia menardii-tumida* complex, *Globigerinoides ruber*, *Globigerinoides sacculifer* and *Globigerinella aequilateralis* became the more dominant species. The absolute abundances of the warm water species were not significantly different between the two cruises. However, the concentrations of *N. dutertrei* and *G. theyeri* are diminished in November as compared to July.

Along with the change in faunal composition, there was a concurrent change in total abundance of planktonic foraminifera at the STIE/CFATE site between July and November of 1979. In July, on average, approximately 8000 specimens per 1000 cubic meters of sea-water inhabited the upper water column. During the November cruise only about 1000 specimens were collected in each 1000 cubic meters of water sampled.

Factors Controlling Planktonic Foraminiferal Distributions

Bé (1977) summarized the existing literature concerning the factors which control the distribution of planktonic foraminifera. These include: the productivity of foraminifera, their predation, the food supply, nutrient concentrations (ie., NO_3, PO_4), light intensities, water temperature and salinity. In interpreting data from a set of plankton tows it is also important to consider several artificial factors such as: the mesh size of the nets, the temporal and spatial aspects of the sampling array, the taxonomic classification used, and the methods of counting and statistics applied to the data.

Bé and Tolderlund (1971) grouped the major species of living planktonic foraminifera into five faunal assemblages related to latitude and sea-surface temperature: ie., Tropical, Subtropical, Transitional, Subpolar and Polar assemblages. Their study encompassed the Atlantic and Indian Oceans.

Previously, Bradshaw (1959) established similar zones for the North Pacific. The eastern equatorial Pacific, as defined in the present study, includes portions of the

Tropical, Subtropical and Transition zones. Ship track Conrad 10 traverses all three regions. Station 33, where large numbers of N. dutertrei and Globigerinoides ruber were found is within the Transitional Zone. No specimens of Globigerinoides sacculifer were obtained at station 33. Stations 34 through 36 are in the Subtropical Zone. In this region large amounts of H. pelagica and Orbulina universa were collected in the plankton nets. The northern most occurance of G. sacculifer was at site 36. This species is present at the remaining stations in this track which are all in the Tropical Zone. The dominant species, however, is Globigerinoides ruber.

This distribution agrees fairly well with the zone deffinitions of Bé and Tolderlund (1971). They state that N. dutertrei prefers the outer margins of the Subtropical Zone and extends into the Transition Zone. In addition, H. pelagica and O. universa are also considered to be Subtropical species, whereas, G. sacculifer is a Tropical species.

The effects of seasonal oceanic changes upon planktonic foraminiferal distributions was described by Bé (1960) and Tolderlund and Bé (1971). They found that phytoplankton blooms during the spring and summer stimulate nearly simultaneous response in foraminiferal abundance maxima. In addition they reported a marked seasonal succession of foraminiferal species populations in the northern Sargasso Sea; with seasonal replacement being less pronounced, or even absent, in both polar and tropical waters.

On shorter time scales, individual species abundances tend to vary significantly due to the patchy nature of plankton populations. Patchiness is thought to be related to: 1) the free drift of specimens into and out of a particular area via shifts in oceanic currents, 2) vertical migratory behavior (Bé, 1977) that cause temporary absences in the surface waters, and 3) changes in the depth habitat of species during their life cycle (Bé and Ericson, 1963; Bé, 1965).

In general, most planktonic foraminiferal species have their juvenile populations in the near surface waters with older individuals living deeper in the water column. This is born out by the LVFS data which indicates that most "living" juvenile foraminifera in the Panama Basin were found in the mixed layer and upper portions of the thermocline. The deeper waters contained empty juvenile shells.

Bé (1977) found that mature individuals of the various species could be classified into three groups according to the observed depth ranges of living specimens: 1) shallow; 0 - 50 m, 2) intermediate; the upper 100 m, but mostly between 50 and 100 m, and 3) deep; deeper than 100 m. In the present investigation the vertical distributions of planktonic foraminifera were studied at the STIE/CFATE site (5°20' N.; 81° 50' W.). The foraminiferal data may be compared to the vertical variations in temperature and suspended chlorophyll-a (an indicator of the concentration of food in the water column) at this locality. Wyrtki (1964b) reports that the center of the thermocline averages only 50 m in depth in this region (Figure II.4), and the temperature-salinity diagram (Figure II.5) for July - August, 1979, illustrates the average top of the thermocline at approximately 30 m. Both the thermal structure and chlorophyll concentrations for succesive days of observation in the Panama Basin are described by Marra et al., in prep.). Figure III.9 illustrates their data. A Deep Chlorophyll maximum (DCM) is is seen to be consistently related to the position of the thermocline. This oceanic feature was previously described by Ortner (1958), and is

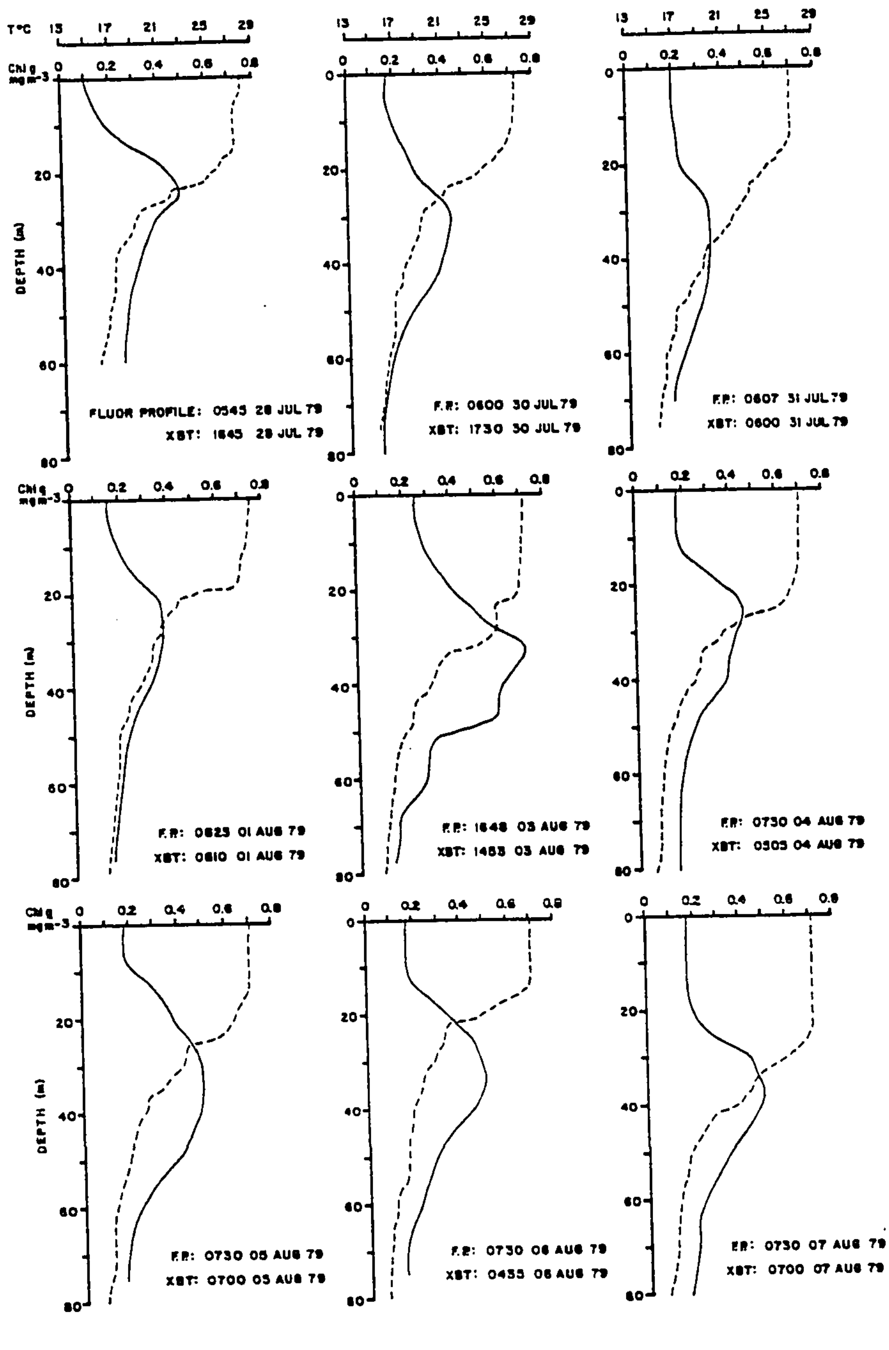


Figure III.9 Fluoresence profiles (solid curves) and expendable bathythermograph (XBT) plots (dashed curves) taken on successive days in the Panama Basin at 5° 2Ø' N; 81° 5Ø' W. The maximum concentrations of chlorophyll-a shown by the fluorescence profiles are related to the the thermocline as indicated by the XBT measurements.

recognized as a major food source for planktonic organisms. It is not unexpected, therefore, that the majority of the planktonic foraminifera in the Panama Basin had their maximal abundances within the depth range of the DCM.

Laboratory experiments conducted by Bé (1980) indicate that a "sac-like" chamber forms as a precursor to gametogenesis (gamete production) in well nourished G. sacculifer specimens. This presumably also applies to the spherical chamber of O. universa. Bé et al. (1981) presented laboratory evidence for a direct relationship between increased ingestion of food and: increased rates of growth, more frequent formation of sac-like chambers, and earlier onset of gametogenesis in the species G. sacculifer. All the evidence indicates that the distinctive final chambers of the living specimens in the Panama Basin are forming as a response to the food supply in the DCM.

In my co-authored paper with Rick Fairbanks (Fairbanks et al., 1982) it was shown that shell growth (associated with actively living specimens) is restricted to the upper 100 m of the water column. Therefore, actual growth of planktonic foraminifera occurs in ranges much reduced from the overall vertical range of occurence of protoplasmic filled tests. This agrees with the finding of green protoplasm filled G. theyeri and N. dutertrei below 200 m. These specimens are full, but are for all intensive purposes not growing because they are below the food supply of the DCM. There is probably little chance for succesful maturation and gametogenesis in specimens which are sinking through the water column. Fairbanks and Wiebe (1980) previously found foraminiferal species depth ranges in the North Atlantic Ocean which are similar to those found in the Panama Basin. In addition, the data in both the 1980 and 1982 studies indicate that most planktonic foraminiferal species have their maximal abundances within the euphotic layers of the thermocline ie., the DCM.

Significant differences in the populations of planktonic foraminifera were reported in the Panama Basin during July-August and November-December of 1979. The explanation for these differences may be found by examining the hydrographic data from each cruise. Temperature data collected with Deep Sea Reversing Thermometers (DSRT) has been used to illustrate the depth of the thermal structure during each cruise (Figure III.7b). In the diagram, the two series of data have been superimposed. Near the sea-surface the temperatures are almost identical, however, the deeper portions of the euphotic zone changed significantly between the two cruises. The depth of the thermocline is approximately 20 to 25 m deeper in November (Gillis data) then it was in July (Knorr). Thus the mixed layer extended deeper into the euphotic zone during the recovery cruise.

When the thermocline is near the surface a strong temperature gradient exists within the euphotic zone, ie., the cooler portions of the DCM are within the well-lit zone. In addition, increased concentrations of nutrients due to upwelling will be available in the upper water column. The overall cooling of the habitat permits species which prefer cooler temperatures to preferentially make use of these nutrients. When the thermal structure is depressed in the water column, cool water will only exist at the very base of, or below, the euphotic zone. During July and August it was possible for the deeper dwelling species, N. dutertrei and G. theyeri, to dominate the foraminiferal population because their prefered temperature range existed within the DCM. The absolute numbers of the warm water species, which prefer the upper portions of the DCM and the overlying mixed layer, remained relatively constant between July and November because their habitat was unchanged, but the populations of N. dutertrei and G. theyeri decreased because less cool water was present in the euphotic zone.

PLANKTONIC FORAMINIFERAL BIOGEOGRAPHY

In this section the distributions of living planktonic foraminifera described from the various ship tracks (see Appendix A, Table 1) are compared to the distributions of these organisms in the Recent sea-floor sediments. Appendix A, Table 2 list the locations and recovery depths of 52 trigger weight core top samples used for this purpose. The sites are plotted in Figure III.10. Forty-eight of these samples were obtained from the core collections of the Lamont-Doherty Geological Observatory. The other 4 samples, taken off the coast of California, were obtained from the Scripps Institution of Oceanography.

After being air dried and weighed, the samples were individually placed in beakers of 5% hydrogen peroxide. The agitation resulting from the reaction between soft organic material in the sediment and the H_2O_2 gently disaggregates the samples. The liberated fossils were then rinsed using a 63 μm siev to remove the fine clay fraction which was saved for nannoplankton studies. The coarse fraction was oven dried and reweighed. If necessary, a sample splitter was

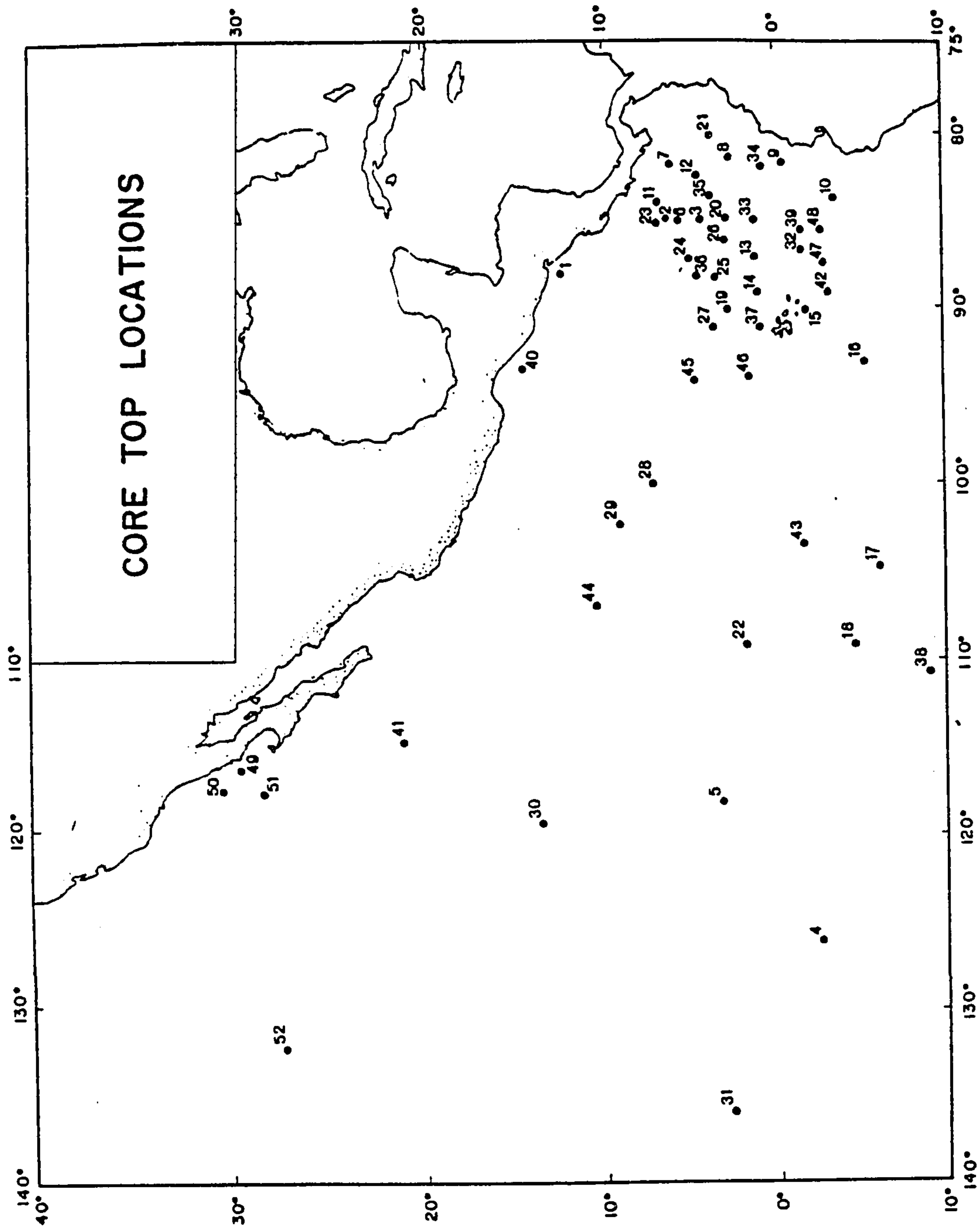


Figure III.10 Locations of trigger weight core tops used to describe the area biogeographic distributions of Recent death assemblages of planktonic foraminifera. The numbered stations are described in Appendix A, Table 2 used to obtain a working sample size of about 300 specimens, each with a maximum diameter of at least 149 µm. The specimens were then identified and mounted in designated locations on 60 square micropaleontologic slides using gum tragacanth.

The relative percentage (of total planktonic foraminifera) data for each species has been plotted with the aid of the SYMAP computer mapping system. (Figures III.12 - III.28; Appendix C). An investigation of these maps indicates discrepancies between the plankton and sediment distributions of the foraminiferal fauna. In a number of instances the samples apparently fail to reflect the true occurrences and ranges of the various species. Several species recovered from the core tops were not found in the water column samples. For other individual species, when regions of maximum abundance are compared, little correlation can be found between their plankton tow and sediment distributions. These discrepancies are most probably attributable to: 1) inadequate temporal and/or spatial sampling with the plankton nets, 2) differences in the data, ie. the time frame each sample represents, and 3) non-ideal preservation of the fauna within the sediments of the sea-floor. A majority of the plankton tows had their sampling depths set within the upper 10 m of the water column and failed to collect deeper dwelling organisms. The tows were obtained by a limited number of cruises of the Lamont-Doherty ships and each available cruise examined the fauna during different seasons of the year. Furthermore, each individual tow only represents an instantaneous sampling of the standing stock community. In contrast, the sediment samples ideally represent the average production of foraminifera over a span of many years. However, Berger (1968) and Parker and Berger (1971) have shown that the various species are not equally preserved in the sediments, and have ranked the species in order of their increasing resistivity to dissolution.

In spite of these difficulties, if the zero contour lines of either the plankton tow and/or the sediment distributions are examined, a majority of the species are found to be related to particular oceanic currents and/or thermal structure variations. Several species do not appear to be related to any particular region and are considered to be endemic to the tropical-subtropical environments of the majority of the study area. The remaining species have been segragated into several groups according to their regions of occurence (Table 3.2; Figure III.11). In general these regions have gradational boundaries, although a drastic difference in faunal communities exists to the north and

TABLE 3.2
DOMINANT SPECIES IN THE EASTERN EQUATORIAL PACIFIC

UBIQUITOUS TROPICAL-SUBTROPICAL SPECIES

Group 1: Species Dominant Throughout the Tropical-Subtropical Region

Globigerinoides sacculifer	(Figure III.12)
Pulleniatina obliquiloculata	(Figure III.13)
Hastigerina pelagica	(Figure III.14)

Group 2: Species With Lowered Abundances Along the Equatorial Divergence

Globigerinita glutinata	(Figure III.15)
Orbulina universa	(Figure III.16)
Globigerinoides ruber	(Figure III.17)

SPECIES DOMINANT IN THE SOUTH EQUATORIAL CURRENT REGION

Neogloboquadrina dutertrei var. 5+ chambers	(Figure III.18)

SPECIES DOMINANT IN THE NORTH EQUATORIAL AND EQUATORIAL COUNTER CURRENT REGION

Globorotalia menardii-tumida complex	(Figure III.19)
Globoquadrina conglomerata	(Figure III.20)
Globigerinoides conglobatus	(Figure III.21)
Globigerinella aequilateralis	(Figure III.22)
Globoquadrina hexagona	(Figure III.23)

SPECIES DOMINANT IN THE EASTERN BOUNDARY CURRENT REGIONS

Neogloboquadrina pachyderma	(Figure III.24)

SPECIES DOMINANT IN THE CENTRAL AMERICA COASTAL REGION

Globigerina bulloides	(Figure III.25)

SPECIES DOMINANT IN THE PANAMA BASIN REGION

Neogloboquadrina dutertrei var. 4 1/2 chambers	(Figure III.26)

SPECIES DOMINANT IN THE CONVERGING ZONE WITH DEEP THERMOCLINE REGION

Globorotalia truncatulinoides	(Figure III.27)
Globorotalia inflata	(Figure III.28)

RARE SPECIES (Appendix C)

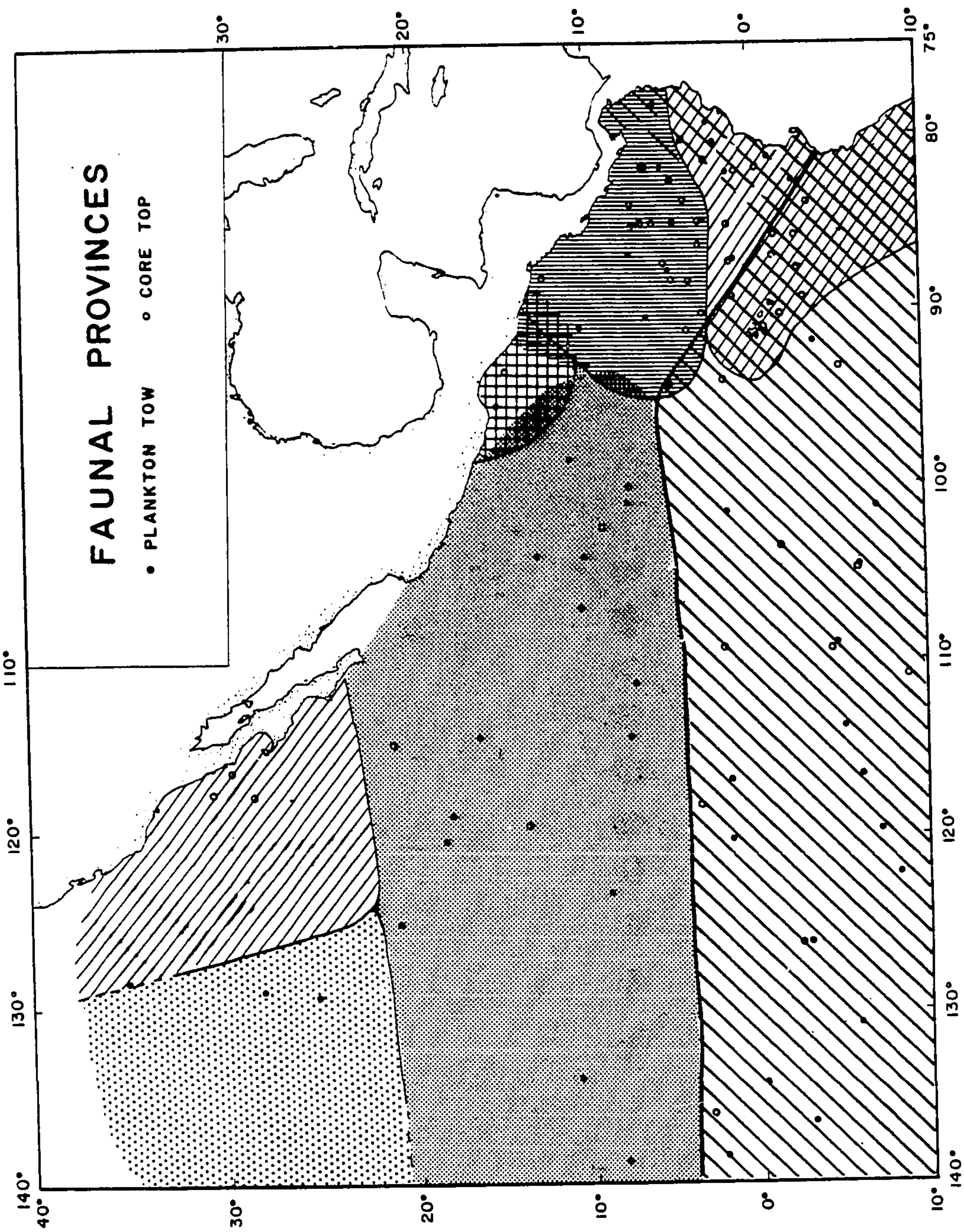


Figure III.11 Biogeographic distributions of planktonic foraminiferal species groups. Group symbols: left diagonal, South Equatorial Current; fine stiple, North and Equatorial Counter Currents; right diagonal, eastern boundary currents; squares, Central America Coastal; vertical, Panama Basin; coarse stiple, converging zone. See Table 3.2 for species compositions. The eastern most groups tend to overlap.

south of the Equatorial Pacific Front. Because a few species are rare (ie., they never display an abundance of 15% of the total planktonic foraminifera) they contribute little ecologic information and are not discussed in the text. Their distribution maps have been included as Appendix C.

Ubiquitous Tropical - Subtropcial Species

The following discussion describes the distribution of several species which could not be assigned, by inspection, to any region of dominance. Even though they all appear to require the tropical to subtropical environmental conditions present in the study area, it was possible to further divide these endemic species into two subgroups. Those species belonging to the first have fairly even distributions throughout the study area, but the other taxa have lowered abundances in the region of the equatorial divergence.

Group 1: Species Dominant Throughout
the Tropical-Subtropical Region

Globigerinoides sacculifer (Brady)

Globigerinoides sacculifera Brady, 1877, Geol. Mag., dec. 2, vol. 4, no. 12, p. 535.

Globigerinoides quadrilobatus sacculifer (Brady) - Parker, 1962, Micropaleontol., vol. 8, no. 2, p. 229, pl. 3, figs 6 - 10.

Globigerinoides trilobus (Reuss) forma typica - Boltovskoy, 1968, Rev. Micropal. vol 11, no. 2, p. 59, pl. 1, fig 1.

Globigerinoides sacculifer was found in all but three of the plankton tows, and eight of the sediment samples. The plankton tow data (Figure III.12a) indicates a contiguous region in the southwest sector of the study area where this species is almost always greater than 15% of the total planktonic foraminiferal population. It has a more patchy distribution to the east of 110°W. longitude although its highest concentration was found to the south of the Galapagos Islands. Its abundance decreases towards the northwest where the California Current transports cool waters southward.

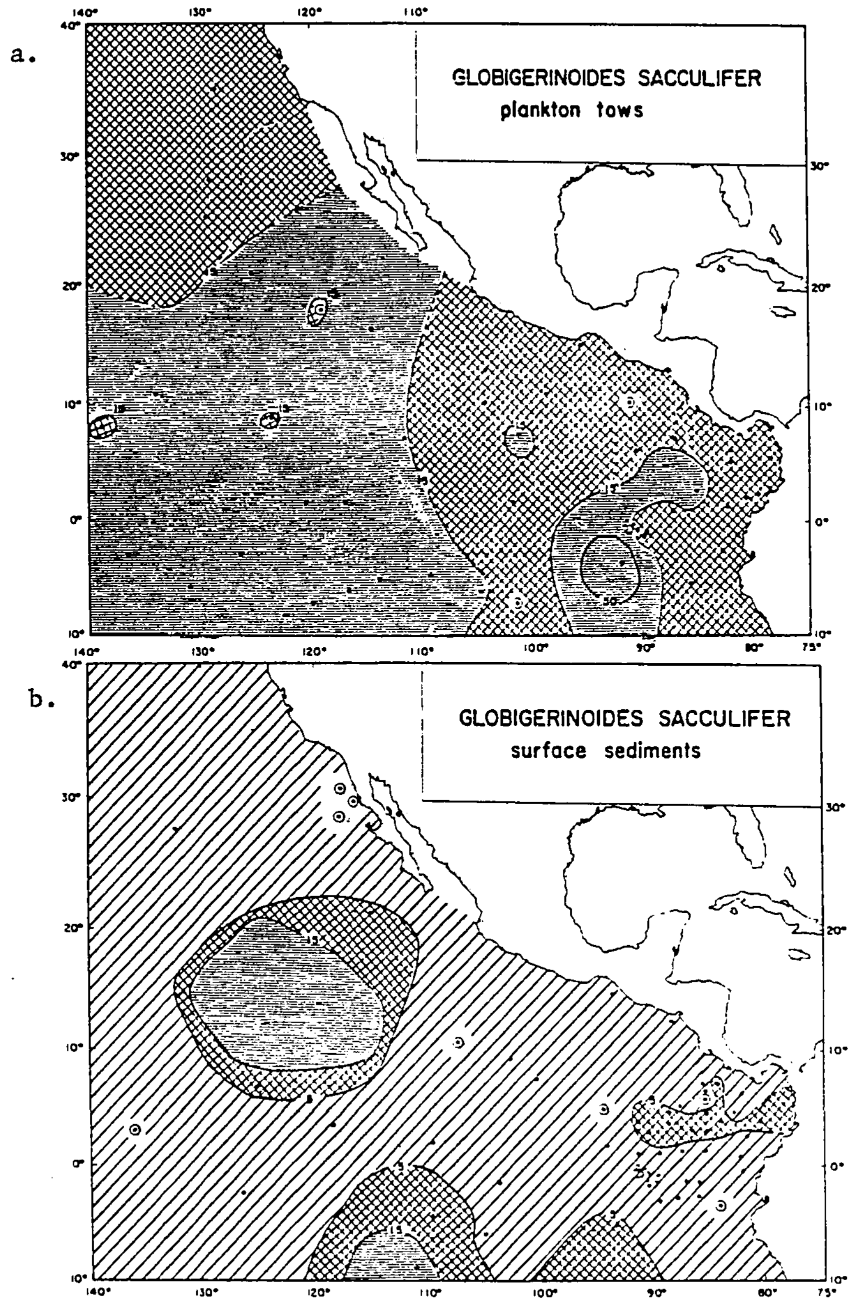


Figure III.12 Biogeographic distribution of Globigerinoides sacculifer based on (a) plankton tow samples; (b) core top samples. Faunal data listed in Appendix B. Contours and patterns represent the percentage of total planktonic foraminifera: unshaded (or ⊙), 0%; diagonal, 0-5%; cross hatched, 5-15%; horizontal, over 15%.

Presumably because of its relatively low ranking (number 6) on the Parker and Berger (1971) dissolution scale, the distribution of _G. sacculifer_ in the sea-floor sediments does not appear to be similar to its occurrence in the plankton samples (Figure III.12b). Its relative abundance in the sediments is reduced, and in only two samples does it exceed 15% of the population. However, this species was found in the sediments of all portions of the study area except off Baja Calafornia, and therefore, its sediment distribution is superficially similar to its plankton distribution.

Pulleniatina obliquiloculata (Parker and Jones)

Pullenia obliquiloculata Parker and Jones, 1862, *in* Carpenter, Introd. Foram., p. 183 (*nom. nud.*)

Pullenia sphaeroides (d'Orbigny) *var. obliquiloculata* - Parker and Jones, 1865, Roy. Soc. London, Philos. Trans., vol. 155, p. 365, 368, pl. 19, figs. 4a, 4b.

Pulleniatina obliquiloculata (Parker and Jones) - Parker, 1962, Micropaleontol., vol. 8, no. 2, p. 234, pl. 4, figs. 13 - 16.

Although *Pulleniatina obliquiloculata* usually only comprises up to 5% of the total planktonic foraminiferal population in the water column of the study area, this species exceeds 15% in two plankton samples (Figure III.13a). Its distribution appears to be limited only by the cool waters of the California Current to the north of 20° N. latitude. The patchy nature of its plankton distribution is not reflected in the sediments where the annual production of this species results in a fairly contiguous distributional pattern (Figure III.13b) which is similar in overall geographic extent to its plankton distribution.

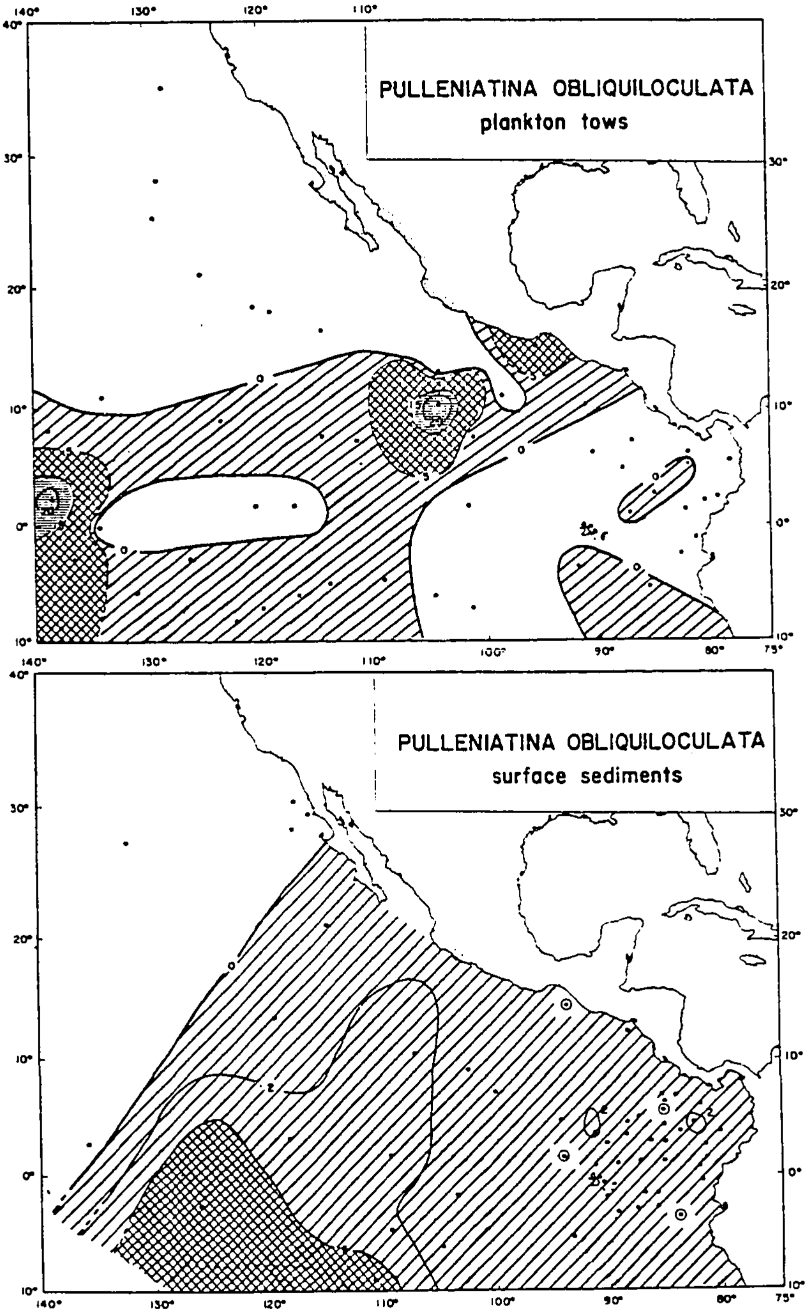


Figure III.13 Biogeographic distribution of Pulleniatina obiquiloculata based on (a) plankton tows and (b) core tops. Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12.

Hastigerina pelagica (d'Orbigny)

Nonionina pelagica d'Orbigny, 1839 (part), p. 27, pl 3, figs. 13, 14 (not figs. 1, 2)

Hastigerina pelagica (d'Orbigny) - Brady, 1884 (part), Rept. Voy. *Challenger*, Zool., vol. 9, p. 613, pl. 83, figs. 1 - 6, 7? (not fig. 8).

Hastigerina pelagica has a thin delicate calcite test which is easily damaged by either physical or chemical means. Bioturbation and dissolution would tend to destroy the tests of this species. This explains why it was only found in the plankton tow samples and was not found in any of the core tops.

Although it was found to be most dominant off Baja California, *H. pelagica* was also present throughout the study area (Figure III.14). Its conspicuous absence in the central region is not well understood. Perhaps this species is affected by the subsurface flow of the Equatorial Undercurrent and/or the upwelling which occurs along the equator and along the central American coast.

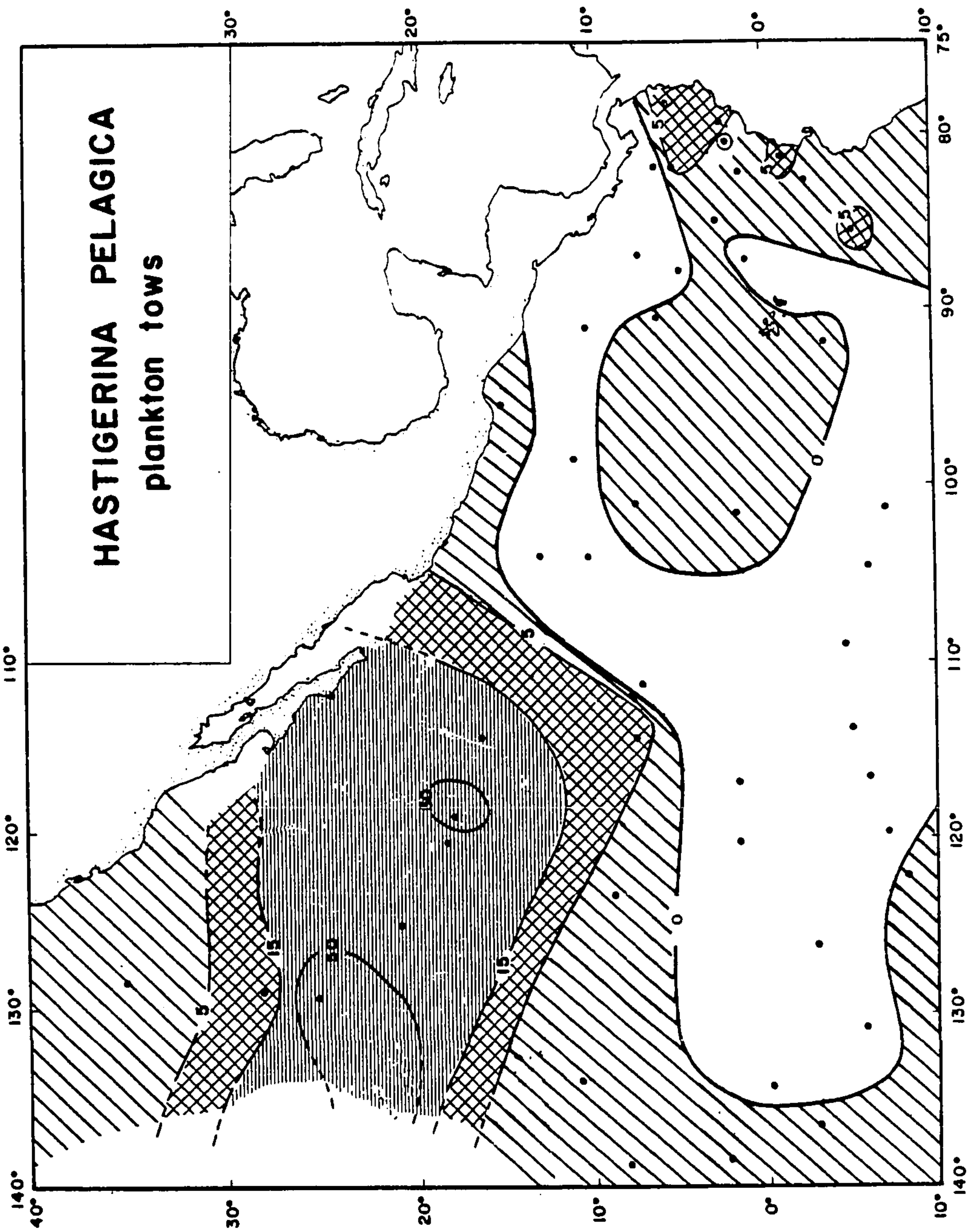


Figure III.14 Biogeographic distribution of <u>Hastigerina pelagica</u> based on plankton tows. Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12.

Group 2: Species Having Lower Abundance at the Equatorial Divergence

Globigerinita glutinata (Egger)

Globigerina glutinata Egger, 1893, Abhandl. K. Bager. Wiss. Munchen, CL II, vol. 18, p. 373, pl. 13, figs. 19 - 21.

Globigerinita glutinata (Egger) - Parker, 1962, Micropaleontol., vol. 8, no. 2, p. 246 - 249, pl. 19, figs. 1 - 16.

Globigerinita glutinata was found in almost every sample from both the plankton tows and the sediments (Figures III.15a,b). In the vicinity of the equator its percentage values are lower than those values to either the north or south. Perhaps the flow of the Equatorial Undercurrent disrupts the distribution of this species.

Orbulina universa d'Orbigny

Orbulina universa d'Orbigny, 1839, *in* de la Sagra, Hist. Phys. Pol. Nat. Cuba, p. 2, pl. 1, fig 1.

The 5% contour of the plankton distribution of *O. universa* (Figure III.16a) suggests that this species is mo t dominant within the eastern boundary currents even though it is found throughout the study area. In the sediments (Figure III.16b) there is a definite absense of this species along the equator and in the Gulf of Tehuantepec. Most

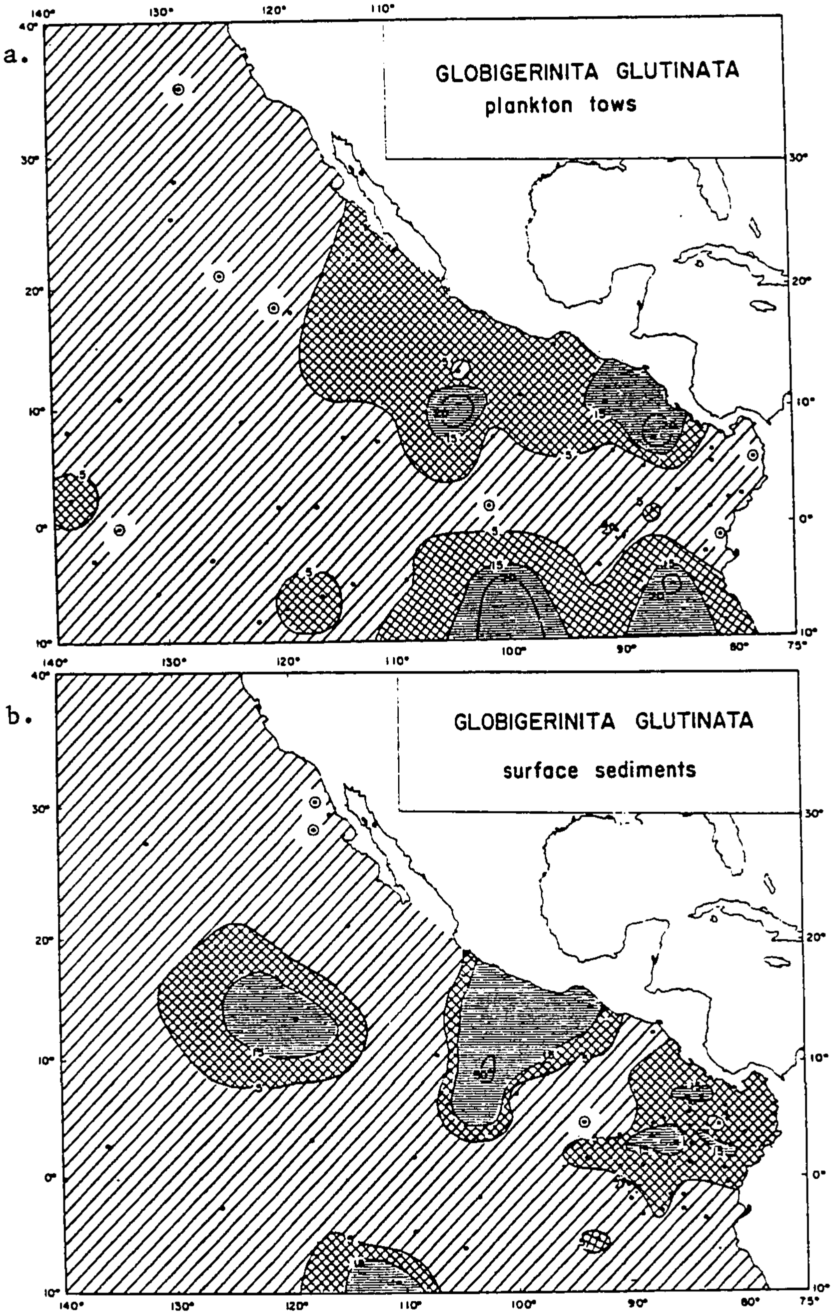


Figure III.15 Biogeographic distribution of Globigerinita glutinata based on (a) plankton tows and (b) core tops. Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12.

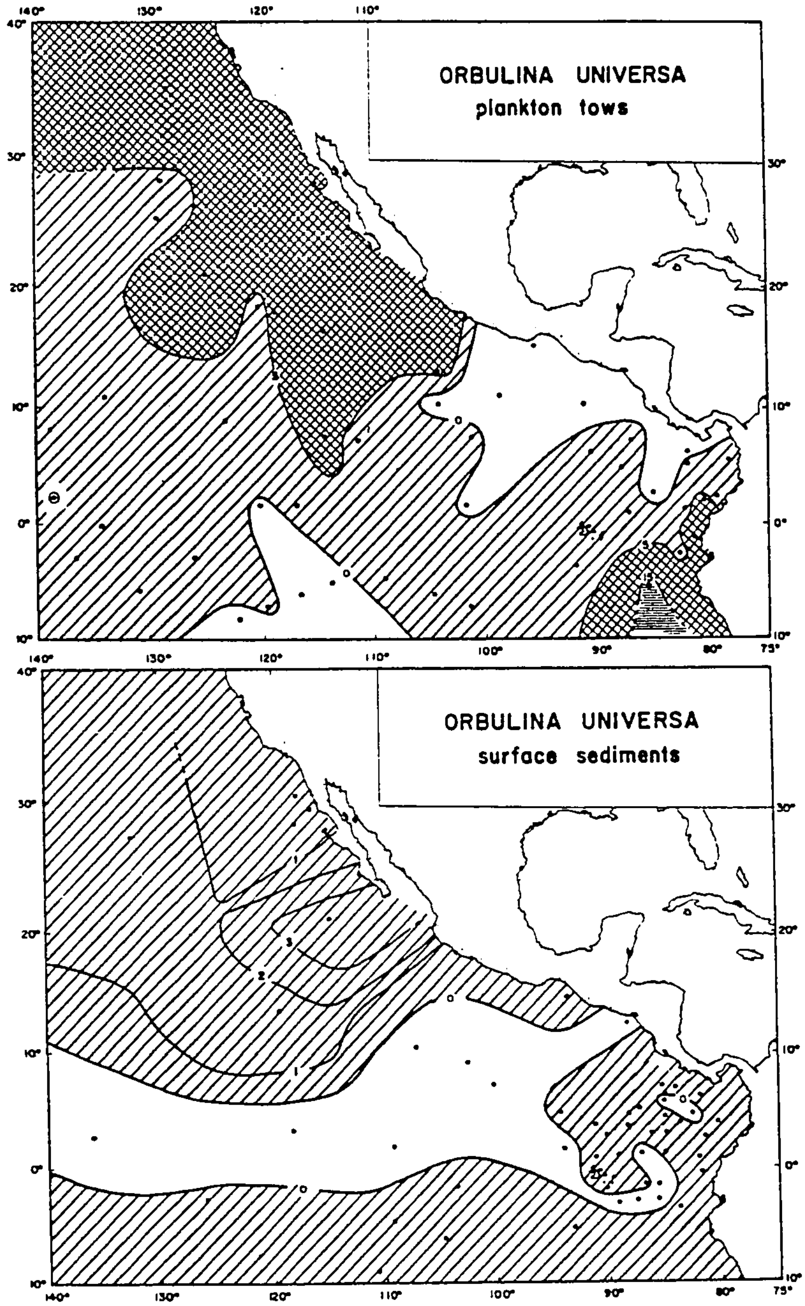


Figure III.16 Biogeographic distribution of Orbulina universa based on (a) plankton tows and (b) core tops. Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12.

probably this is a dissolution artifact, although this distribution may also be related to the flow of the Equatorial Undercurrent.

Globigerinoides ruber (d'Orbigny)

Globigerina rubra d'Orbigny, 1893, *in* de la Sagra, Hist. Phys. Pol. Nat. Cuba, pp. 82 - 83, pl. 4, figs. 12 - 14.

Globigerinoides ruber (d'Orbigny) - Parker, 1962, Micropaleontol., vol. 8, no. 2, p. 230, pl. 3, figs. 11 - 14; pl. 4, figs. 1 - 10.

Globigerinoides ruber was found in every plankton tow sample (Figure III.17a). It is more abundant along the coast of Central America than along the equator. The cool waters which well up from the Equatorial Undercurrent may be responsible for lowering the abundance of this tropical species in this region. The high dissolution suseptability of this species drastically affects its sediment distribution (Figure III.17b). Even so, this species still displays lower abundances along the equator in the sediments.

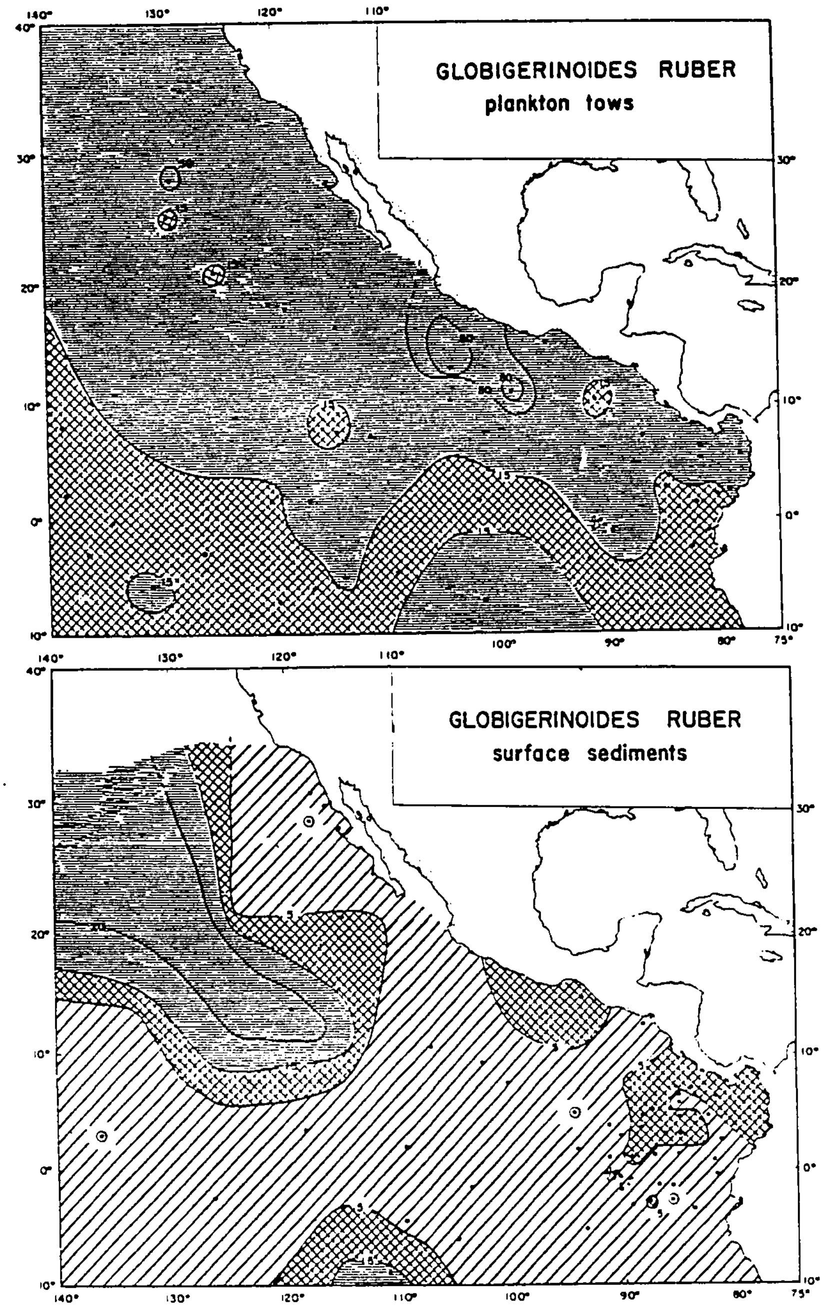


Figure III.17 Biogeographic distribution of Globigerinoides ruber based on (a) plankton tows and (b) core tops. Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12

Species Dominant in the South Equatorial Current Region

<u>Neogloboquadrina</u> <u>dutertrei</u> (d'Orbigny) var. 5+ chambers

<u>Globigerina</u> <u>rotunda</u> d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 277, no. 6 (<u>nom</u>. <u>nud</u>.)

<u>Globigerina</u> <u>dutertrei</u> d'Orbigny, 1839, <u>in</u> de la Sagra, Hist. Phys. Pol. Nat. Cuba, p. 84, pl. 4, figs. 19 – 21.

<u>Globigerina</u> <u>eggeri</u> Rhumbler, 1901, <u>in</u> Brandt, Nordisches Plankton, Lief. 1, no. 14, p. 19, text-fig 20 (after Brady).

<u>Globigerina</u> <u>subcretacea</u> Lomnicki, 1901, Naturf. Ver. Berlin, Bd. 39 (1900), Abh., p. 17.

<u>Neogloboquadrina</u> <u>blowi</u> Rogl and Bolli – Saito, Thompson and Breger, 1981, p. 114, pl. 37, figs. 1a – 1d.

<u>Remarks</u>:

This species includes specimens with five or more chambers visible in umbilical view (Figure III.3a). It has been distinguished from specimens with four to four and one half chambers visible in umbilical view. Both morphotypes of <u>N</u>. <u>dutertrei</u> differ from <u>N</u>. <u>pachyderma</u> in possessing a recurved apertural margin.

<u>Neogloboquadrina</u> <u>dutertrei</u> was found in almost all of the water column samples throughout the study area. However, its plankton tow distribution indicates an ecologic preference for the eastern boundary currents and the South Equatorial Current (Figure III.18a). These waters are either subject to coastal upwelling or upwelling from the Equatorial Undercurrent.

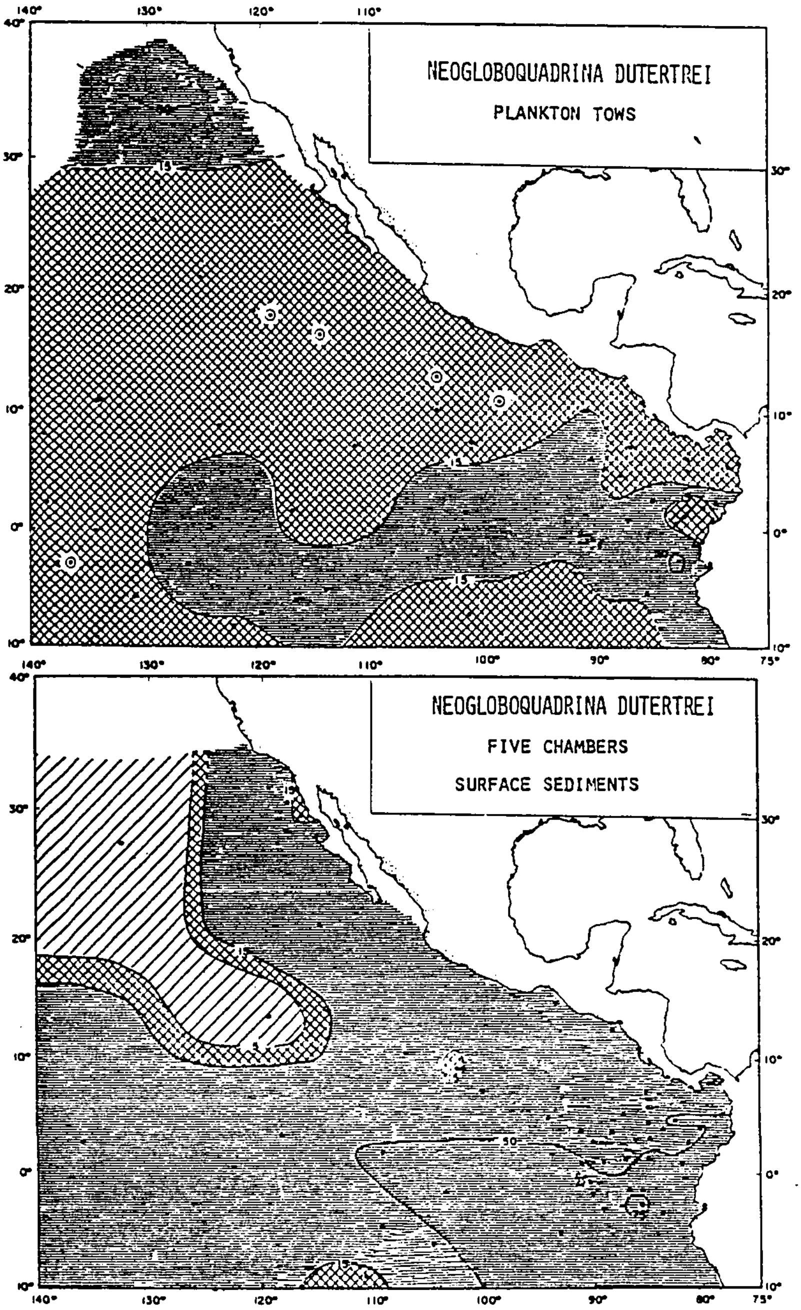


Figure III.18 Biogeographic distribution of Neogloboquadrina dutertrei based on (a) plankton tows and (b) core tops. For the sediment samples specimens with 4 1/2 chambers in the last whorl were counted separately (see Figure III.25). Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12.

In the case of the sediment samples, the 5 or more chambered specimens of N. *dutertrei* were counted separately from the 4 to 4 1/2 chambered individuals. In the eastern sector of the study area there is a strong correlation between the 5+ chambered variety and the South Equatorial Current (Figure III.18b). These specimens generally comprise more than 50% of the foraminiferal population. Towards the north and west their abundance decreases but, below the South Equatorial Current, always remains greater than 15%.

Species Dominant in the North Equatorial and Equatorial Counter Current Region

Globorotalia menardii (Parker, Jones and Brady)

Rotalia (*Rotalie*) *menardii* d'Orbigny, 1826, Ann. Sci. Nat. Paris, Ser. 1, vol. 7, p. 273, no. 26 (*nom. nud.*).

Rotalia menardii Parker, Jones and Brady, 1865, Ann. Mag. Nat. Hist., vol. 16, ser. 3, p. 20, pl. 3, fig. 81.

Globorotalia cultrata (d'Orbigny) - Parker, 1962, Micropaleontol., vol. 8, no. 2, p. 235 - 236, pl. 5, figs. 2 - 5.

Globorotalia neoflexuosa Srinivasan, Kennett and Bé, 1974, Deep-Sea Res., vol. 21, p. 321 - 324, pl. 1, figs. 1, 2, 8, 9, 10.

Globorotalia menardii (d'Orbigny) *gibberula* Bé, 1977, *in* Ramsay (ed.) Oceanic Micropalaeontology, London: Academic Press, p. 61, pl. 12, figs. 36 a - c.

Globorotalia tumida (Brady)

Pulvinulina menardii (d'Orbigny) var. *tumida* Brady, 1877, Geol. Mag., London, new ser. dec. 2, vol. 4, no. 12, p. 535.

Pulvinulina tumida Brady, 1884, Rept. Voy. *Challenger* Exp., Zool., vol. 9, p. 692, pl. 103, figs. 4 - 6.

Globorotalia tumida (Brady) - Parker, 1962, Micropaleontol., vol. 8, no. 2, p. 239 - 240, pl. 6, figs. 8 - 10.

The data for *Globorotalia menardii* and *Globorotalia tumida* have been combined and are presented together as the *G. menardii-tumida* complex. In the plankton tows this group is most abundant in the western sector of the study area, and in the Panama Basin (Figure III.19a). These two regions

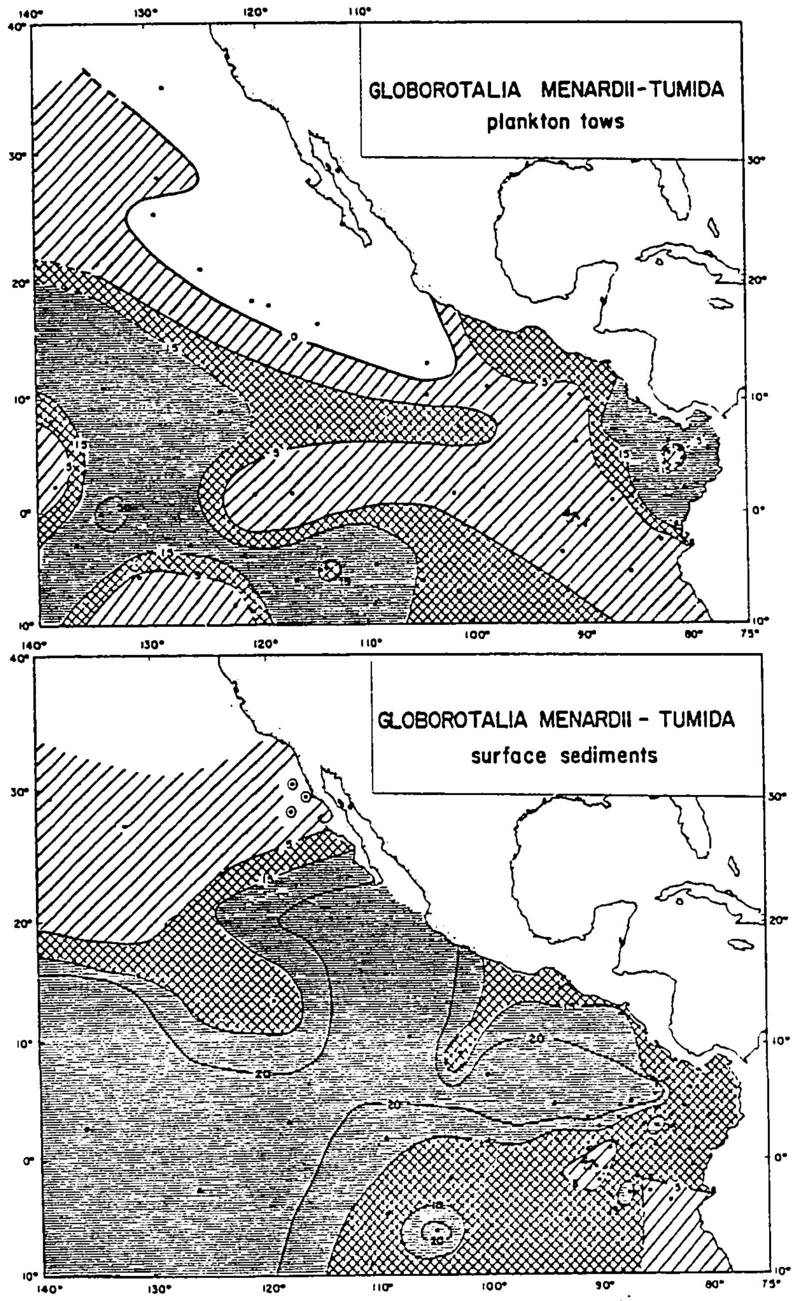


Figure III.19 Biogeographic distribution of the <u>Globorotalia menardii-tumida</u> complex based on (a) plankton tows and (b) core tops. Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12.

are joined by the eastward flowing Equatorial Counter Current which is deliniated by the sharp curvature of the 5% contour line. The species complex has low population densities in the South Equatorial Current and was absent from the tows taken off the coasts of California and Mexico.

The high resistance to dissolution of the G. menardii-tumida complex preserves, in the sediments, the overall pattern of its biogeographic distribution in the water column (Figure III.19b). The flow of the warm central Pacific waters towards the Panama Basin, via the Equatorial Counter Current, is reflected by the sediment distribution of these species. Only limited numbers of this group were found in the sediments off the coast of California, and below the Peru and South Equatorial Currents.

Globoquadrina conglomerata (Schwager)

Globigerina conglomerata Schwager, 1866, Novara Exped. 1857-59, Geol. Theil. Bd. 2, Abt. 2, p. 255, pl. 7, fig. 113.

Globoquadrina conglomerata (Schwager) - Parker, 1962, Micropaleontol., vol. 8, no. 2, pp. 240 - 242, pl. 6, figs. 11 - 18.

In the plankton tow samples G. conglomerata has its highest concentrations in the southwest corner of the study

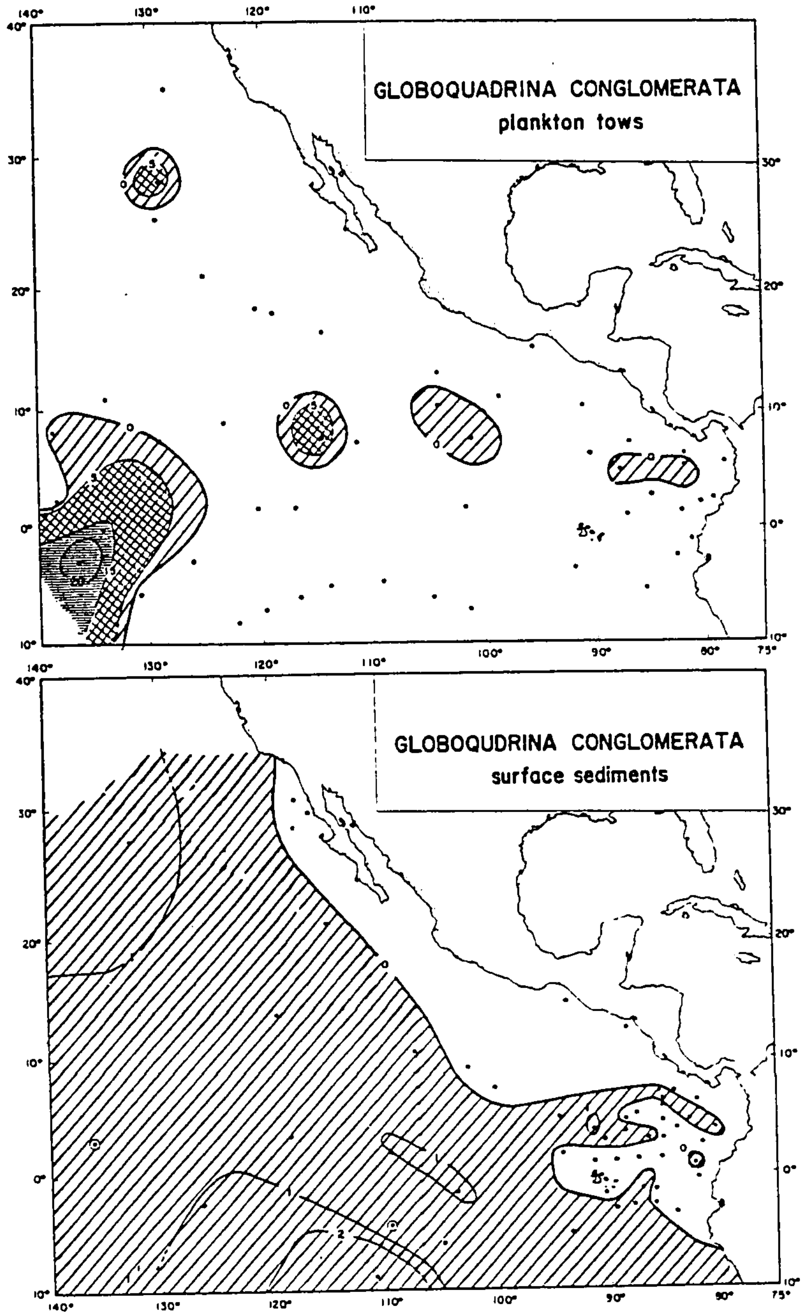


Figure III.20 Biogeographic distribution of Globoquadrina conglomerata based on (a) plankton tows and (b) core tops. Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12.

area (Figure III.20a). This suggests that this species prefers the central waters of the South Pacific gyre. Its discontinuous distribution in the water column between 4° N. and 10° N. latitude reflects the easterly flow of the Equatorial Counter Current. In the sediment samples, G. conglomerata was most often found either towards the northwest or towards the south of the study area (Figure III.20b). In the Panama Basin area there is a prominant finger-like extension of its geographic range between 3° N. and 7° N. latitude reflecting the flow of the Equatorial Counter Current.

Globigerinoides conglobatus (Brady)

Globigerina conglobata Brady, 1879, Quart. Jour. Micr. Sci., new ser., vol. 19, p. 286.

Globigerinoides conglobatus (Brady) - Parker, 1962, Micropaleontol., vol. 8, no. 2, p. 229, pl. 3, figs. 1 - 5.

Globigerinoides conglobatus, with few exceptions, was present in all the plankton tows throughout the study area (Figure III.21a). In the west, between 5° N. and 20° N. latitude, this species comprises more than 5% of the planktonic foraminifera. An easterly extension of this region (at about 10° N. latitude, between 110° W. and 100° W. longitude), and a 15% value found in the Panama Basin

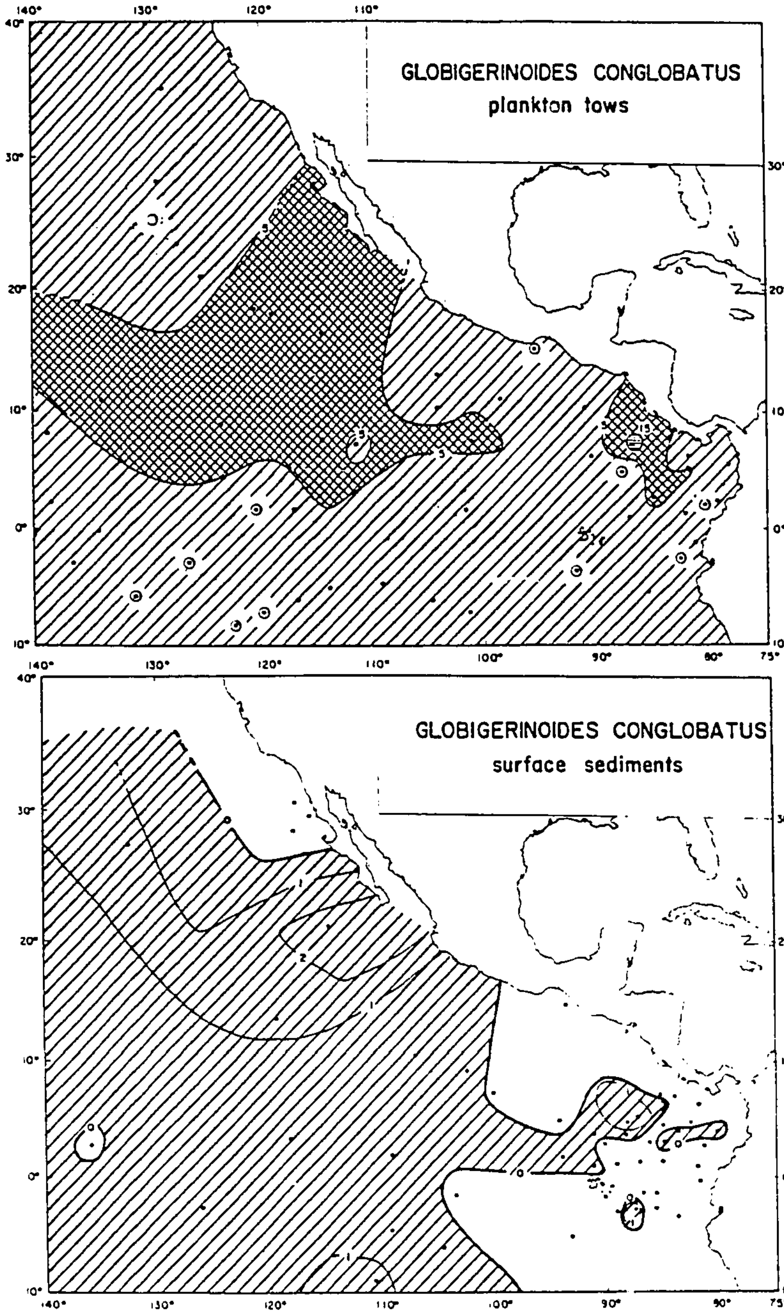


Figure III.21 Biogeographic distribution of Globigerinoides conglobatus based on (a) plankton tows and (b) core tops. Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12.

suggest that the waters of the Equatorial Counter Current are a favorable habitat for this species.

The widespread occurence of _G. conglobatus_ is also seen in the sediment samples (Figure III.21b). However, this species was not found in samples to the east of 100° W. longitude except between the equator and 8° N. latitude. The lower percentages of _G. conglobatus_ in the sediments are probably due to selective dissolution of this susceptable species.

Globigerinella aequilateralis (Brady)

Globigerina siphonifera d'Orbigny, 1839, _in_ de la Sagra, Hist. Phys. Pol. Nat. Cuba, p. 83, pl. 4, figs. 15 - 18.

Globigerina aequilateralis Brady, 1879, Quart. Jour. Micr. Sci., new ser., vol. 19, p. 285.

Globigerinella aequilateralis (Brady) var. _involuta_ - Cushman, 1917, U.S. Nat. Mus. Proc., vol. 51, no. 2172, p. 662 (plates published 1921).

Globigerinella siphonifera (d'Orbigny) - Parker, 1962, Micropaleontol., vol 8, no. 2, p. 228, pl. 2, figs. 22 - 28.

Globigerinella aequilateralis was found fairly consistently throughout the study area in both the water column (Figure III.22a) and the sediment samples (Figure III.22b). The 5% contour of the plankton tow distribution weakly suggests a relation between this species and the

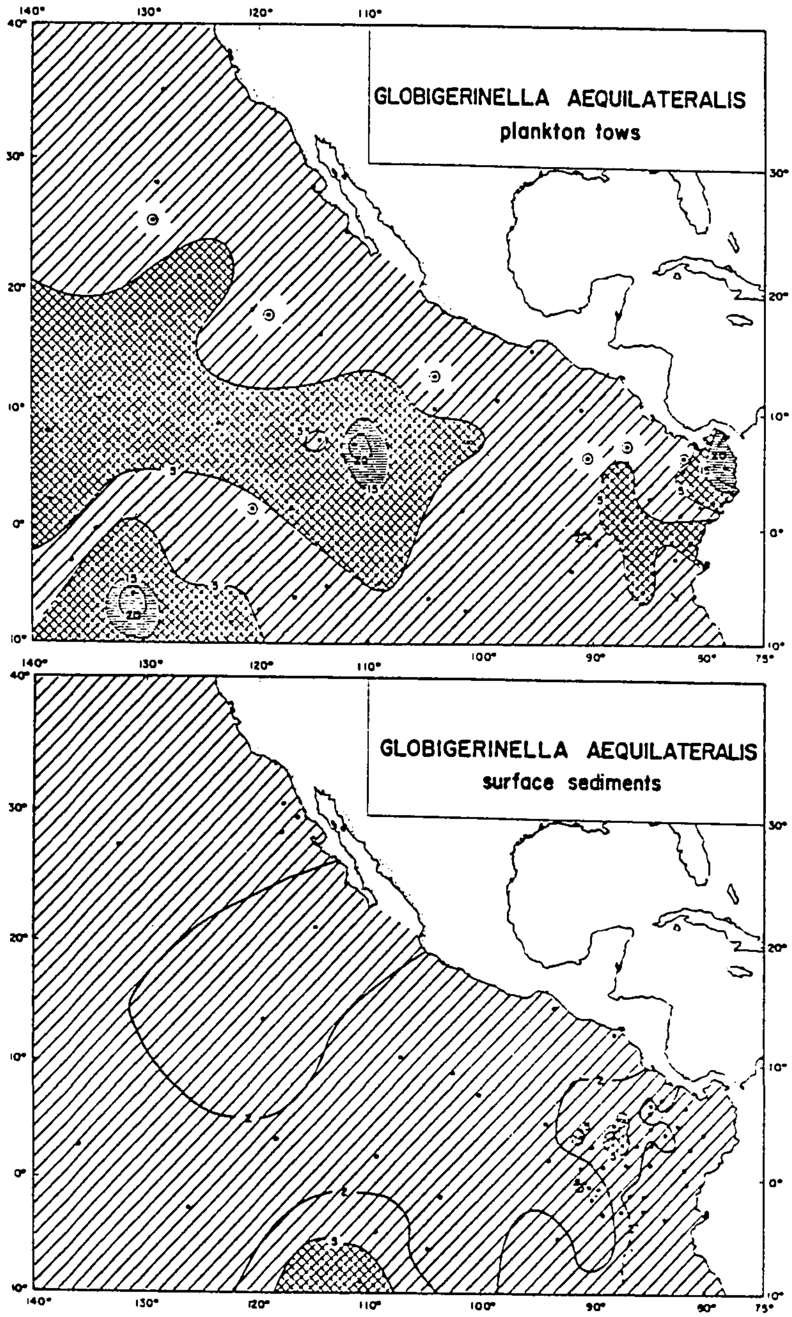


Figure III.22 Biogeographic distribution of <u>Globigerinella</u> <u>aequilateralis</u> based on (a) plankton tows and (b) core tops. Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12.

Equatorial Counter Current. No such conclusion has been derived from the sediments.

Globoquadrina hexagona (Natland)

Globigerina hexagona Natland, 1938, Calif. Univ., Scripps Inst. Oceanography Bull., Tech. Serv., vol. 4, no. 5, p. 149, pl. 17, fig. 1.

Globoquadrina hexagona (Natland) - Parker, 1962, Micropaleontol., vol. 8, no. 2, p 244, pl. 8, figs. 5 - 13.

Globorotaloides hexagona (Natland) - Saito, Thompson and Breger, 1976, *in* Takayanagi and Saito (eds.), Amer. Mus. Nat. Hist. Micropaleontology Press, p. 286, pl. 4, fig. 3; pl. 7, fig. 3; pl. 8, fig. 6.

The water column (Figure III.23a) and sediment (Figure III.23b) distributions of *G. hexagona* are quite dissimilar. The greater numbers of this species between 5°S. and 10°N. latitude in the plankton tows may reflect the Equatorial Counter Current, however, the sediment distribution does not convey this relationship.

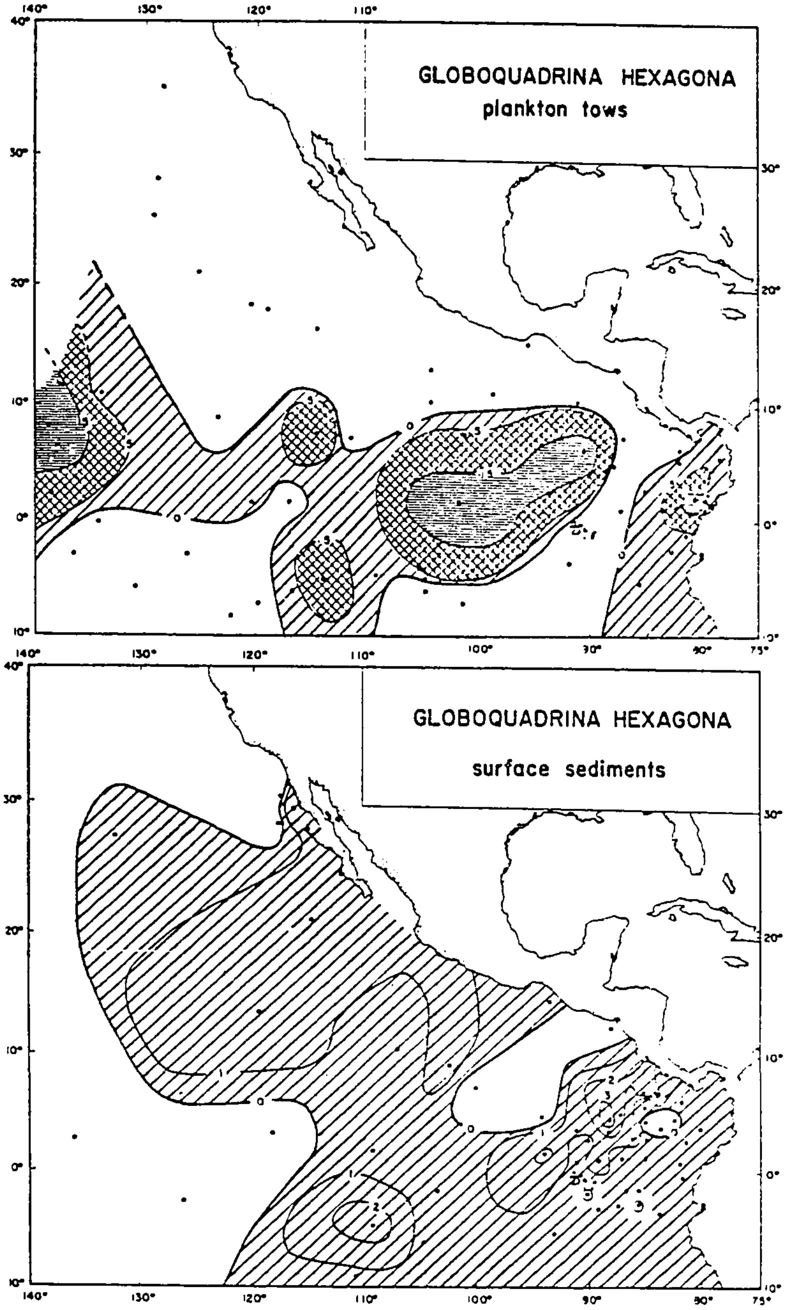


Figure III.23 Biogeographic distribution of Globoquadrina hexagona based on (a) plankton tows and (b) core tops. Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12.

Species Dominant in the Eastern Boundary Current Regions

Neogloboquadrina pachyderma (Ehrenberg)

Asterospira pachyderma Ehrenberg, 1861, K. Preuss. Wiss. Berlin, Monatsber., p. 276 - 277, 303.

Globigerina pachyderma (Ehrenberg) - Parker, 1962 (part), Micropaleontol., vol. 8, no. 2, p. 224, pl. 1, figs. 26?, 28, 29, 31?, 34 (not figs. 27, 30, 32, 33, 35); pl. 2, figs. 1, 2, 3? (not figs. 4, 5, 6).

Remarks:

This species is restricted to individuals which appear quadrate in outline when observed in umbilical view (Figure III.3c). The apertural margin is straight, and often thickens to become a lip, so that the 4 chambers are tightly appressed. Specimens with 4 to 4 1/2 chambers in the final whorl are classified as N. dutertrei var. 4 1/2 chambers.

Although N. pachyderma is normally associated with the subpolar and polar environments, this species is found in the sediments beneath the eastern boundary currents of the tropical Pacific (Figure III.24). Off Baja California, under the California Current, right coiling individuals of this species comprise over 50% of the total planktonic foraminiferal population. Left coiling individuals, normally associated with extreme polar waters, are present in abundances exceeding 2%. This region has the coldest waters of the study area. In February, sea-surface

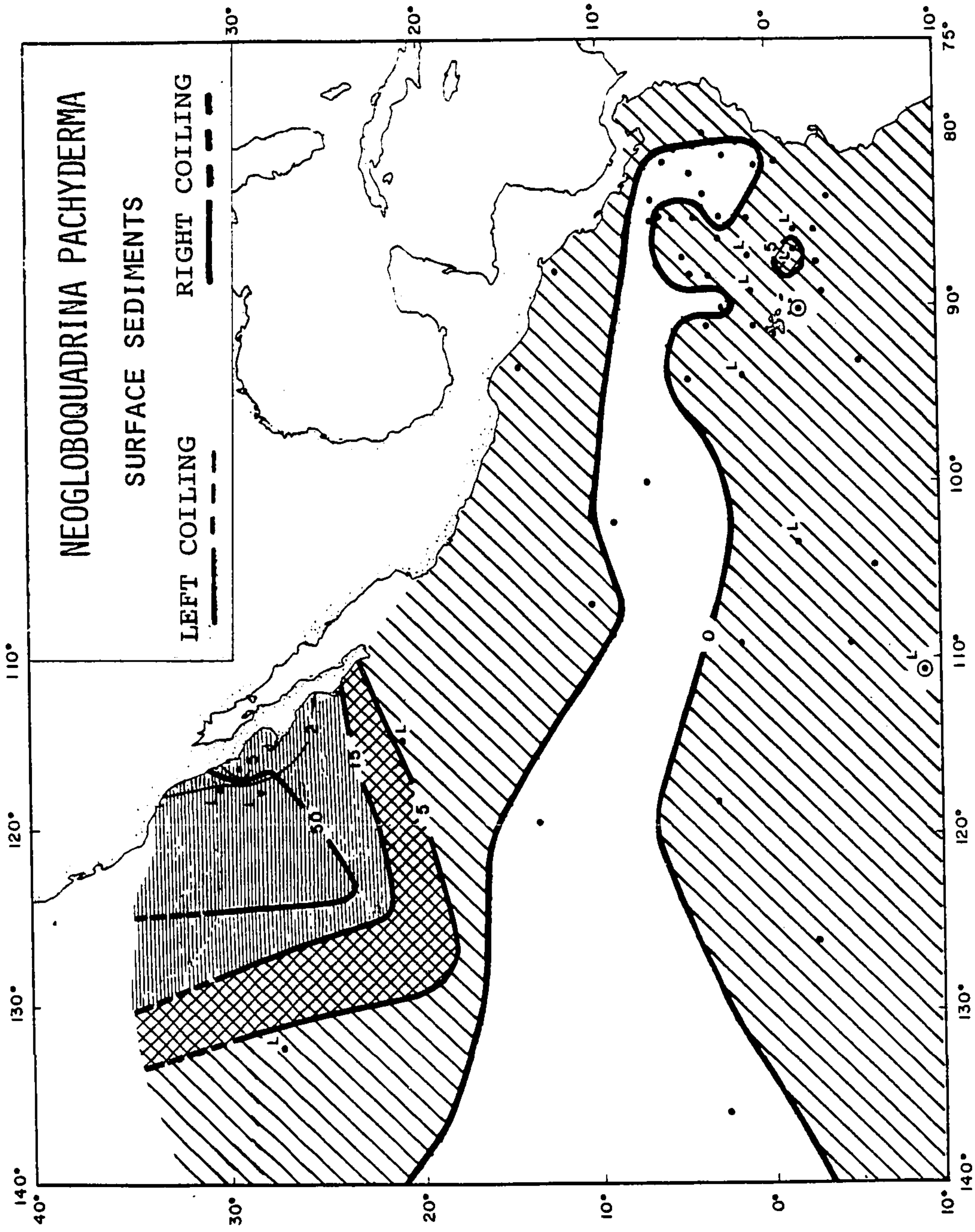


Figure III.24 Biogeographic distribution of Neogloboquadrina pachyderma based on core top sediment samples. Contours and patterns represent percentage of total planktonic foraminifera: bold curves, right coiling specimens; fine curves, left coiling; L, less than 1% left coiling present; ⊙ , 0% right coiling; other patterns as in Figure III.12.

temperatures are approximately 12° C. (D. Hahn, unpublished).

The water where the Peru Current terminates, and where the South Equatorial Current originates is not as cold as the California Current water. Thus, in the region to the east of the Galapagos Islands _N. pachyderma_ comprises only 5% of the foraminiferal population.

The conspicuous absence of _N. pachyderma_ in a zonal band centered at 10° N. latitude is not very well understood. Possibly, this species is inhibited by the warm waters of the Equatorial Counter Current, which flows at this latitude. This anomalous distribution may also be a result of inadequate sampling of the sea-floor dictated by the poor preservation of carbonate in these sediments.

Species Dominant in the Central America Coastal Region

Globigerina bulloides d'Orbigny

"*Polymorphium tuberosum et globiferum*" Soldani, 1791 (part), Testaceogr. ac. Zoophytogr., vol. 1, pt. 2, p. 117, pl. 123, fig. O (not figs. H, I, P)

Globigerina bulloides d'Orbigny, 1826, Ann. Sci. Nat., ser. 1, vol. 7, p. 277.

Although *G. bulloides* normally is associated with subpolar waters, Be (1977) has described an equatorial (upwelling) variety of this species. The morphology of the *G. bulloides* specimens found in the eastern equatorial Pacific compares favorably to those Be found in the Indian Ocean (Be personal communication). In the study area, this species was most predominant: 1) off the coast of Central America, 2) in the region between the coast of Ecuador and the Galapagos Islands, and 3) at 10° N; 105° W. (Figure III.25a). The first two localities are known to be areas of upwelling. Stumph (1975) reported storm induced upwelling in the Gulf of Tehuantepec, and Pak and Zanveld (1974) discuss the upwelling that occurs to the east of the Galapagos Islands. No specific upwelling activity is known to occur at the third locality. Perhaps this high population is only a transient event. This assumption is supported by the sediment distribution (Figure III.25b) of *G. bulloides*. This species is only present in relatively large numbers in the sediments of the Gulf of Tehuantepec and to the east of the Galapagos.

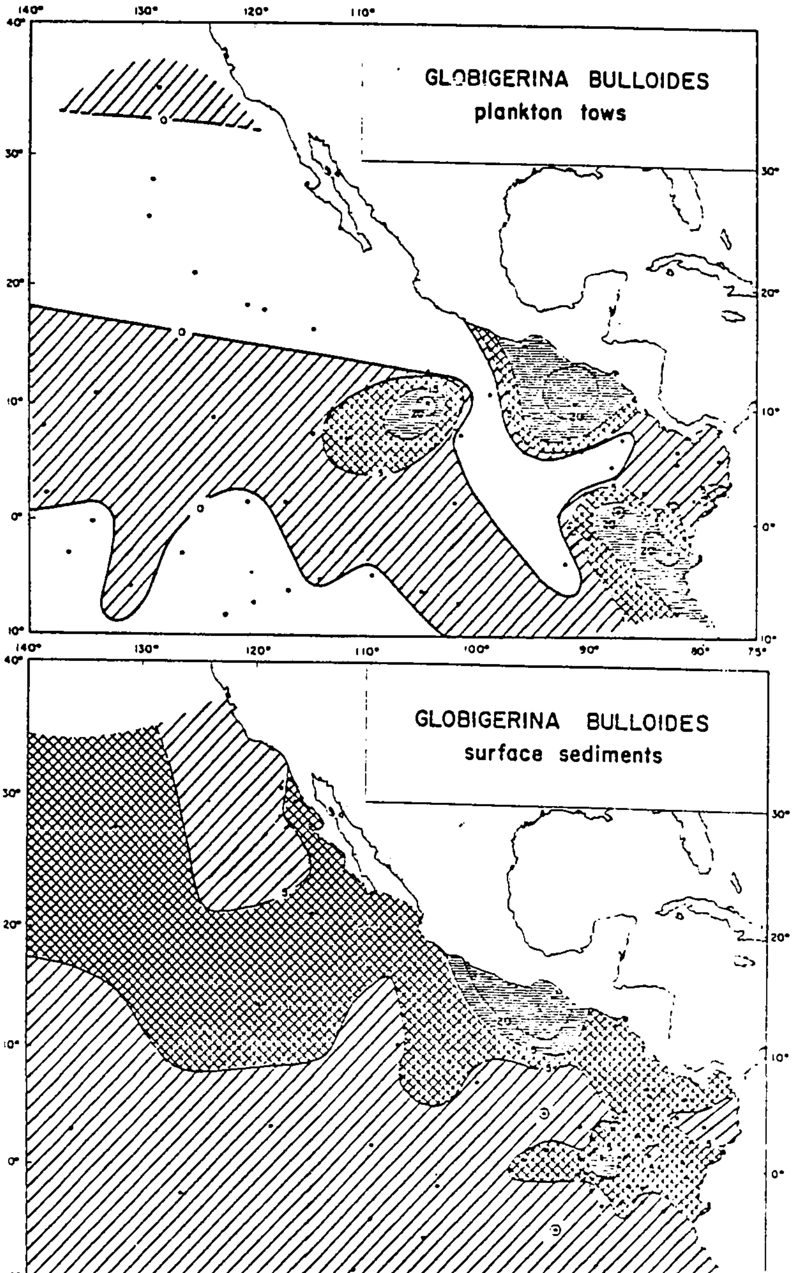


Figure III.25 Biogeographic distribution of Globigerina bulloides based on (a) plankton tows and (b) core tops. Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12.

Species Dominant in The Panama Basin

Neogloboquadrina dutertrei (d'Orbigny) var. 4 1/2 chambers

Globigerina incompta Cifelli, 1961, Cushman Found. Foram. Res. Contr., vol. 12, pt. 3, p. 83, pl. 4, figs. 1 - 7.

Remarks:

This morphotype most nearly resembles the P-D intergrade category of Kipp (1976) but includes both left and rigt coiling specimens (Figure III.3b).

Specimens of this morphotype of *N. dutertrei* were counted separately from the more typical morphotype with 5 or more chambers in the last whorl. They are most abundant in the Panama Basin (Figure III.26) where a strong shallow thermocline develops (compare Figure III.26 with Figure II.4). The limits of dominance of this morphotype of *N. dutertrei* coincides with the abrupt deepening of the thermal structure depicted in Figures II.6 and II.7.

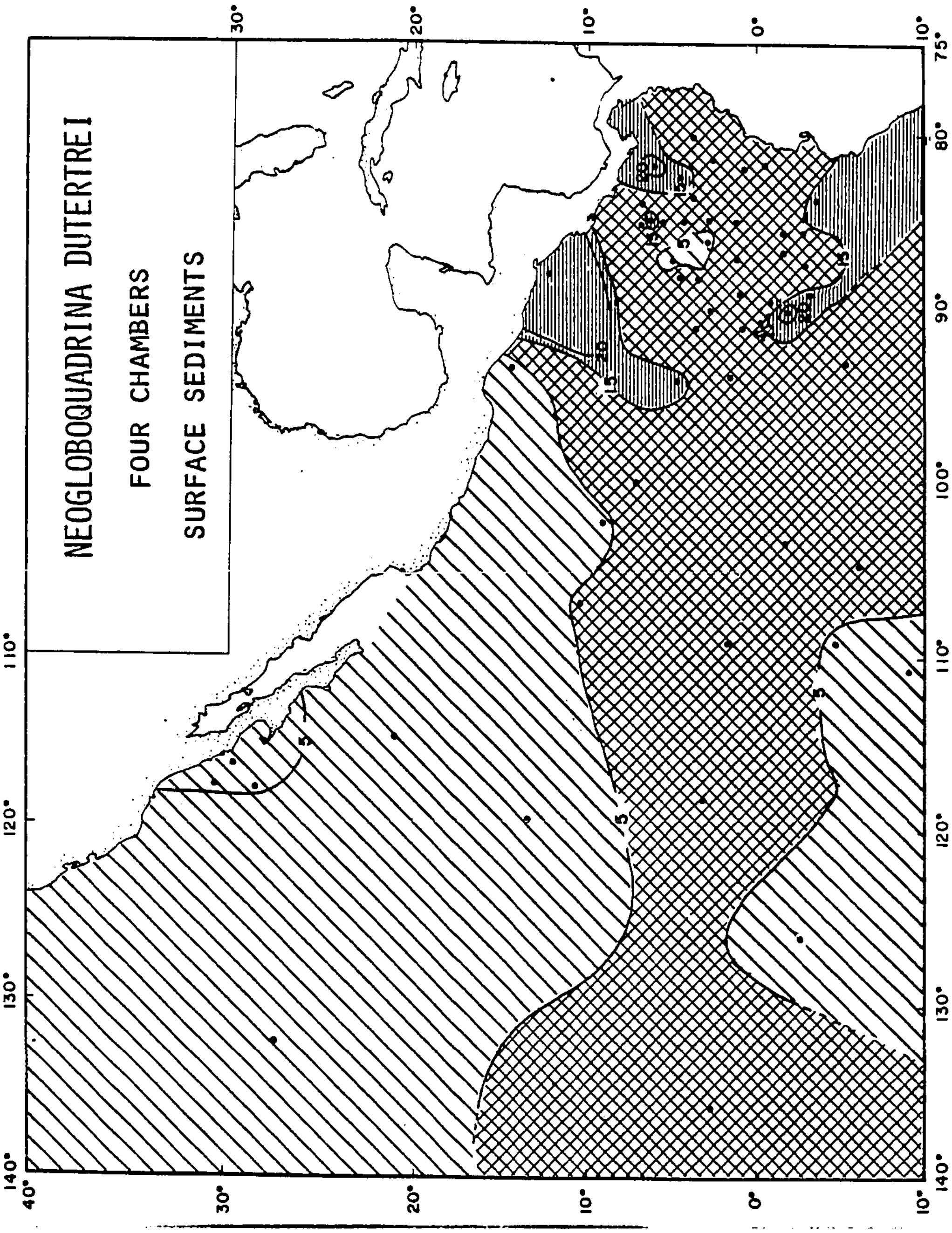


Figure III.26 Biogeographic distribution of <u>Neogloboquadrina</u> <u>dutertrei</u> with 4 to 4 1/2 chambers in the final whorl based on core top sedimens samples. Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12. Figure III.17 illustrates the biogeography of specimens with 5 or more chambers in the final whorl.

Species Dominant in the Converging Zone With Deep Thermocline Region

Globorotalia truncatulinoides (d'Orbigny)

Rotalina truncatulinoides d'Orbigny, 1839, *in* Barker-Webb and Berthelot, Hist. Nat. des Iles Canaries. "Foraminiferes", vol. 2, pt. 2, p. 132, pl. 2, figs. 25 - 27.

Globorotalia truncatulinoides was not found in any of the 49 plankton tows used to describe the biogeography of the planktonic foraminifera. However, two specimens were seen in tows from the Panama Basin used to analyze the vertical distributions of foraminifera. The sediment distribution of this species (Figure III.27) illustrates the preference of *G. truncatulinoides* for the region where the California Current converges with the North Equtorial Current. In this region of the Pacific there is a dominance of the left coiling variety of *G. truncatulinoides*.

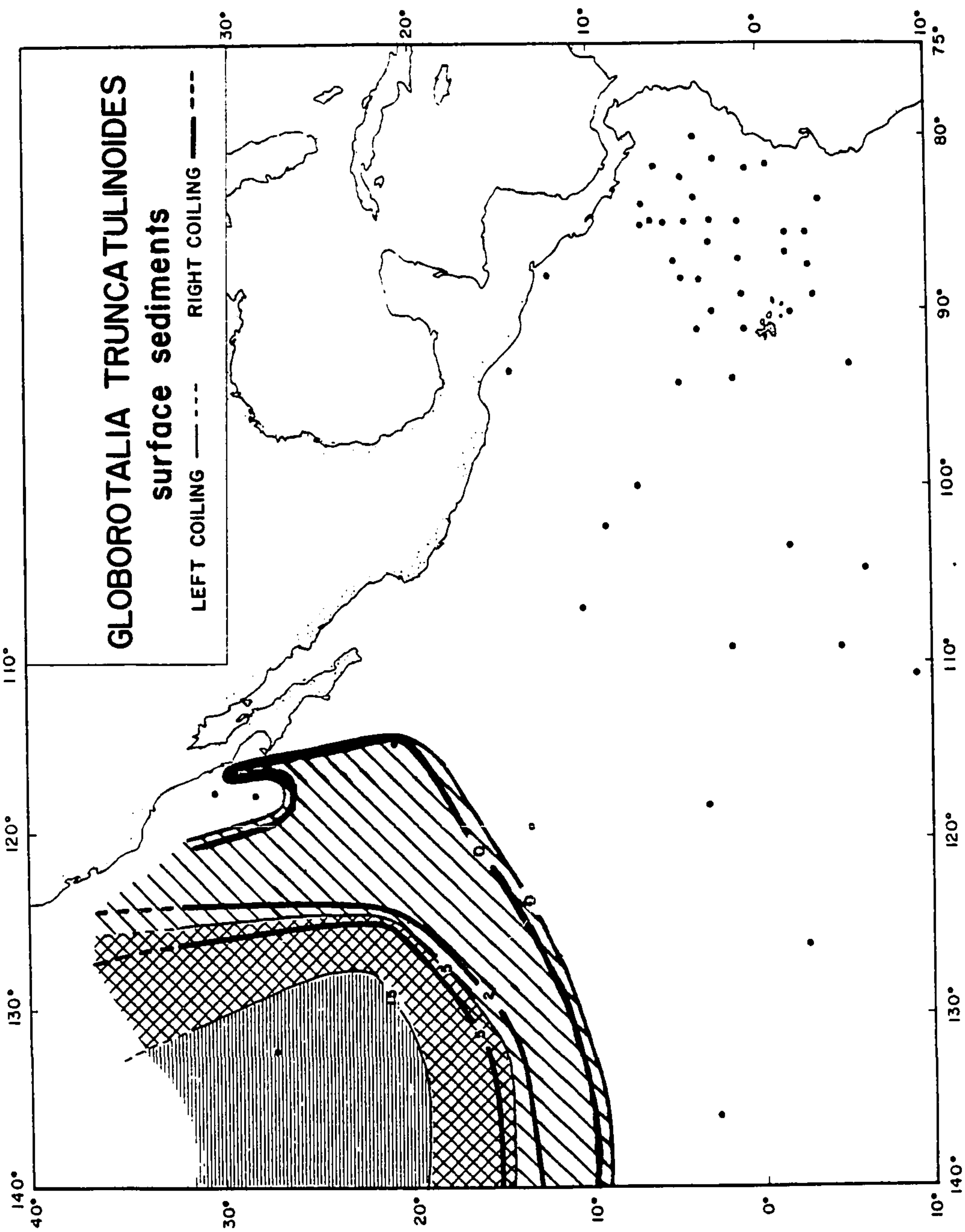


Figure III.27 Biogeographic distribution of <u>Globorotalia truncatulinoides</u> based on core top sediment samples. Contours and patterns represent percentage of total planktonic foraminifera: bold lines, right coiling specimens; fine lines, left coiling; patterns as in Figure III.12.

Globorotalia inflata (d'Orbigny)

Globigerina trigonula d'Orbigny, 1826, (nom. nud.)

Globigerina inflata d'Orbigny, 1829, in Barker-Webb and Berthelot, Hist. Nat. des Iles Canaries, "Foraminiferes", vol. 2, pt. 2, p. 134, pl. 2, figs. 7 - 9.

Globorotalia inflata was not recovered in any of the plankton tows. Its distribution in the sediments (Figure III.28) illustrates its preference for the northwestern region of the study area where the Calfornia Current converges with the North Equatorial Current. Here, oceanic convergence causes sinking of surface waters and a depression of the thermal structure (Figure II.4). Trace quantities of G. inflata were found in the sediments near the Galapagos Islands and to the south of 5°S. latitude in the south eastern sector.

Adelseck (1977) found trace quantities of G. inflata near the equator in the center of the present study area. Luz (1973) found this species to be present in the southeastern tropical Pacific. He ascribed its absence to the north of 1Ø°S. latitude to a shoaling of the oxygen minimum layer in the Panama Basin region. An alternate ecological limiting factor may be inferred by comparing Figures II.4 and III.28. The location of the zero percent contour line for G. inflata corresponds to the location of

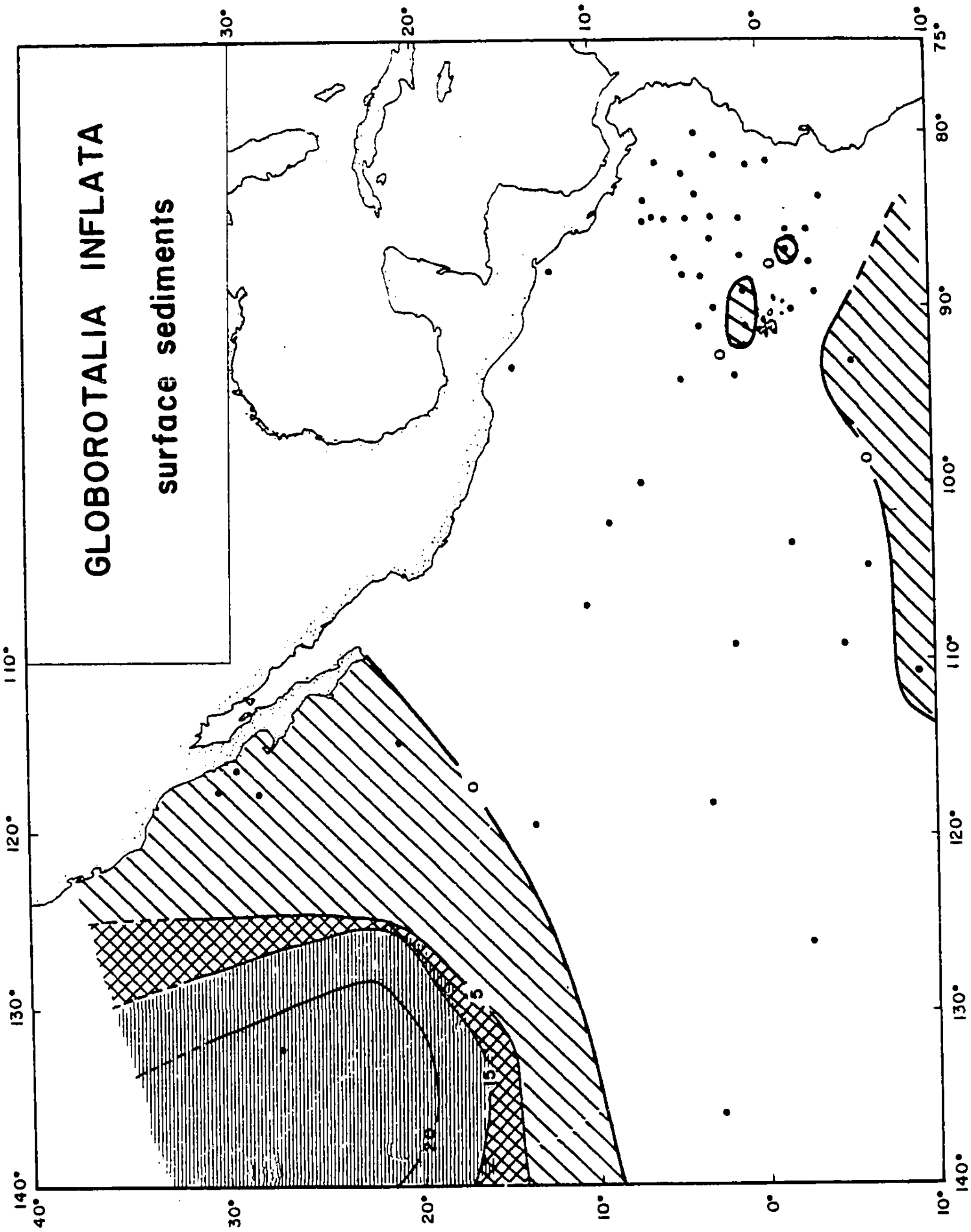


Figure III.28 Biogeographic distribution of Globorotalia inflata based on core top sediment samples. Contours and patterns represent percentage of total planktonic foraminifera as in Figure III.12.

the 150 m depth contour for the average depth of the thermocline according to Wyrtki (1964b). This correlation indicates that G. inflata prefers regions where the thermocline is depressed and a deep mixed layer is present.

DISCUSSION

The first reports concerning planktonic foraminifera from the Pacific Ocean were published after the Challenger Expedition. Brady (1884) and Murray (1895) described data from a total of 45 plankton tows scattered accross the Pacific. Agassiz (1902) described tows from the Albatross Expedition, but only mentioned the occurance of planktonic foraminifera. He made no attempt to identify the species. King and Hida (1957) described variations in total planktonic foraminiferal abundances in the equatorial Pacific but they did not present information concerning individual species distributions.

Prior to this study only cursory investigations of the biogeographic and vertical distributions of planktonic foraminifera in the eastern equatorial Pacific had been undertaken. They either encompassed the entire North and equatorial Pacific (Bradshaw, 1959; Coulbourn et al., 1980) or only small localized sectors of the study area: coastal

Baja California region (Berger and Soutar, 1976, 1977; Berger 1970, 1971a; Parker, 1973), coastal region off Ecuador (de Miro and Luzuriaga, 1974; Luzuriaga, 1976), the southeastern tropical Pacific (Luz, 1973) and the equatorial Pacific (Thompson, 1976; Adelseck, 1977).

Luz (1973) discussed foraminiferal assemblages from the southeastern tropical Pacific sediments in relation to sea-surface and 200 m depth temperature distributions. Thompson (1976) worked with equatorial Pacific foraminiferal assemblages. Both of these authors created transfer functions from their data in order to predict Pleistocene temperatures for down core samples. Adelseck (1977), while studying the processes of carbonate and biogenic opal sedimentation, presented data on the distribution of foraminifera in the surface sediments of the equatorial Pacific. A significant fact, which can be discerned from the last three studies is that Globorotalia inflata is rare to absent in the eastern equatorial Pacific to the north of about 5°S. latitude, in agreement with the data reported here.

Bradshaw (1959) studied plankton samples in the North and equatorial Pacific collected by: the Scripps Institution of Oceanography, the Pacific Oceanic Fisheries Investigation (POFI) and the U.S. Navy Electronics Laboratory. He presented a set of species distribution maps and discussed his data in terms of faunal assemblages. These assemblages are related to the major water masses of the North and equatorial Pacific, and are similar to those assemblages described by Bé and Tolderlund (1971). A Sub-Arctic Fauna was found to exist to the north of approximately 45°N. latitude. It is separated from a Central Fauna (which inhabits the waters from about 40°N. to 20°N. latitude) by a Transition Fauna. The Transition Fauna also extends southward along the California coast with the California Current to approximately 25°N. latitude. There is a definite boundary between the regions occupied by the Central and an Equatorial Fauna in the eastern equatorial Pacific, but Bradshaw (1959) was only able to suggest a gradational boundary between these groups in the western Pacific.

More recently, Coulbourn et al. (1980) described the distribution of planktonic foraminifera from the sediments of the North and equatorial Pacific. In their study they compared their data to that of Bradshaw (1959). Using multivariate statistical techniques they were able to demonstrate that the sediment distributions could be described in terms of Bradshaw's plankton assemblages. They also defined, using stepwise discriminant analysis, six good

"Eco-indicators": *Neogloboquadrina pachyderma* (left coiling), *N. pachyderma* (right coiling), *Globigerina bulloides*, *Globigerina quinqueloba*, *Globigerinoides ruber*, and *Globorotalia inflata*. The distributions of these species alone, were found to vary roughly in the same manner as Bradshaw's assemblages.

The seven regional groups described in table 3.2 and Figure III.11 compare favorably with the Bradshaw (1959) and Coulbourn *et al.* (1980) distributions. The eastern boundary current, and converging zone-deep thermocline groups correspond to the Transitional and Central Faunal assemblages of the earlier studies. The remaining groups all pertain to the eastern sector of the study area, and encompass the Equatorial Fauna of the former studies.

In considering the faunal assemblages of Bradshaw (1959) and Coulbourn *et al.* (1980) it is clear that in the western portion of the study area, sea-surface temperature exerts a significant control on the distributions of the various species. However, in the central region, to the south of 20°N. latitude, no latitudinal temperature induced distributions are obvious. Rather, the biogeographies of the various species deliniate the major near surface circulation and thermal structure patterns. In particular, three species (and/or morphotypes) are especially significant: <u>Neogloboquadrina</u> <u>dutertrei</u> with 4 1/2 chambers, <u>Globorotalia</u> <u>theyeri</u>, and <u>Globorotalia</u> <u>inflata</u>.

The ecologic relationship between the strong shallow thermocline in the Panama Basin and the large numbers of 4 1/2 chambered <u>N</u>. <u>dutertrei</u> has been discussed earlier. The biogeographic distribution of <u>Globorotalia</u> <u>theyeri</u> may also be related to this unique thermal structure. Using the data from this study alone (see Appendix C), it is not possible to accurately determine the geographic range of <u>G</u>. <u>theyeri</u>. Oxygen isotope data have shown that this species actively lives between 50 and 100 m in the water column, unfortunately many of the plankton tows used for biogeography were from the upper 10 meters. Also, because it has a thin shell, and lacks a secondary cortex, it is rarely preserved in the sediments. However, at the STIE/CFATE site <u>G</u>. <u>theyeri</u> was remarkably abundant in the water column below 100 m.

<u>Globorotalia</u> <u>theyeri</u> has previously been reported in the eastern equatorial Pacific. Boltovskoy (1974) attributed similar specimens to the new subspecies <u>Globorotalia</u> <u>hirsuta</u> <u>eastropacia</u>. However, the present author agrees with Coulbourn <u>et</u> <u>al</u>. (1980) that this form is conspecific with <u>G</u>. <u>theyeri</u>. These authors mention their earlier work, (ie., Parker and Berger, 1971) where they

referred to G. theyeri as Globorotalia sp. B. They conclude that this species is confined to the eastern Pacific between 10° N. and 30° S. latitude. Globorotalia sp. B was earlier reported as Globorotalia hirsuta, group 1 by Parker (1962, her plate 5, Figures 12 and 14). Luz (1973; unpublished data) also found Globorotalia sp. B in sediments between 4° N. and 25° S. latitude to the east of 130° W. longitude. This distribution is remarkably similar to that described by Bradshaw (1959) for Globorotalia hirsuta. Illustrations of these specimens (his plate 8, Figures 1 and 2) compare favorably with the concept of G. theyeri.

Whereas the 4 1/2 chambered variety of N. dutertrei and G. theyeri are very common in the Panama Basin, G. inflata is almost totally absent from these waters (Figure III.28: also Luz, 1973; Thompson, 1976, 1977). Luz (1973) suggested that a shallow oxygen minimum layer somehow restricts the distribution of this species, however, it was pointed out earlier that a better correlation exists between the depth of the thermal structure and the distribution of G. inflata.

The rarity of G. inflata in the eastern equatorial Pacific deserves further investigation. According to the oxygen Isotope data of Fairbanks et al. (1982) each foraminiferal species lives within a depth interval corresponding to its prefered temperature range. The data presented in the cross sections of Figure II.6 indicate that temperatures from 28° to 15°C. are available in the euphotic zone of the Panama Basin. Thus a large variety of foraminiferal species inhabit this region, including the warm water *Globigerinoides ruber* and *Globigerinoides sacculifer*, and the cool water *Globigerina bulloides* and *Neogloboquadrina pachyderma*. The earlier work of Bé and Tolderlund (1971) and Bé (1977) indicate that *G. inflata* is the only indigenous foraminiferal species of the Transitional Fauna. Its global distribution indicates the preference of this species for moderately cool waters. Coulbourn *et al.* (1980) indicated an extremely narrow observed sea-surface temperature range for *G. inflata*, ie., 17.4±1.8 C. If the temperatures in the Panama Basin euphotic zone span the ecologic range from the tropical to subpolar environments, why then is *G. inflata* absent to rare in these waters?

In the regions where *G. inflata* is commonly found ie., to the north of 20° N. latitude in the western sector of the study area, and to the south of 10° S. latitude (Luz, 1973), the average depth of the permanent thermocline exceeds 150 m (Wyrtki, 1964b). In both these areas surface water masses of differing temperature and salinity are known to be converging. In the north, the North Equatorial Current converges with the California Current (Figures II.1, II.2) and in the south, there exists the oceanic region known as the Subtropical Convergence. In regions of convergence surface waters attain densities greater than either parent water mass. As a result the surface waters tend to sink and thereby depress the thermal structure. Within the study area, _G. inflata_ appears to be restricted to regions of oceanic convergence which develop deep mixed layers.

On a global scale, the Transitional Fauna of Bé and Tolderlund (1971) corresponds to regions of convergence between warm subtopical waters and cool subpolar waters. The most important species in this assemblage is _G. inflata_. The data published by Parker and Berger (1971) demonstates that this species is very abundant in the Subtropical convergence and less so in other regions of the South Pacific. In the North Pacific, the distributions of Bradshaw (1959) and Coulbourn _et al_. (1980) agree with Figure III.28. Thompson (1981) reports the maximal abundance of this species in the sediments beneath the convergence between the Kuroshio and Oyashio Currents off Japan. The planktonic foraminifera in surface sediments of the North Atlantic have been described by Ruddiman (1969), Imbrie and Kipp (1971) and Kipp (1976). All of these investigations indicate that *G. inflata* is most abundant in the Gulf Stream where it converges with the Labrador Current. Concentrations of this species are highest in the transition waters between the subpolar and subtropical waters of the North Atlantic, they fall off sharply within subpolar waters, but remain significant well into the subtropics ie., 4% of the total planktonic foraminiferal population at Bermuda (Bé and Tolderlund, 1971). Tolderlund and Bé (1971) found this species to be present throughout the year in the transition zone. Away from this region *G. inflata* was found only in the winter or early spring. Apparently, outside of converging zones, *G. inflata* populations are restricted to winter conditions when the water column becomes more isothermal due to increased mixing. During the summer months thermal stratification occurs. This somehow seems to inhibit the continued proliferation of this species.

Although *G. inflata* is very rare in the eastern equatorial Pacific because of the continuous presence of a shallow thermocline, it was found in trace quantities to the east of the Galapagos Islands, near the equator, where the thermocline is at its shallowest (Figure III.28). Also, Adelseck (1977) reported a few specimens of this species from core tops near the equator between 115° W. and 100° W.

longitude. If *G. inflata* is inhibited by a shallow thermocline why is it present where the thermocline rises in the equatorial divergence?

A possible answer to this question may be found by examining the results of laboratory feeding experiments with living specimens of *Globigerinoides sacculifer* conducted by Bé *et al.* (1981). They found an inverse relation between the amount of food ingested and the rate of growth to maturity and reproduction. In addition, Bé (personal communication) has found that species of *Globorotalia* have longer life spans than *Globigerinoides* species. Some specimens of *G. inflata*, where it is abundant in the Subtropical Convergence Zone, may descend to the lower depths of the deep mixed layer, especially durring the winter. At these depths, below the chlorophyll maximum, only a limited food supply exists so that it is possible for them to grow very slowly and delay gametogenesis which effectively ends the life of an individual foraminifer.

The Subtropical Subsurface Water which originates in the deeper levels of the mixed layer of the Subtropical Convergence (Wyrtki, 1965) may be capable of transporting the passive *G. inflata* specimens towards the equator. At the equator the rapid flow of the Equatorial Undercurrent can transport the inert foraminifera to the Panama Basin region. All along the equator, the upwelling reported by Cromwell *et al.*, (1954), King *et al.*, (1958) and Knauss (1960), but especially to the east of the Galapagos Islands where Pak and Zaneveld (1974) describe intense upwelling and mixing, the *G. inflata* specimens may be brought back to the euphotic zone where they could complete their life cycles. This explains the occurence of this species in a region postulated to be unfavorable for its normal growth.

POST-MORTEM EFFECTS UPON PLANKTONIC FORAMINIFERAL ASSEMBLAGES

Post-mortem Effects in the Panama Basin

MOCNESS tows, 0 - 200 m oblique hauls, sediment trap samples and sea-bed samples were all used to investigate post mortem changes in planktonic foraminiferal assemblages of the STIE/CFATE locality. Figure III.29 illustrates the absolute abundance of planktonic foraminifera (black + white) caught in four series of MOCNESS hauls between August 3, and August 8, 1979, from the upper 1000 m of the Panama Basin. Also shown are the numbers of G. theyeri in each sample (white). Selected samples from the various series of MOCNESS hauls have been used to construct Figure III.30 (a composite diagram of instantaneous standing stock, "S"): MOC 126, eight tows from 0 - 100 m (Aug. 3); MOC 127, four tows from 100 - 200 m (Aug. 4); MOC 128, four tows from 200 - 1000 m (Aug. 5); and MOC 131, four tows from 1000 to 2000 m (Aug. 8). The cumulative percentage of the total foraminiferal population for the 7 most abundant species has been plotted for each depth interval. In the center panel, the standing stock percentages have been multiplied by the height of the water column above each sample (H) to convert

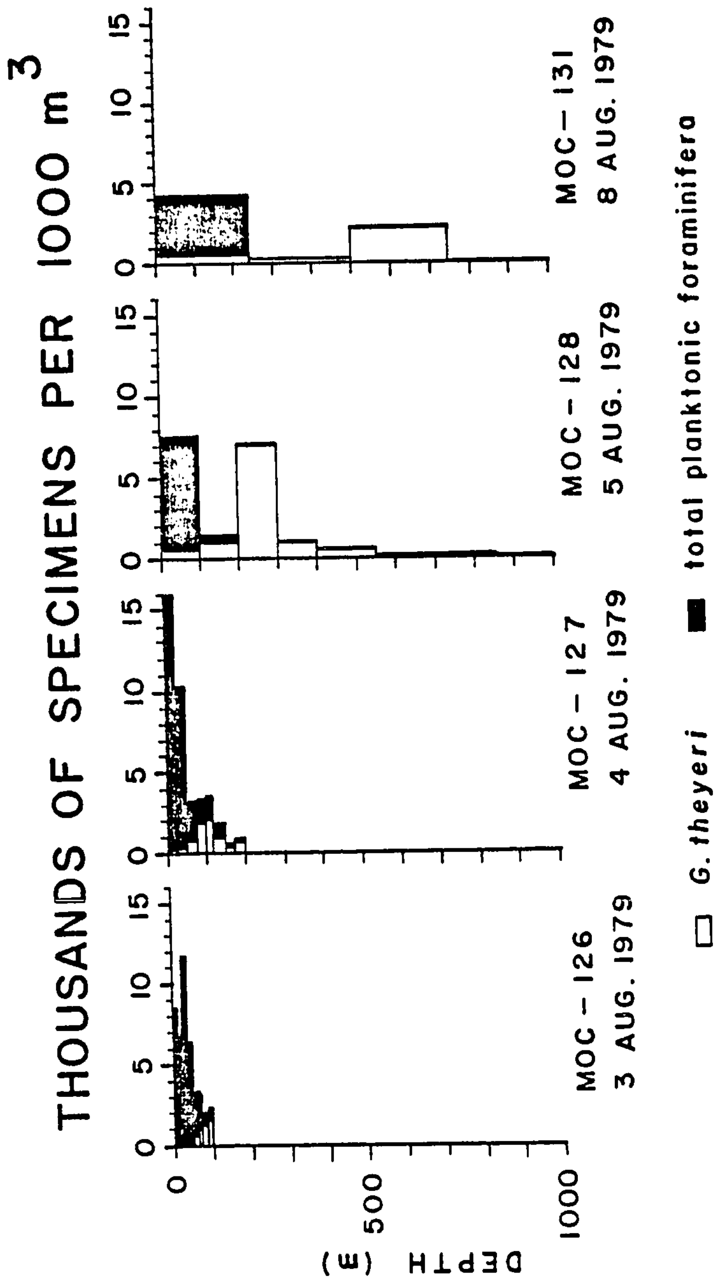


Figure III.29 Absolute abundance of total planktonic foraminiferal population (solid black) at the STIE/CFATE site (5° 20' N.; 81° 50' W.) on 4 successive days of August, 1979. Also shown in white is the number of Globorotalia theyeri specimens present at each sampled interval. Its large population below 200 m is passively settling without growth, see text.

the MOCNESS data from percent specimens per 1000 meters cubed to percent specimens per 1000 meters square, the units used to measure flux of foraminifera in the traps. These data are illustrated in the right portion of the figure.

A comparison of the data in the upper right and central panels of Figure III.30 gives the false impression that there is a discrepancy in the data concerning G. theyeri and N. dutertrei. The problem is actually caused by the asynchronous collection of the samples. The upper right hand panel presents the relative flux rates for each of the selected species caught in the floating traps between July 30, and August 1, 1979. During this interval a large death assemblage of G. theyeri was collected at 105 m depth. The water column was not sampled by the MOCNESS until August. The extremely large quantities of G. theyeri found on August 5, in MOC 128 between 200 and 300 m, and on August 8, in MOC 131 between 500 and 750 m have already been shown to be passively settling through the water column. These specimens probably represent the same population found by the sediment traps a few days earlier.

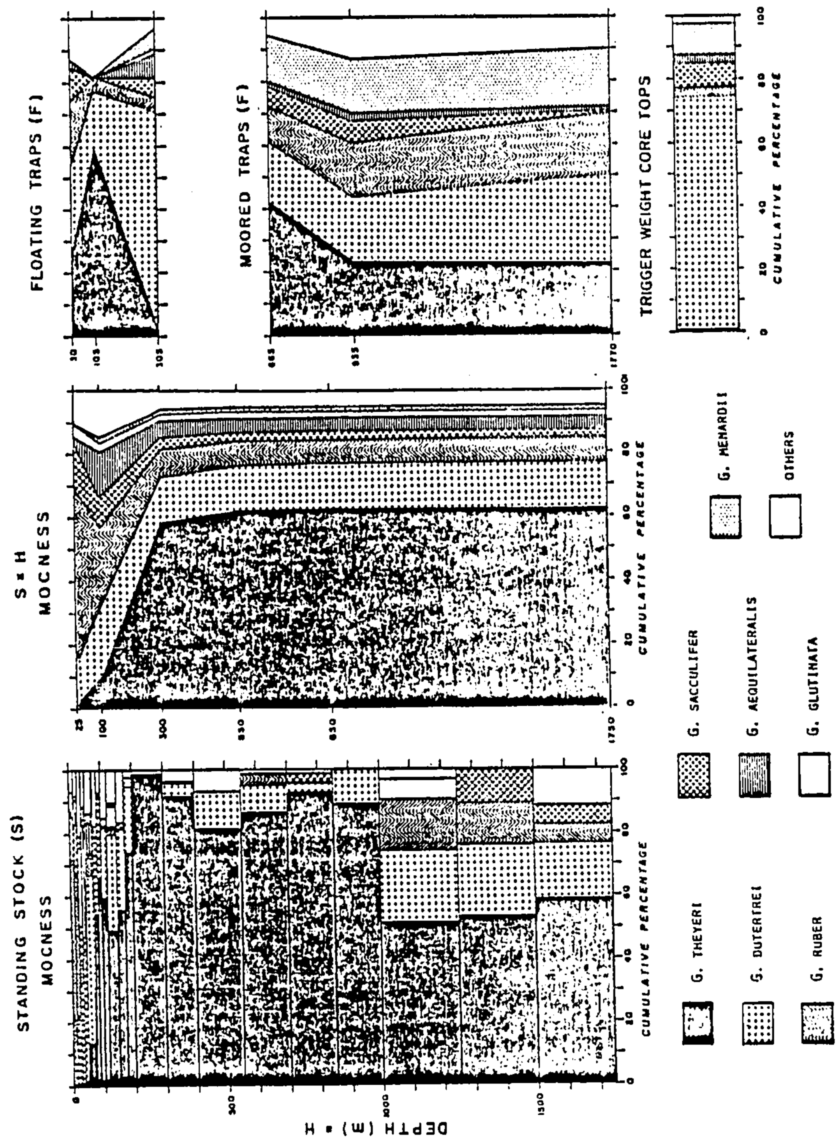


Figure III.30 Comparison of data from: MOCNESS, floating traps, moored traps, and sea floor sediments at the STIE/CFATE site (5° 20' N.; 81° 50' W.). Left: 0–100 m, MOC 126; 100–200 m, MOC 127; 200–1000 m, MOC 128; 1000–2000 m, MOC 131. Center: Standing Stock (S) multiplied by height of water column (H). Right: floating traps, 6.5 or 24 hours; moored traps; 112 days; sediments, average of 3 core top samples.

Data from the moored traps (middle, right hand panel of Figure III.30) agrees fairly well with the MOCNESS data from below 1000 m. This is so because: 1) fewer transient produtivity events occur in the deeper waters below the DCM, and 2) these traps were deployed for 112 days rather than for 6.5 to 24 hours, and therefore represent average fluxes. The figure illustrates that the flux rates of the species remain relatively constant with depth. The insigificant change implies that there is practically no selective dissolution of the foraminiferal population in the upper 1770 meters of the water column. This finding is in agreement with the results recently obtained by Thunell and Honjo (1981) who conducted an experiment in the Panama Basin to investigate the effects of selective dissolution upon planktonic foraminifera in sea-floor sediments. They preweighed samples of sediment from a box core taken in the Caribbean sea, and placed them at various depths on a moored line in the Panama Basin for 123 days. After reweighing the samples, the percentages of weight loss were shown to vary with depth of exposure to the Panama Basin waters. Little dissolution occured above 2700 m, but below this depth a rapid increase in dissolution rate was found.

The effects of dissolution upon sea-floor sediments from the Panama Basin itself were investigated by examining the foraminiferal fauna in three trigger weight core tops close to the STIE/CFATE site (Figure III.2). The actual sediment that was recovered from the core top samples appears to be very much affected by carbonate dissolution. A great deal of the sediment is composed of fragments of foraminifera. Only fragments that were larger than 1/2 of a specimen and displayed the initial chamber were counted as specimens. These were very chalky, and tended to crumble when handled with a fine brush. Many of the specimens were hollow, ie., they contained none of the inner chamber walls that were not thickened with a cortex of gametogenically precipitated calcite.

The percentages of the total planktonic foraminiferal fauna of each species was averaged among the three cores. The average cumulative percents are plotted in the bottom right hand panel of Figure III.30 where they may be compared to the data from the sediment traps. A drastic difference in relative abundances of foraminifera exists between the two types of samples. In the moored traps the percentage of G. theyeri exceeded 20%, and nearly 20 to 30 percent of each sample was comprised of N. dutertrei. On the sea-floor, less than 1% of the foraminifera are G. theyeri, whereas, the population of N. dutertrei has increased to over 70%. A comparison of these two species' test walls reveals the reason for this reversal in relative abundance. *Neogloboquadrina dutertrei* almost always forms a thick outer cortex, but none of the *N. theyeri* specimens have been observed to have a cortex layer. The only evidence for secondary calcification in this species are the small pustules of calcite seen near the aperture of some specimens. Thus, *N. dutertrei* is much more resitant to dissolution than is *G. theyeri*. In fact, *N. dutertrei* is the most resitant species of the seven being compared. As for the other selected species, the most resistant according to Parker and Berger (1971) is the *Globorotalia menardii-tumida* complex, and the least resistant, *Globigerinoides ruber*. Figure III.30 illustrates this selective removal of *G. ruber* in comparison to the *G. menardii-tumida* complex.

Post-mortem Effects in the Eastern Equatorial Pacific

In the previous discussion of the biogeography of planktonic foraminifera in the eastern equatorial Pacific significant differences in the plankton tow assemblages and sediment assemblages were noted for several species. Therefore, the ecologic information supplied by the foraminifera is not properly recorded in the sediments.

This is not an unusual situation, especially in the equatorial regions of the Pacific Ocean.

Berger (1971a) describes post-mortem changes that may affect the preservation and species abundances of living populations of planktonic foraminifera when their empty shells ultimately settle on the sea-floor. These include: 1) ingestion of living specimens in the water column by predators, and the destruction of dead shells by scavengers on the sea-floor, 2) redistribution of foraminifera in the water column by oceanic currents, and the winnowing of smaller tests in the sediments by bottom currents, 3) mixing of the upper sediment layer by bioturbation, and 4) the effects of selective dissolution upon the carbonate tests of the various species. When a large oceanic region is examined as a whole, the effects of predation, scavenging, and sediment mixing probably do not greatly affect the overall faunal data. However, the effects of dissolution are another matter. Because, organically produced carbonate is supplied to the sea-floor at a greater rate than dissolved carbonate ions are returned to the sea from the continents, most foraminiferal tests must redissolve in order that a geochemical balance be maintained (Sillen, 1967; Broecker, 1971). Berger (1968) and Parker and Berger (1971) noted that the various species of planktonic foraminifera do not dissolve at the same rate. They have ranked the species in order of increasing resistance to dissolution.

Solubility of calcium carbonate increases with increasing pressure and decreasing temperature (Garrels and Christ, 1965) so that water at greater oceanic depths tends to be more undersaturated with respect to calcite than shallower waters. Therefore, carbonate dissolution is expected to increase with depth. In fact a carbonate compensation depth, where the rate of supply from pelagic sedimentation is balanced by dissolution, exists below 4000 - 5000 meters, depending on the particular location. Berger (1968) defined another level, the lysocline, approximately 1000 m above the compensation depth where carbonate dissolution becomes significant and increases rapidly.

The majority of the core-tops used in this study are from below the lysocline (Appendix A, Table 2). This explains most of the discrepancies between the plankton tow and sediment foraminiferal distributions, especially in the case of the species most prone to dissolution, ie., Hastigerina pelagica, Globorotalia theyeri, Globigerinoides ruber, and Globigerinoides sacculifer. How important is this information? How well can paleoecologic interpretations be derived from the data of the species which are not severely dissolved?

To answer these questions the species percentage data for the 52 core top sediment samples (Figure III.10) were subjected to a Q-mode factor analysis. The resulting factors may be thought of as assemblages of species which have common ecologic and preservational distributional controls. Only the first factor (an assemblage highly dominated by both varieties of Neogloboquadrina dutertrei) was spatially related to the oceanic circulation of the study area. A map of these factor loadings corresponded to the flow of the Peru and South Equatorial Currents. Globigerinita glutinata was the most predominant constituent of the second factor. A plot of its factor loadings revealed that its importance was inversely related to water depth at the core sites. The remaining factors were composed of species groupings that did not correspond to any of the ecologic assemblages described by Bradshaw (1959), Bé and Tolderlund (1971), and Coulbourn, Parker and Berger (1980). The inverse relationship of G. glutinata to depth and the atypical admixtures of species in the other factors, indicate that selective dissolution had significantly altered the original faunal population, therby distorting the ecologic message recorded in the sediments. The results of this analysis dominantly reflect a non-biologic control upon the planktonic foraminiferal fauna in the surface sediments. The results obtained by using all 28 taxonomic categories listed in Appendix A, table 3 were therefore not satisfactory. This situation is not unusual for the Pacific Ocean, nor any other ocean, when sediments accumulate below the lysocline.

How does one avoid the loss of accuracy in the paleoecologic data set? A method of minimizing the distortion was developed by following the lead of Luz (1973). He discovered that because larger foraminifera specimens have thicker shells and are therefore more resistant to dissolution than smaller specimens of the same species, transfer functions based on those specimens with maximum diameters greater than 250 µm are better estimators of paleoecologic parameters than similar equations based on specimens greater than 149 µm in size. This method was not used in this study because it would have necessitated the exclusion of the ecologically significant species, Neogloboquadrina pachyderma, mature specimens of which rarely attain sizes greater than 250 µm. Instead, specimens greater than 149 µm of the eleven most resistant species (rankings after Parker and Berger, 1971) found in the sediments of the study area were used in further factor analysis (see section IV). The species selected by this alternate method happen to be the same species used by Luz (1973) with the addition of *N. pachyderma*.

IV. THE LATE PLEISTOCENE AND HOLOCENE EASTERN EQUATORIAL PACIFIC AND THE PANAMA BASIN

PALEONTOLOGY AND BIOSTRATIGRAPHY

Previous Investigations

Distributions of planktonic marine micro-organisms in sediments have been used to model the physical oceanography and the paleoceanography of the Pacific Ocean, ie.: planktonic foraminifera (Luz, 1973, 1977; Thompson, 1976, 1977; Bielak and Briskin, 1978), coccoliths (Geitzenauer et al., 1976), radiolarians, (Sachs, 1973a, 1973b, 1975; Moore, 1973, 1978; Robertson, 1975, Molina-Cruz, 1977a, 1977b; Romine and Moore, 1981; Romine, 1982), and diatoms (Sancetta, 1979; Cooke-Poferl et al., 1975). Most of this research culminated in the CLIMAP reconstruction of sea-surface temperatures for the Pacific of 18,000 B.P., based on the distributions of microfossils from deep-sea cores (Moore et al., 1980). From their data, these authors inferred significant changes for the surface circulation of the glacial-mode Pacific. The North Pacific current apparently was intensified, and it migrated southward in response to an equatorward shift of the Polar Front. Less severe shifts in circulation were suggested for the South Pacific and the equatorial region. The gyre margin circulation was strengthened and a distinct current "swirl" was inferred in the Panama Basin region as suggested by the sharp curvature of the paleoisotherms presented on the 18,000 B.P. temperature reconstruction (Moore et al., 1980) Within the South Pacific Central Water, Bielak and Briskin (1978) reported minor changes in sea-surface temperature and significant, subtle shifts in salinity inferred from the foraminiferal record of core RC 11-220.

Selection of cores

The biogeographic distribution of planktonic foraminifera in the eastern equatorial Pacific (Figure III.11) is a record of the surface oceanic circulation and thermal structure variations of the study area. The vertical distributions of individual species (Figure III.5) studied in the Panama Basin indicates a strong relationship between planktonic foraminifera and the euphotic thermoclinal layers. Their ecology indicate that their vertical as well as their areal distribution is dominantly related to variations in temperature. Therefore, a three-dimensional thermal model of the Panama Basin was obtained by "calibrating" the distributions of foraminiferal species in 52 sea-floor trigger weight core tops (Figure III.10) to latitudinal and vertical surface water temperatures. This three dimensional thermal structure was then projected in several deep-sea cores from the Panama Basin, and any deviation from this "norm" was taken to reflect variations in the Late Pleistocene and Holocene thermal regime.

Three deep-sea cores were examined. The entire length (1690 cm) of core V19-29 (3°35'S; 83°56'W.), and the upper 200 cm of cores V21-29 (0°57'N; 89°21'W.), and V21-212 (2° 50'N; 85°8'W.) were sampled (Appendix G, Tables 1 - 6). Figure IV.1 depicts the locations of these three cores. Core V19-29 is located just to the southwest of the Pacific Equatorial Front, which extends from north of the Galapagos Islands to the coast of Ecuador (Wooster, 1969). Because of its location, Pleistocene southerly transgressions of this front should be detectable in the faunal record of this core. Core V21-29 is situated beneath the northern branch of the Equatorial Undercurrent (described by Pak and Zaneveld, 1973) as it skirts the Galapagos Islands. Thus it is a perfect core to measure fluctuations

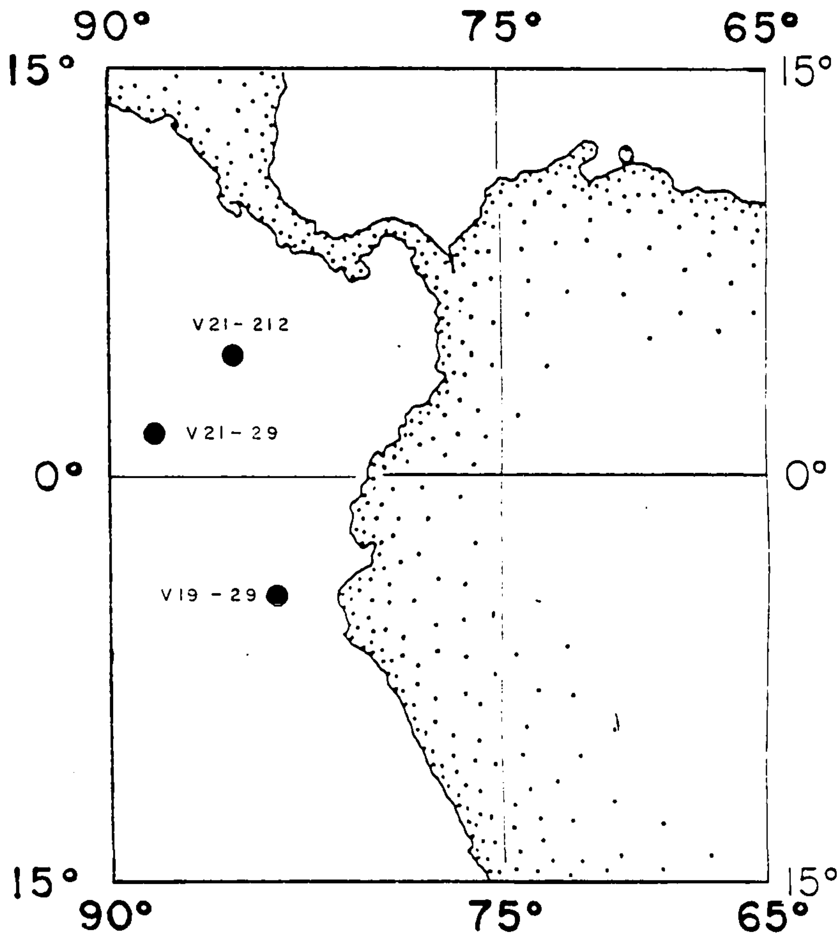


Figure IV.1 Locations of deep-sea cores used to study the Late Pleistocene and Holocene paleoceanography of the Panama Basin: V19-29 (3° 35' S.; 83° 56' W.), V21-29 (0° 57' N.; 89° 21' W.), V21-212 (2° 50' N.; 85° 3' W.).

in the activity of the Equatorial Undercurrent. Core V21-212 is situated below the Equatorial Counter Current, and monitors the Late Pleistocene history of the region to the north of the Pacific Equatorial Front.

Biostratigraphy

Stratigraphic correlations can be established between these cores based on oxygen isotope data. Oxygen isotope boundaries, identified in any deep-sea core, are excellent stratigraphic horizons because they reflect variations in global ice volumes as well as temperature changes (Shackleton and Opdyke, 1973). The ages established for the isotope stage boundaries in central Pacific core V28-238 by Shackleton and Opdyke (1973) have been used for the same boundaries identified in cores V19-29, V21-29 and V21-212. The O data for these cores, plotted in figure IV.8, was supplied by Ninkovich and Shackleton (1975) for V19-29, Shackleton (unpublished) for V21-29, and Fairbanks (unpublished) for V21-212.

Two additional stratigraphic horizons are present in core V19-29. Ninkovich and Shackleton (1975) determined the age of, the unique ash layer "L" (occuring at the 1330 cm level) as 230,000 B.P.. In addition, Thompson *et al.*,

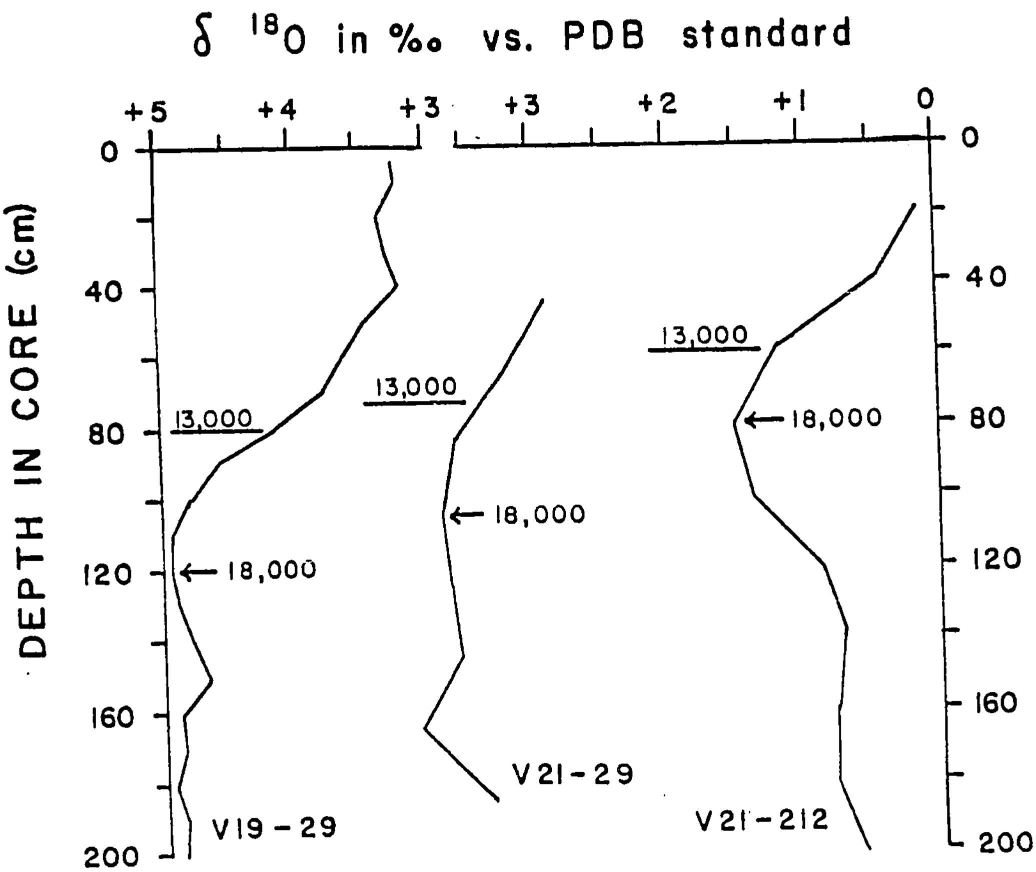


Figure IV.2 Stratigraphic correlations between cores V19-29, V21-29 and V21-212 based on oxygen isotope data. Values of $\delta^{18}O$ for V19-29 from Ninkovich and Shackleton (1975), V21-29 from Shackleton (unpublished) and V21-212 from Fairbanks (unpublished).

(1979) noted the dissapearance of the pink variety of Globigerinoides ruber at 120,000 B.P. in the Indian and Pacific Oceans. This occurs at the 865 cm level in core V19-29. All further representations of the data for all three cores will be related to the absolute chronology derived by assuming constant sedimentation rates between the various horizons listed in table 4.1.

TABLE 4.1

STRATIGRAPHIC CORRELATIONS

^{18}O stage	depth (cm) in V19-29	depth (cm)* in V21-29	depth (cm)* in V21-212	age (years)
1				
------------	80	80	60	13,000
2 max $\delta^{18}O$	120	105	80	18,000
------------	250			32,000
3				
------------	495			64,000
4				
------------	615			75,000
5				
-- + pink ruber --	865			128,000
6				
------------	1200			195,000
7 "L"	1390			230,000
------------	1395			251,000
8				
------------	1555			297,000
9				

* Only the upper 200 cm of V21-29 and V21-212 were examined

QUANTITATIVE ANALYSIS

Observed Temperature Data

The faunal data for the 52 core top samples (Appendices: A, table 2; B, table 2; Figure III.10) have been calibrated to several sets of observed oceanic temperature data. Sea-surface temperatures were obtained from D. Hahn (unpublished) and temperatures and depths of the thermocline from Wyrtki (1964b). These data were used to derive temperatures at the center of the euphotic thermoclinal layer. See the section on oceanography for a description of the methods employed. The results of the calculations are plotted in Figure II.9

The thermal equator passes through the study area so that it is difficult to apply the normal concepts of north and south hemisphere seasons. Accordingly, at each core site the warmer sea-surface and thermocline temperatures (whether February or August) are considered to represent summer conditions, and the cooler temperatures to represent winter conditions. Appendix D includes both winter and summer data at each core site for the following: tables 1 and 2, sea-surface temperatures; tables 3 and 4, depths of the base of the mixed layer; tables 5 and 6, depths of the center of the euphotic thermoclinal layer; tables 7 and 8, temperatures at the center of the euphotic thermoclinal layer.

Paleoceanography Transfer Function Technique

Imbrie and Kipp (1971) developed the transfer function technique for estimating paleotemperature or paleosalinity conditions in the world's oceans based on marine microfossil assemblages. The method involves three major steps: 1) Q-mode factor analysis of an array of sea-bed microfossil data, 2) regression analysis to calibrate the resulting factors (assemblages) with specific observed Recent oceanographic parameters and 3) paleoenvironmental estimations by application of the paleoecologic equation (transfer function) to down-core sample data.

A summary of the analytic method follows (Figure IV.3). The relative percent species data matrix (Xct) of the core tops is first row normalized. The normalized data matrix (Uct) contains all of the original information, but is easier to use in the computations that follow. Q-mode factor analysis transforms the cumbersome species data into manageable, non redundant, statistically independent factor (assemblage) data The output of the FORTRAN program, CABFAC

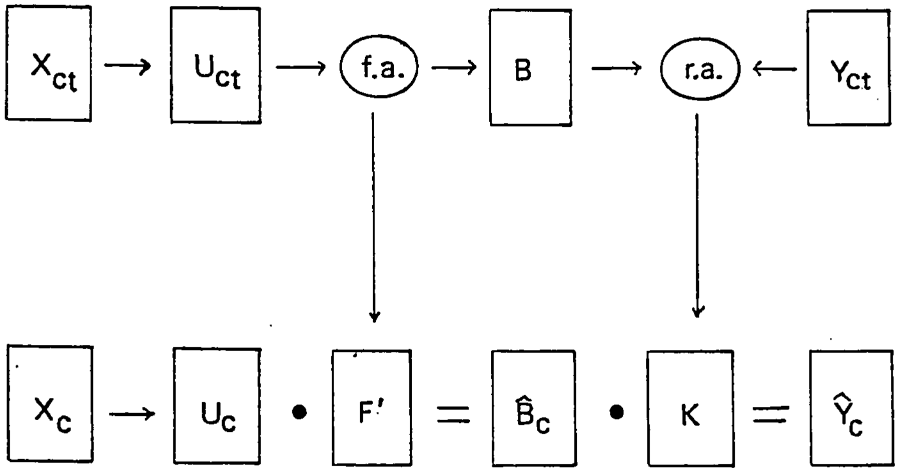


Figure IV.3 Flow diagram illustrating the Imbrie and Kipp (1971) analytic method used in this study. Boxes represent data matricies, arrows are simple mathematical processes, ovals are complex processes, large dots are matrix multiplication. The symbols are as follows.

Xct = Raw core top data

Uct = Normalized core top data

Bct = Varimax factor loadings

F' = Transposed factor scores

Yct = Observed Recent oceanic parameters

Xc = Raw down-core data

Uc = Normalized down-core data

$\hat{B}$c = calculated estimates of varimax factors in terms of surface factors

K = Regression coefficients

$\hat{Y}$c = Estimates of oceanic parameters for down-core samples

f.a. = Factor analysis via CABFAC (Klovan and Imbrie, 1971)

r.a. = Stepwise regression analaysis

(Klovan and Imbrie, 1971), consists of a varimax factor matrix (Bct) and a factor description matrix (F). The elements of Bct are the factor loadings (essentially correlation coefficients) between the original samples and the derived factors. The end-member factors are described in terms of the original species by the factor scores of the F matrix. If the number of factors is equal to the number of species, then:

$$Uct = Bct \cdot F.$$

The number of factors that are actually derived and used to estimate Uct is determined by trial. The desired result is to obtain the minimum number of ecologically meaningful factors which still explain a majority of the original species data. Because the factors are derived in order of decreasing statistical significance, the number of factors is controlled by maximizing the cumulative variance explained while retaining only those factors which have meaningful biogeographic distributions.

Stepwise multivariate regression analysis is used to calibrate the factor loadings of Bct with observed values of the selected oceanic parameters at each core locality (matrix Yct). A least-squares criterion is used to write a transfer function of the form:

$$Yct = Bct \cdot K + c,$$

where K is a column vector of regression coefficients and c is the intercept term of the paleoecologic equation.

Data from down-core samples (Xc) is normalized to Uc and post multiplied by the transform matrix, F', of the surface factor analysis. This yields a matrix of down-core faunal estimates ($\hat{B}c$) in terms of the assemblages (factors) derived for the surface. This step may be written:

$$\hat{B}c = Uc \cdot F'.$$

Finally, a matrix of paleo-environmental estimates ($\hat{Y}c$) may be calculated by post multiplying $\hat{B}c$ by the surface regression coefficients, K, and adding the intercept, c:

$$\hat{Y}c = \hat{B}c \cdot K + c.$$

Statistical Results

Surface Sediments - Factor Analysis

Only the eleven most dissolution resistant species according to Parker and Berger (1971) were used in the analysis. See the discussion on pages 130 - 131. Appendix E, Table 1 lists the data for these resistant taxa recalculated to 100%. The resistant species percentage data for the 52 core top sediment samples were used in the Q-mode factor analysis program CABFAC. Five ecologically significant factors (assemblages), that explained 99.62% of the variance within the resistant species, were produced. The factor loadings of the Bct matrix and the factor scores of the F-matrix appear as tables 2 and 3 of Appendix E. Each of the five factors have biogeographic distributions which reflect the present-day circulation and thermal structure of the eastern equatorial Pacific. The distributions are summarized in Figure II.7 and are discussed in detail below.

The factor scores for the first factor illustrate that this assemblage is dominated by *N. dutertrei* specimens with

5 or more chambers in their final whorl. The factor loadings were plotted, and the resulting map (Figure IV.4) indicates a direct correlation between this assemblage and the flow of the Peru and South Equtorial Currents. This distribution pattern reflects the the regions of upwelling at the equator and along the coast of South and Central America.

The second factor is dominated by the Globorotalia menardii-tumida complex. Its factor loadings indicate the preference of this assemblage for the waters in the southwestern sector of the study area (Figure IV.5). Its distribution also extends eastward, delineating the flow of the Equatorial Counter Current.

Factor 3 consists largely of N. pachyderma (right coiling) specimens. The distribution of this factor reflects the cold upwelling waters off the California coast (Figure IV.6), where its factor loadings exceed 0.800. Lower but significant loadings (greater than 0.200) also

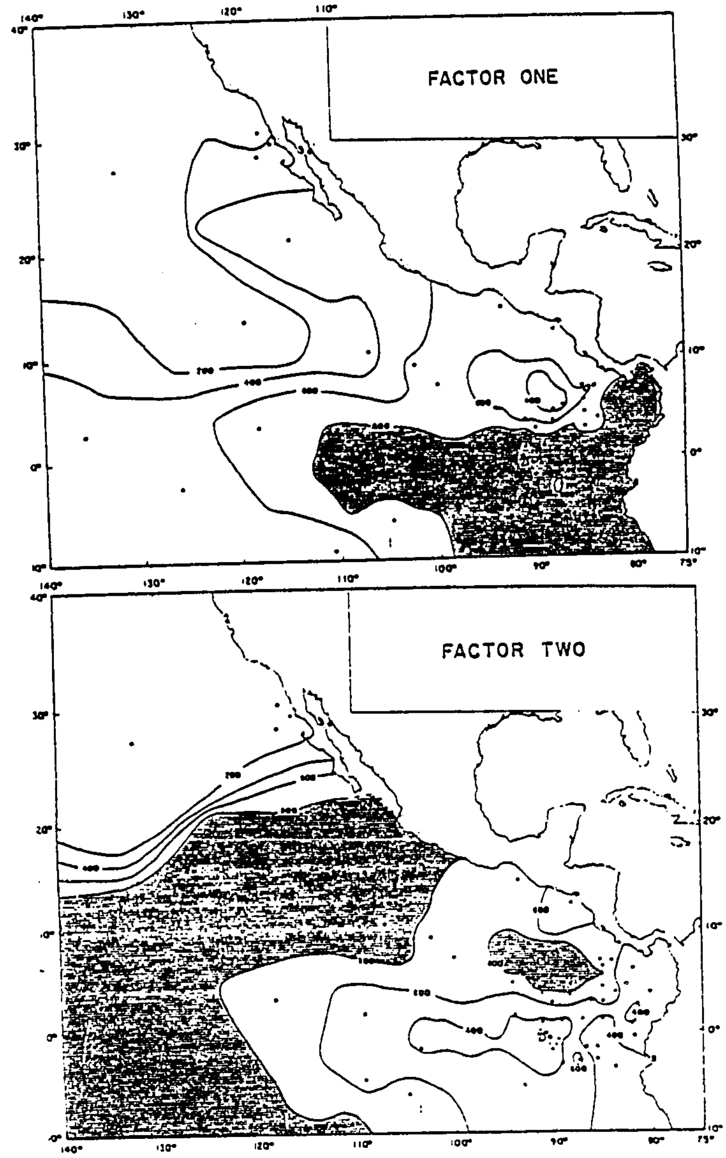
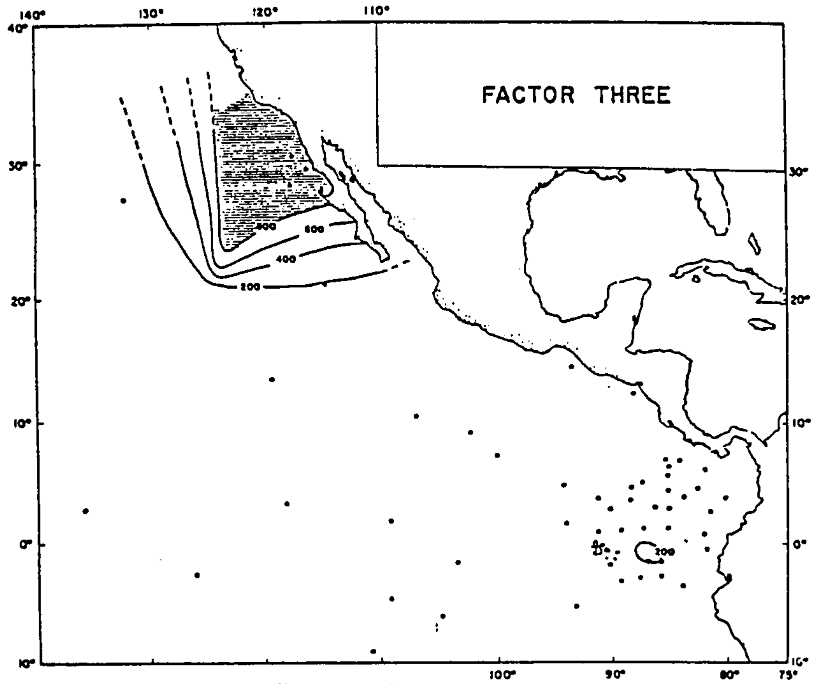


Figure IV.4 (top) This map illustrates the distribution of varimax factor loadings for Factor One (N. dutertrei var 5+ chambers). Contours represent data in Appendix E, Table 2 for each of the 52 core top samples. Values have been multiplied by 1000. Shading emphasizes region with loadings over 0.800.

Figure IV.5 (bottom) Factor loadings for Factor Two (G. menardii-tumida complex). Contours and shading as in Figure IV.4



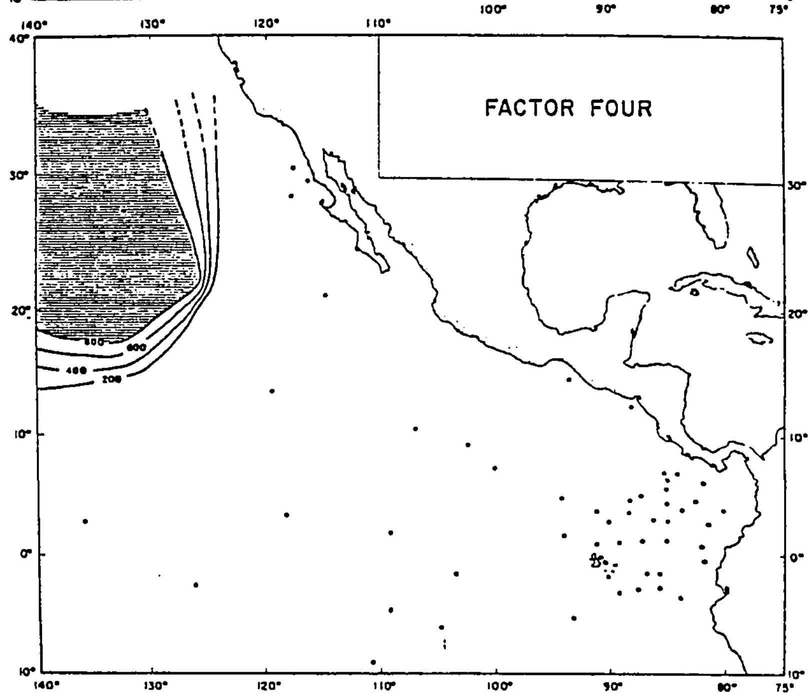


Figure IV.6 (top) Factor loadings for Factor Three (N. pachyderma, right coiling). Contours and shading as in Figure IV.4

Figure IV.7 (bottom) Factor loadings for Factor Four (G. inflata). Contours and shading as in Figure IV.4

exist in the region of the Peru and South Equatorial Currents. Thus, this assemblage may be considered as an eastern boundary current factor.

Factor 4 consists mostly of Globorotalia inflata and Globorotalia truncatulinoides. Its highest factor loadings occur in the zone of convergence between the cool waters of the California Current and the warmer waters of the North Equatorial Current (Figure IV.7). This region, as a result of the mixing and sinking of surface waters, attains a deep mixed layer and a depressed thermocline.

The fifth factor consists mainly of N. dutertrei specimens with 4 to 4 1/2 chambers in their final whorl. It reflects the low salinity cap and shallow thermocline off the coasts of Nicaragua, Costa Rica, and Panama (Figure IV.8).

Regression Analysis

Eight transfer functions have been derived via stepwise multivariate regression analysis. These include, for summer (s) and winter (w) conditions, paleoecologic equations for: sea-surface temperature (Ts and Tw), depth of the base of the mixed layer (Dms and Dmw), depth of the center of the

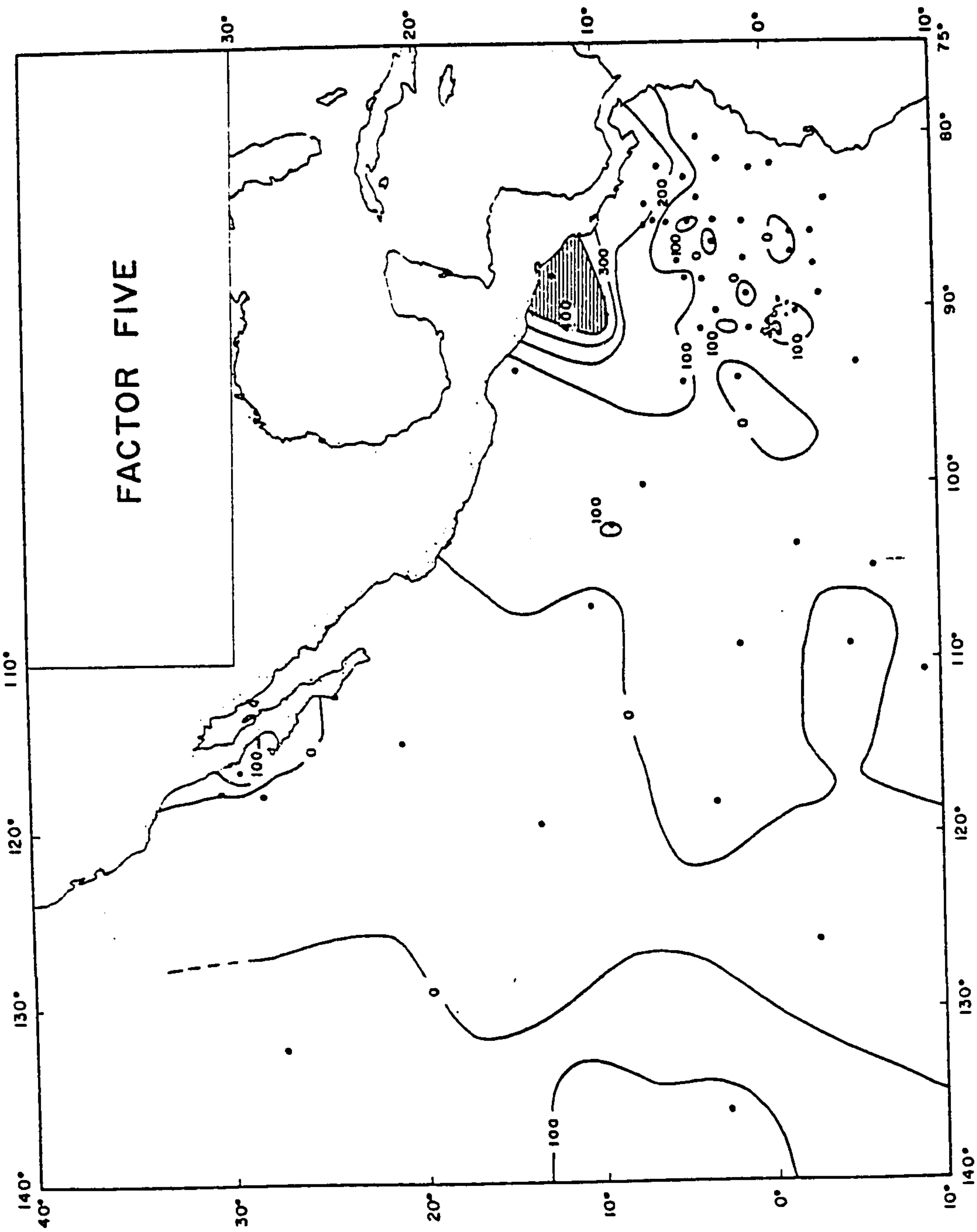


Figure IV.8 Factor loadings for Factor Five (N. dutertrei var 4 1/2 chambers). Contours and shading as in Figure IV.4.

euphotic themoclinal layer (Dths and Dthw), and temperature at the center of the euphotic thermoclinal layer (Tths and Tthw). Table 4.2 presents the statistics for each equation. In this Table, the regression coefficients appear in the order the factors were added to the equation by the stepwize regeression. As an example, the equation for estimating summer sea-surface temperatures would be written as:

Ts = 24.444 − 4.795 _N. pachyderma_ (factor)
− 2.994 _G. inflata_ + 2.651 _N. dutertrei_ (4 1/2)
+ 3.196 _G. menardii-tumida_ complex
+ 1.663 _N. dutertrei_ (5+).

The _N. pachyderma_ factor is the best single criterion for estimating summer sea-surface temperatures. The second best criterion is the _G. inflata_ factor, etc.

For each equation, also listed in Table 4.2 are: the total proportion of explained variance in the original data, the multiple correlation coefficient, and the standard error of estimate. The last two mentioned parameters have been corrected for degrees of freedom.

If there were no relationship between the observed and estimated values, then the correlation coefficient would be equal to zero. A correlation coefficient equal to 1.0 indicates a perfect correspondence, and equal to −1.0 an inverse relationship. A student's t test for N = 52 (core

TABLE 4.2

STATISTICS FOR TRANSFER FUNCTIONS

Winter Sea-surface Temperatures (Tw)

Variable	Regression coefficient
N. pachyderma (right)	-3.390
G. menardii-tumida	7.132
N. dutertrei (4 1/2)	6.846
N. dutertrei (5 +)	3.018
G. inflata	0.046
INTERCEPT	18.142
Total proportion variance explained	0.764
Multiple correlation coefficient	0.862
Standard error of estimate	1.473

Summer Sea-surface Temperatures (Ts)

Variable	Regression coefficient
N. pachyderma (right)	-4.795
G. inflata	-2.994
N. dutertrei (4 1/2)	2.651
G. menardii-tumida	3.195
N. dutertrei (5 +)	1.663
INTERCEPT	24.444
Total proportion variance explained	0.874
Multiple correlation coefficient	0.929
Standard error of estimate	0.760

Winter Mixed Layer Depth (Dmw)

Variable	Regression coefficient
N. dutertrei (5 +)	-40.289
N. dutertrei (4 1/2)	-49.490
G. menardii-tumida	-1.229
G. inflata	26.905
N. pachyderma (right)	10.868
INTERCEPT	69.920
Total proportion variance explained	0.541
Multiple correlation coefficient	0.708
Standard error of estimate	14.245

Summer Mixed Layer Depth (Dms)

Variable	Regression coefficient
N. dutertrei (5 +)	-19.343
N. pachyderma (right)	-2.087
N. dutertrei (4 1/2)	-28.205
G. inflata	19.677
G. menardii-tumida	14.733
INTERCEPT	31.259
Total proportion variance explained	0.319
Multiple correlation coefficient	0.511
Standard error of estimate	13.231

<u>Winter Depth of the Center of the Euphotic Thermoclinal Layer</u> (Dthw)

Variable	Regression coefficient
N. dutertrei (5 +)	-41.468
G. inflata	115.897
N. dutertrei (4 1/2)	-63.758
N. pachyderma (right)	22.585
G. menardii-tumida	18.526
INTERCEPT	80.067
Total proportion variance explained	0.649
Multiple correlation coefficient	0.787
Standard error of estimate	19.185

<u>Summer Depth of the Center of the Euphotic Thermoclinal Layer</u> (Dths)

Variable	Regression coefficient
G. menardii-tumida	42.748
N. dutertrei (5 +)	-24.705
N. dutertrei (4 1/2)	-49.528
G. inflata	24.684
N. pachyderma (right)	-5.382
INTERCEPT	47.504
Total proportion variance explained	0.388
Multiple correlation coefficient	0.579
Standard error of estimate	20.912

Winter Temperature at the Center of the Euphotic Thermoclinal Layer (Tthw)

Variable	Regression coefficient
N. pachyderma (right)	-3.740
G. inflata	-5.093
N. dutertrei (4 1/2)	3.784
G. menardii-tumida	-0.688
N. dutertrei (5 +)	0.150
INTERCEPT	18.106
Total proportion variance explained	0.325
Multiple correlation coefficient	0.570
Standard error of estimate	1.682

Summer Temperature at the Center of the Euphotic Thermocline Layer (Tths)

Variable	Regression coefficient
N. dutertrei (5 +)	0.332
N. dutertrei (4 1/2)	3.354
G. menardii-tumida	-5.288
N. pachyderma (right)	-4.881
G. inflata	-3.566
INTERCEPT	23.944
Total proportion variance explained	0.279
Multiple correlation coefficient	0.467
Standard error of estimate	1.807

tops), indicates that any correlation exceeding 0.321 is statistically significant at the 0.01 confidence level, and any correlation exceeding 0.354 is significant at the 0.005 level. Therefore, for all of the equations, there is less than 5 chances in a thousand that the estimated values would occur randomly.

The standard errors of estimate for each equation are the standard deviations of the residual values between the observations and the estimates. For example, for the summer sea-surface temperature equation, approximately 68% (one standard deviation about the mean) of the estimates would be within 0.76°C. of the observed values. This assumes that the errors are normally distributed.

Each transfer function was evaluated by re-entering the core top faunal data into the derived paleoecologic equation. In this situation, an ideal least-squares regression equation should accurately reproduce the observed dependant value. For each observed value listed in Appendix D, the estimated and residual (observed minus estimated) values are also shown. The residuals have also been plotted in a series of scatter diagrams (one for each eqution) in Appendix F. These plots display non-random patterns of deviation, especially for the thermal structure equations. Appendix F also contains maps showing the distributions of the residuals that exceed one standard error of estimate.

Down-core Results

Core V19-29

Two dominant faunal constituents of the Recent (top) sediments from core V19-29 are Neogloboquadrina dutertrei (both varieties) and Globigerina bulloides. The Globorotalia menardii-tumida complex and Neogloboquadrina pachyderma are also present, but in low abundances. The occurance of G. bulloides and the Neogloboquadrina species suggests that cool waters are present in the euphotic portion of the water column of this locality, at least during part of the year. Another species, usually associated with cool waters, Globorotalia inflata, was not found in Recent V19-29 sediments. It should be noted that this species is rare in the entire Panama Basin region, a situation also noticed by Luz (1973) and Thompson (1976, 1977). The down-core faunal data of V19-29 (Appendix G, Tables 1 and 2) shows, that although G. inflata was rare to absent throughout most of the 320,000 year record, it became an important faunal constituent between 36,000 B.P. and 18,000 B.P. (Figure IV.9). Thompson (1976) not only found

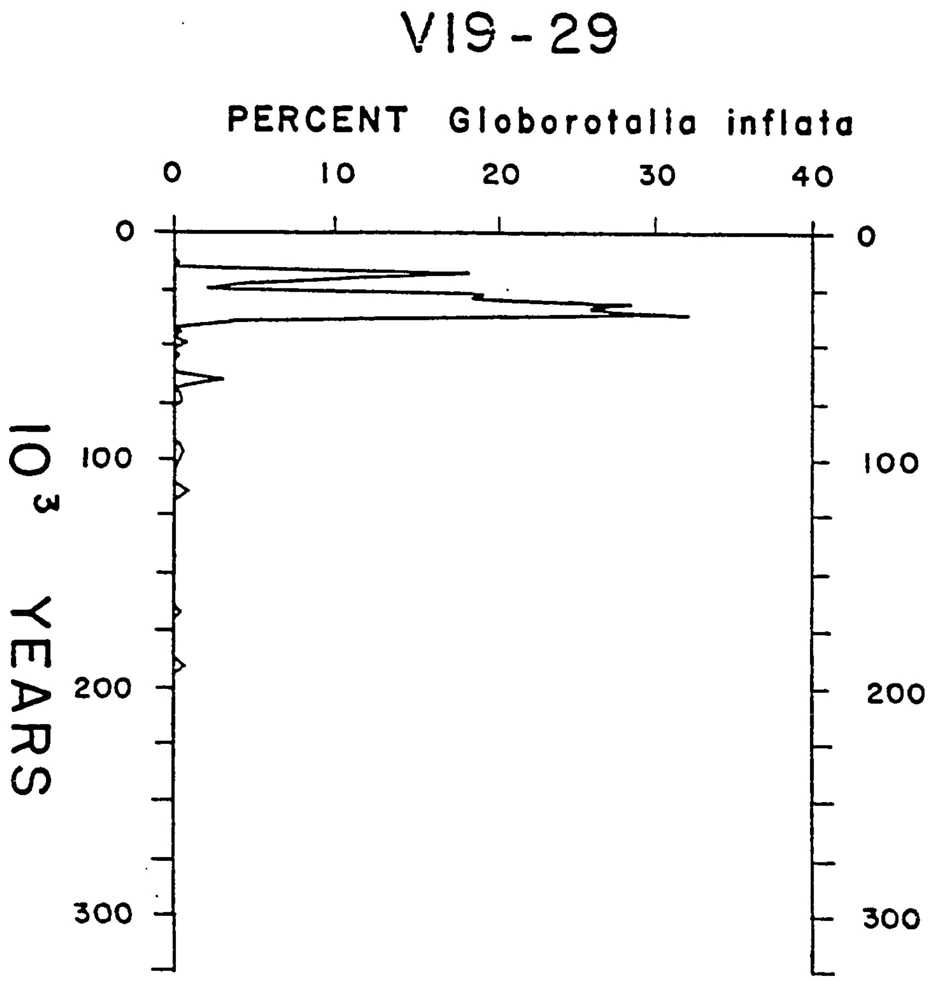


Figure IV.9 Percentages of resistant fauna for <u>Globorotalia inflata</u> in down-core samples of V19-29. Data listed in Appendix E, Table 1. This species is rare to absent for most of the 320,000 year record, and is absent in the surface (Recent) sediments. It was an important faunal constituent between 36,000 B. P. and 18,000 B. P.

G. inflata in 18,000 B.P. sediments of this core but also found this species in similar aged sediments from the equatorial Pacific as far west as 110° W. longitude. This abrupt faunal change indicates a major modification to the physical oceanography of the Panama Basin region during the above time interval which includes the last glacial episode.

The eight transfer functions derived in the previous sections have been applied to the faunal data of core V19-29 (Appendix G, tables 1 and 2) in order to estimate the paleoceanographic temperatures of the sea-surface, as well as the depths and temperatures of the thermal structure at this locality during the past 320,000 years (Appendix H, tables 1 - 5). Core V19-29 was taken from the region where the winter sea-surface temperature equation overestimates temperatures by more than one standard error of estimate (See maps in Appendix F). Accordingly, the data for this particular parameter (in core V19-29) has been adjusted by subtracting the core top residual from each down-core estimate. These adjusted values are considered better estimates of winter sea-surface temperature, and are plotted as curve Tw in Figure IV.10. In any case, the pattern of shifts in paleotemperature are not effected by this procedure. The summer estimates (Ts) have not been

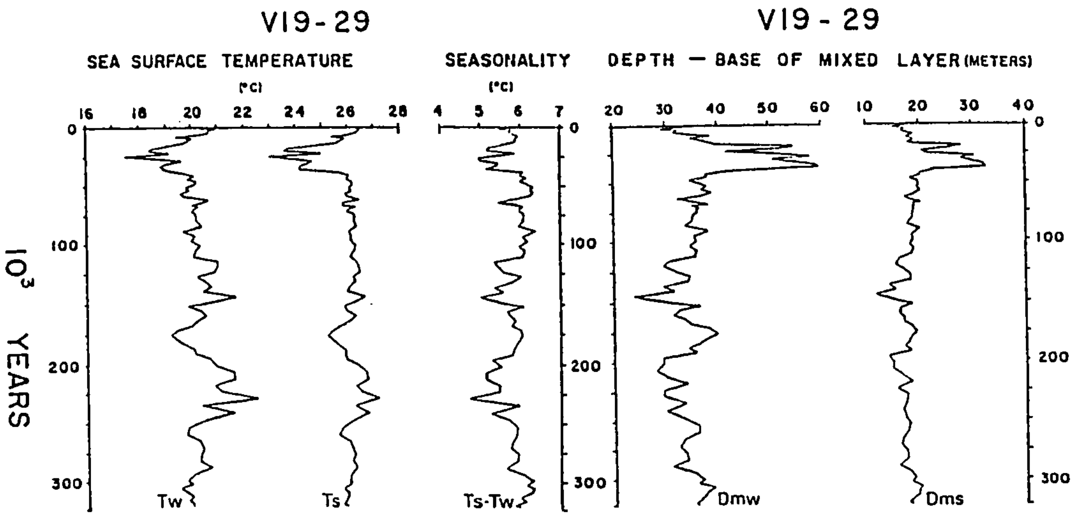


Figure IV.10 (left) Estimates of sea-surface temperature (Tw = winter, Ts = summer) and seasonality (Ts - Tw) for down-core samples of V19-29 for the past 320,000 years. The values of Tw have been adjusted by subtracting the core top residual from each down-core estimate (see text).

Figure IV.11 (right) Estimates of depth of the base of the mixed layer for down-core samples of V19-29 (Dmw = winter, Dms = summer) adjusted.

The data indicate a temperature minimum at 25,000 B.P., when the sea-surface temperature was about 3°C cooler than it is today, and a temperature maximum at 220,000 B.P., with sea-surface temperatures slightly warmer than at present. Briskin and Berggren (1975) defined seasonality to mean the difference between summer and winter estimates of sea-surface temperature. For V19-29, periods of cooler sea-surface temperatures are related to years of greater seasonal change, and warmer intervals of time were related to less severe seasonality. During the time interval when G. inflata became abundant the opposite relationships seem to hold (compare Figures IV.9 and IV.10).

Figure IV.11 illustrates the paleo-environmental estimates for the depth of the base of the mixed layer during winter and summer seasons (Dmw and Dms) at site V19-29. The data indicate, during the interval between 36,000 B.P. and 18,000 B.P., that the depth of the mixed layer was approximately twice today's average annual value of 25 m. Approximately 140,000 years ago, the mixed layer was 5 to 10 meters shallower than today. This shoaling event is coupled with a secondary sea-surface temperature maximum (compare Figures IV.10 and IV.11). At approximately 225,000 B. P. the maximum sea-surface temperatures occured.

At that time the depth of the mixed layer was approximately as deep as it is today.

Figure IV.12 shows the estimates of the depth of the center of the euphotic thermoclinal layer in the vicinity of V19-29. While only a small increase in depth occured during the summers between 36,000 B.P. and 18,000 B.P., the winter thermocline depths were much deeper than at present. A comparison of Figures IV.11 and IV.12 illustrates that the entire thermal structure migrated as a unit. The Figures also show that the thermocline became thicker from top to bottom.

Site V19-29 is within the region of underestimation (by more than one standard error of estimate) of winter temperatures within the euphotic thermoclinal layer (see Appendix F). An examination of this transfer function indicates that the high residuals are produced by the absence of G. *inflata* specimens within the region of underestimation. Except during the time interval when G. *inflata* is present, the values for winter thermocline temperatures at V19-29 have been adjusted by subtracting the core top residual from each down-core estimate. These data are considered to be better estimates of winter thermocline temperature and are plotted as curve Tths in Figure IV.13. The summer estimates have not been adjusted. Thermocline

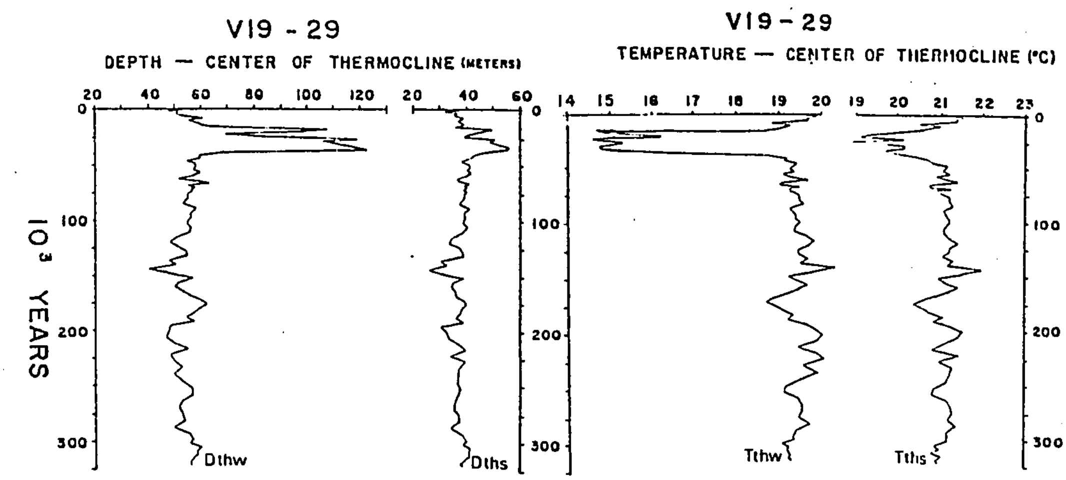


Figure IV.12 (left) Estimates of the depth of the euphotic thermoclinal layer for down-core samples of V19-29 for the past 320,000 years: Dthw = winter; Dths = summer.

Figure IV.13 (right) Estimates of temperature at the center of the euphotic thermoclinal layer for down-core samples of core V19-29 for the past 320,000 years: Tthw = winter; Tths = summer.

temperatures may have been as much as 5°C cooler than at present during the winter season between 36,000 B.P. and 18,000 B.P., although only about a 3°C change occured during the summer months. The cooler thermocline temperatures are occur together with lower sea-surface temperatures and a deeper thermal structure.

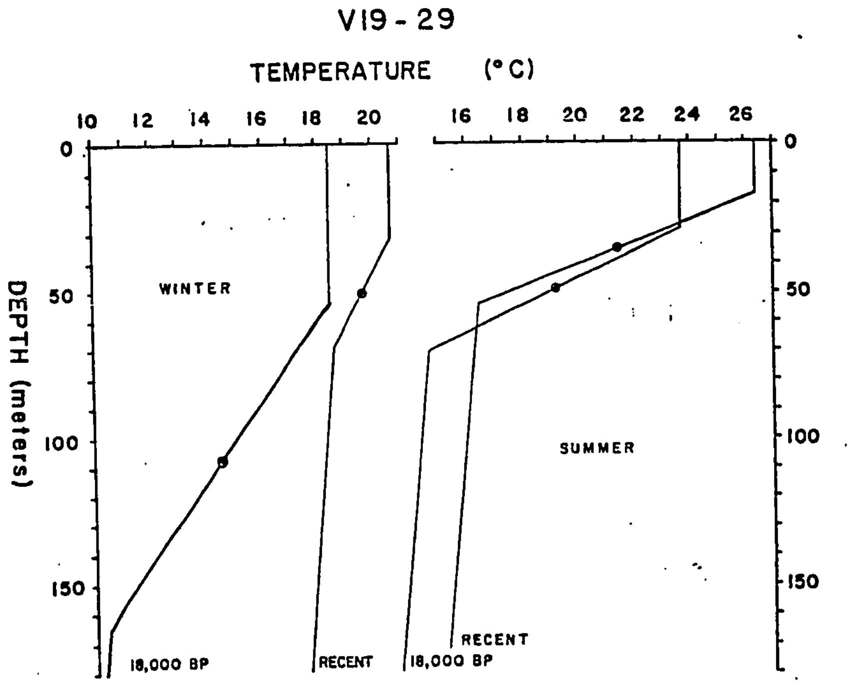
A pictorial reconstruction of the thermal structure for summer and winter -- for both Recent and the last glacial maximum (18,000 B.P.) -- is shown in Figure IV.14. In this diagram, and others presented later, the depth of the base of the thermocline was derived by doubling the distance from the base of the mixed layer to the center of the euphotic thermoclinal layer. The subsurface layer is presented by an arbitrary slope of less than 0.3°C/10 m depth.

A new parameter, Delta Thermocline (ΔTH), is here defined to be the difference between the temperature at the base of the mixed layer and the temperature at the center of the euphotic thermoclinal layer. Figure IV.15 illustrates the values of ΔTH for the winter and summer, as well as the seasonality, in V19-29 for the last 320,000 years. In general, the two curves of ΔTH show similar trends, and both curves fluctuate inversely to the seasonality curve. However, between 36,000 B.P. and 18,000 B.P. the fluctuations of ΔTHw and ΔTHs are opposite in sign. In the winter there is a major increase in ΔTH of almost 3° C, whereas, in the summer, ΔTH is lower by about 1° C. Concomitant with these fluctuations is a decrease in seasonality. The other major shift in ΔTH at approximately 220,000 B.P., is not only different because the two curves remain parallel, but also because this event correlates with a maximum warm sea-surface temperature interval rather than a cold water interval encompassing 25,000 B.P. (compare Figures IV.10 and IV.15).

Cores V21-29 and V21-212

Since the foraminiferal record of core V19-29 indicates that only one major paleoceanographic event occured in the Panama Basin during the last 320,000 years, an investigation of the full length of cores V21-29 and V21-212 was not considered to be necessary. In order to investigate the history of thermal structure variation in the northern Panama Basin, the eight transfer functions were applied to samples from the upper 200 cm of these two cores. This core interval corresponds to the past 32,000 years for V21-29 and the last 43,000 years for V21-212 (table 4.1, Figure IV.2).

Core V21-29 was taken to the northeast of the Galapagos Islands (Figure IV.1). Pak and Zaneveld (1973) have shown



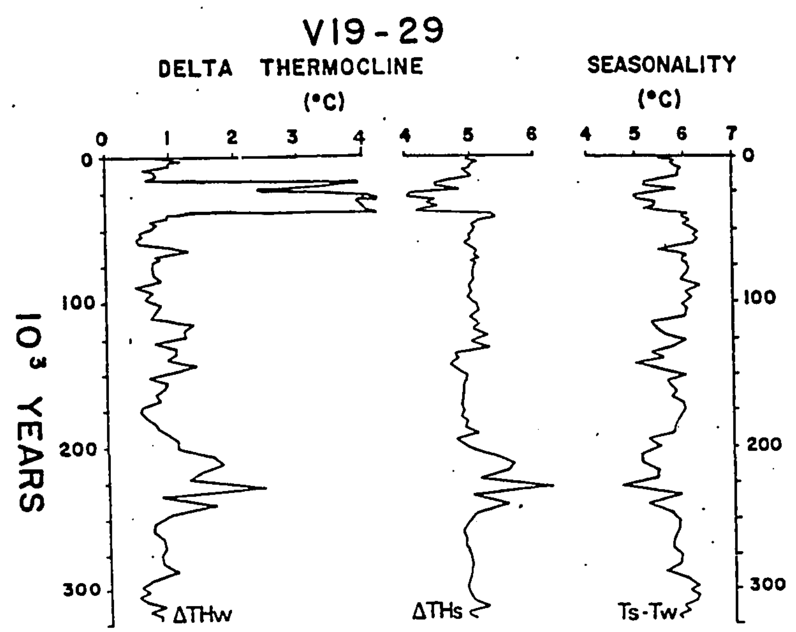
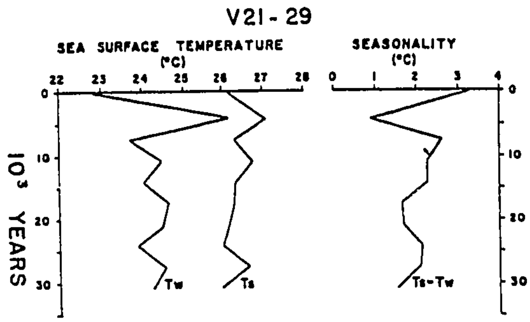


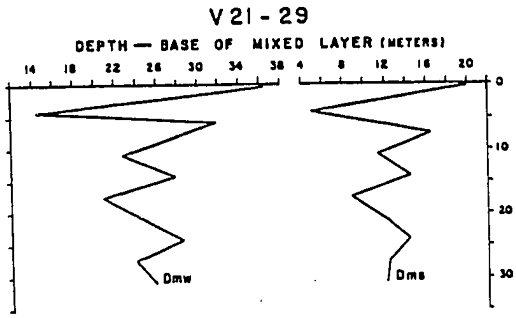
Figure IV.14 (top) Reconstruction of 18,000 B. P. thermal structure at V19-29 as compared to Recent conditions. A circle marks the center of the euphotic thermoclinal layer.

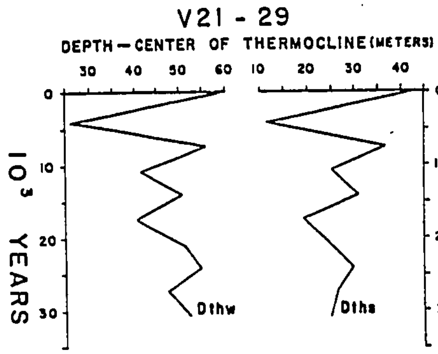
Figure IV.15 (bottom) Calculated values of Delta Thermocline and seasonality for down core samples of V19-29 for the past 320,000 years: ΔThw = winter; ΔThs = winter.

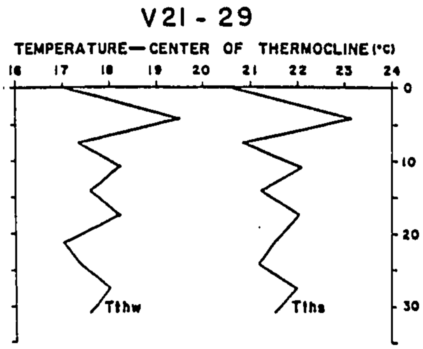
that a northern branch of the Equatorial Undercurrent flows at the site of this core. The dominant species found in the core top include the G. menardii-tumida complex and both varieties of N. dutertrei. A very few specimens of G. inflata were also found in this sample. This species is definately a minor faunal constituent. Down-core samples did not significantly differ in foraminiferal abundances (Appendix G, tables 3 and 4) and consequently only minor environmental changes were estimated by the transfer functions (Appendix H, tables 6 - 10). Only at 4,000 B.P. did significant environmental shifts occur. Winter sea-surface temperature appears to have been 3°C warmer than today in the vicinity of V21-29 (Figure IV.16). Concomitant with a warmer sea-surface layer, the thermal structure appears to have risen to shallower depths (Figures IV.17 and IV.18) and become warmer than at present (Figure IV.19). Delta thermocline values for V21-29 are shown in Figure IV.20. None of the estimated parameters indicate any significant paleoceanographic events at 18,000 B.P. in this region.

Core V21-212 was recovered from beneath the Equatorial Undercurrent, from the region where it begins to flow northward around the Costa Rica Dome (Figure IV.1). The dominant species in the Recent sediments of this core also









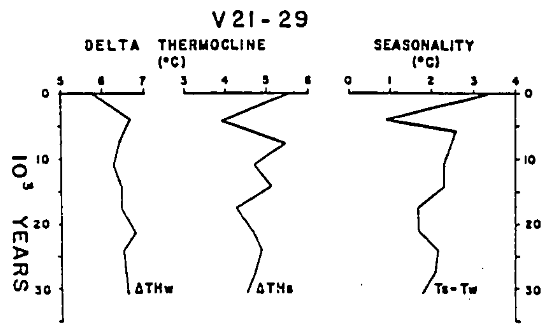


Figure IV.16 (top left) Estimates of sea-surface temperature (Tw, winter; Ts, summer) and seasonality (Ts-Tw) for down-core samples in V21-29 for the past 32,000 years.

Figure IV.17 (top right) Estimates of depth of the base of the mixed layer (Dmw, winter; Dms, summer) in V21-29.

Figure IV.18 (center left) Estimates of the depth of the center of the euphotic thermoclinal layer (Dthw, winter; Dths, summer) in V21-29.

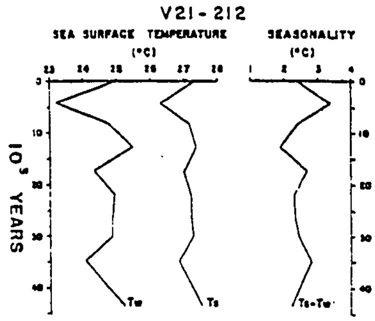
Figure IV.19 (center right) Estimates of temperature at the center of the euphotic thermoclinal layer (Tthw, winter; Tths, summer) in V21-29.

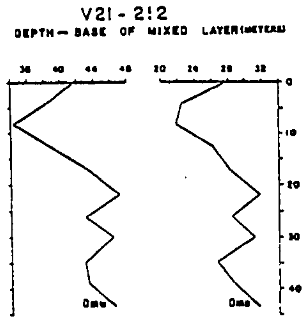
Figure IV.20 (bottom) Calculated values of Delta Thermocline (ΔTHw, winter; ΔTHs, summer) in V21-29.

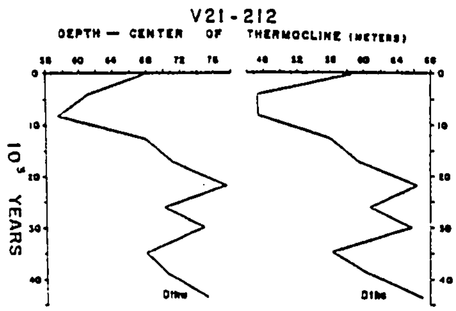
include the G. menardii-tumida complex and N. dutertrei. Little faunal variation was found in the down-core samples (Appendix G, tables 5 and 6), and therefore the transfer function estimates also varied little (Appendix H, tables 11 - 15). Unlike the findings for core V21-29, cooler temperatures (than Recent conditions) were present at site V21-212 four thousand years ago (compare Figures IV.16 and IV.21). The 4,000 B.P. thermal structure at V21-212 appears to have been shallower (Figures IV.22 and IV.23) and warmer (Figure IV.24) than today, especially during the summer. The shoaling event appears to have proceeded the warming trend by approximately 3,000 years. Values for Delta Thermocline are shown in Figure 3.25. As in the case of V21-29, there is no evidence for a major thermal structure shift between 36,000 B.P. and 18,000 B.P. at V21-212.

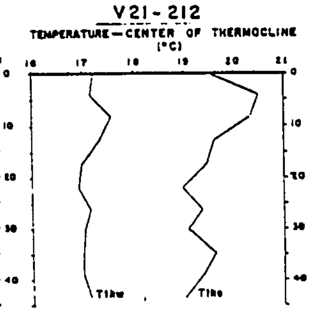
A comparison of the data for all three cores indicates that the thermal structure shift found in the northern Panama Basin at sites V21-29 and V21-212 between 7,000 B.P. and 4,000 B.P. was not recorded in the sediments of V19-29, located to the south. Only a general warming of the water column is seen in this core during that interval.

Pictorial reconstructions for V21-29 and V21-212 of the winter and summer thermal structure during the Recent and at 18,000 B.P. appear in Figures IV.26 and IV.27. These









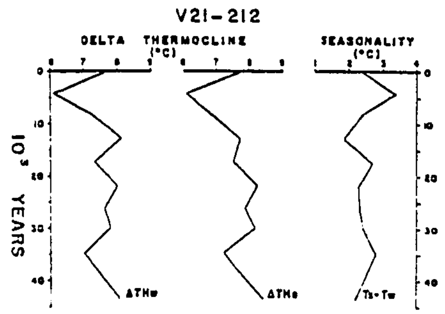


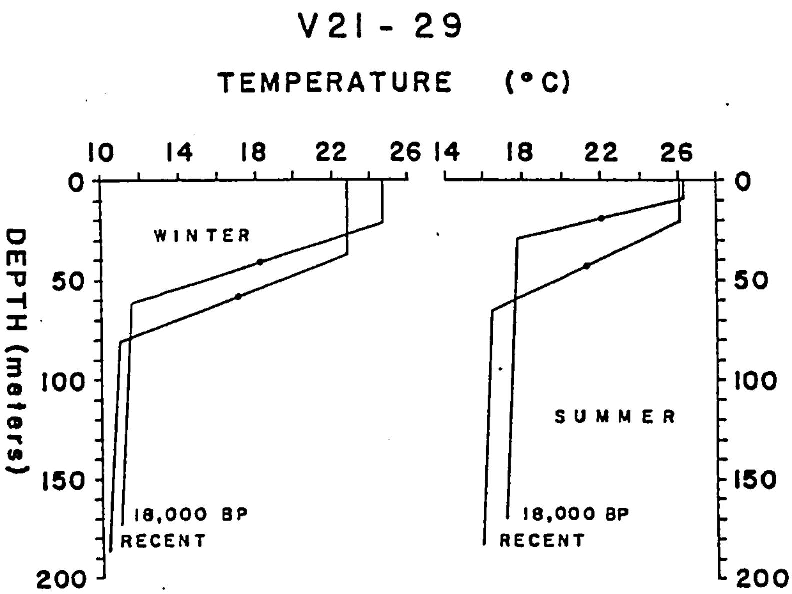
Figure IV.21 (top left) Estimates of sea-surface temperature (Tw, winter; Ts, summer) and seasonality (Ts-Tw) for down-core samples in V21-212 for the past 42,000 years.

Figure IV.22 (top right) Estimates of depth of the base of the mixed layer (Dmw, winter; Dms, summer) in V21-212.

Figure IV.23 (center left) Estimates of the depth of the center of the euphotic thermoclinal layer (Dthw, winter; Dths, summer) in V21-212.

Figure IV.24 (center right) Estimates of temperature at the center of the euphotic thermoclinal layer (Tthw, winter; Tths, summer) in V21-212.

Figure IV.25 (bottom) Calculated values of Delta Thermocline (ΔTHw, winter; ΔTHs, summer) in V21-212.



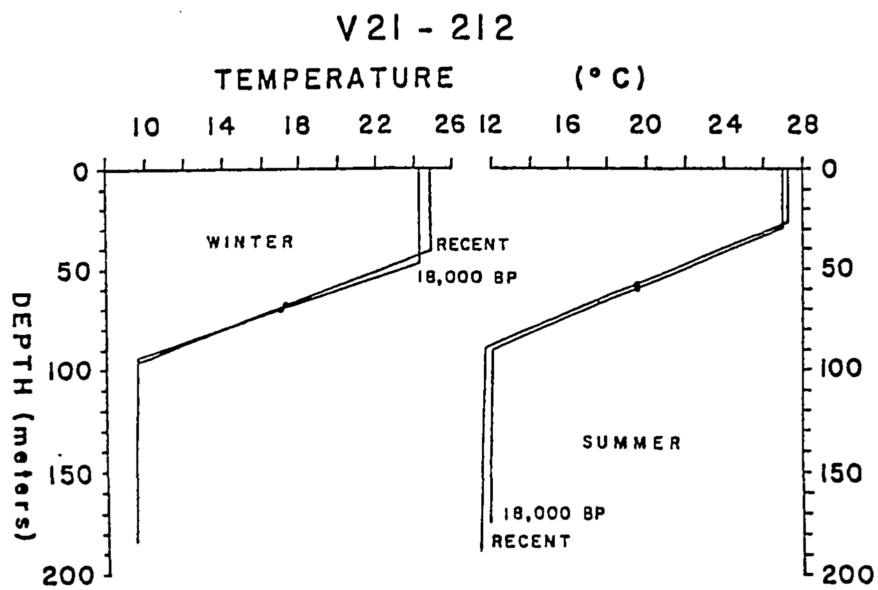


Figure IV.26 (top) Reconstruction of the 18,000 B. P. thermal structure at V21-29 as compared to the Recent. Compare with Figure IV.14.

Figure IV.27 (bottom) Reconstruction of the 18,000 B. P. thermal structure at V21-212 as compared to the Recent. Compare with Figure IV.14.

diagrams can be compared to the V19-29 reconstruction (Figure IV.14). The major cooling and depression of the thermocline that occured between 36,000 B.P. and 18,000 B.P. in the Peru and South Equatorial Currents, to the south of the present location of the Pacific Equatorial Front, did not occur in the northern Panama Basin region. Rather, just to the northeast of the Galapagos Islands, at V21-29, the thermocline may have been slightly shallower than today 18,000 years ago. No change was detected at V21-212.

PALEOCEANOGRAPHIC MODEL

Thermal Structure Type Model

It was previously shown that biogeographic ranges of the various species of planktonic foraminifera are significantly controlled by the environmental conditions within the euphotic thermoclinal layer. For example, Neogloboquadrina dutertrei var. 4 1/2 chambers, and Globorotalia theyeri, were largely controlled by the shallow thermocline within the Panama Basin. Another species which appears to be strongly effected by the depth of the thermal structure is Globorotalia inflata. This species is most abundant in areas where oceanic convergence produces a deep mixed layer and a depressed thermocline. Conversely, a shallow thermal structure inhibits the growth of _G. inflata_, so that today, this species is rare to absent in the Panama Basin where the thermocline is only about 50 m deep (Wyrtki, 1964b). The down-core samples of core V19-29 reveal a sudden incursion of _G. inflata_ into the region between the Galapagos Islands and the coast of Ecuador between 36,000 and 18,000 years ago. This has been interpreted to mean that the thermal structure of this region must have become depressed and therfore provided _G. inflata_ with its preferred habitat.

Figure IV.28c illustrates the present day distribution of thermal structure types according to Wyrtki (1964b). Within the shaded regions, a seasonal "summer thermocline" (indicated by the letter, S) develops above the "permanent thermocline". The unshaded areas represent regions with only permanent thermoclines. Wyrtki (1964b) classified the permanent thermocline as deep if it is below 150 m in the water column, otherwise he considered it to be shallow. The dotted line in the diagram indicates the boundary between these two depth regimes. Consquently thermal structure types P, PS, and PSW are all considered to be shallow, while types D and DSW are considered to be deep. The letter, W, indicates the occurence of a deep mixed layer in the winter season. The distribution of _G. inflata_ as shown in Figure

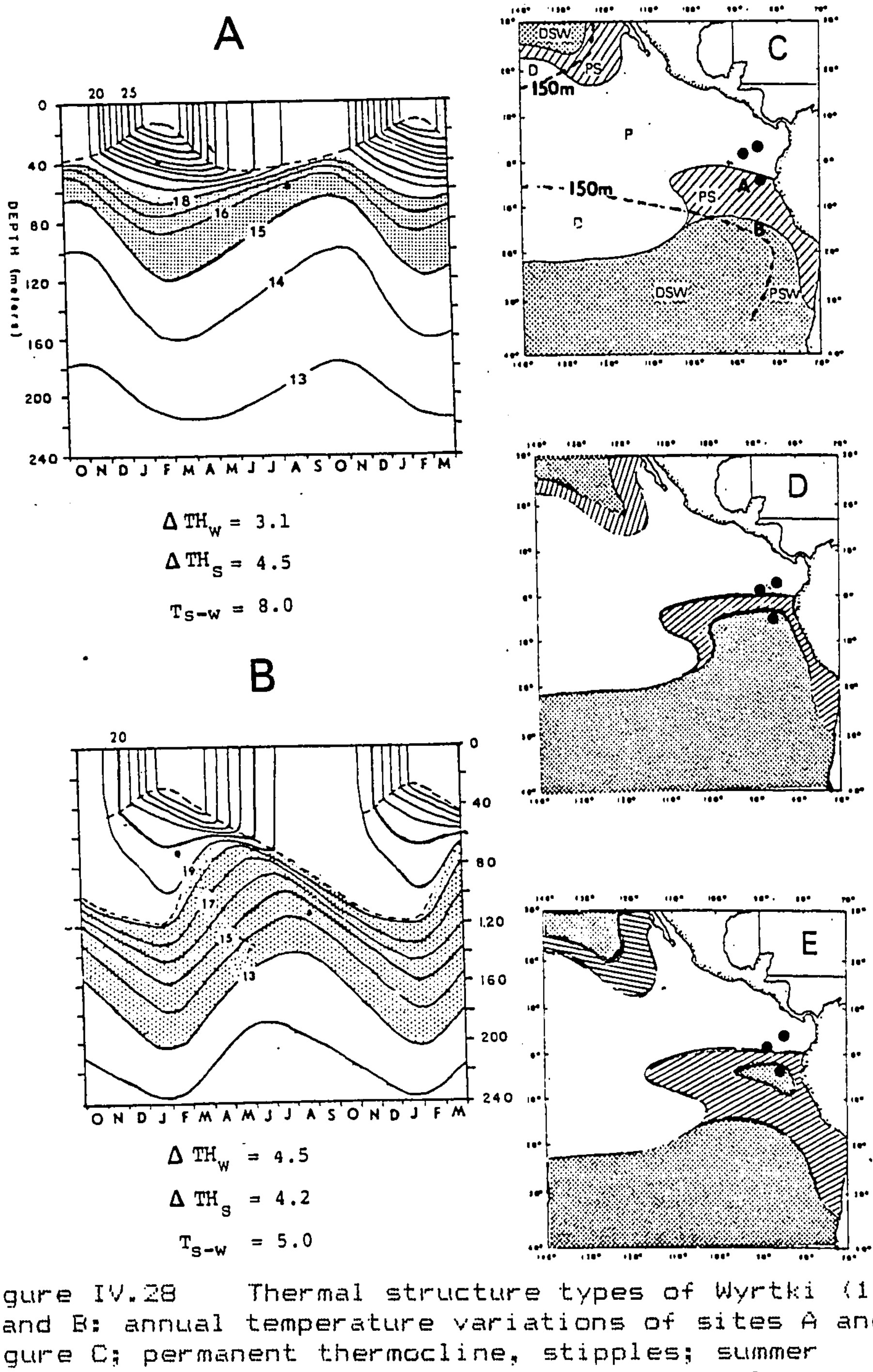


Figure IV.28 Thermal structure types of Wyrtki (1964b). A and B: annual temperature variations of sites A and B of Figure C; permanent thermocline, stipples; summer thermocline, closely spaced isotherms; mixed layer above dashed line; center of euphotic thermoclinal layer, dots. C: Recent distributions of thermal structure types. D and E: two alternative hypothetical distributions for 18,000 B. P. ΔTH and Ts-w values from Table 4.3.

III.28 and as reported by Bradshaw (1959), Parker and Berger (1971), Luz (1973), Thompson (1976) and Coulbourn, Parker and Berger (1980) appears to be related to the distribution of thermal structure type PSW and DSW.

For the sake of clarity, cores V19-29, V21-29 and V21-212 are not labeled in Figure IV.28c (see Figure IV.1 for identifications). Site V19-29 is situated within the present day regime of thermal structure type PS. Because of its proximity, site A (in Figure IV.28c) was taken as model for Recent V19-29. Figure IV.28a illustrates the annual thermal structure variations that occur at site A according to Wyrtki (1964b). In this diagram, the base of the mixed layer is shown as a dashed line, and the closely spaced isotherms indicate the summer thermocline which exists over the permanent thermocline (stippled). The center of the euphotic thermoclinal layer for both summer (February) and winter (August) is shown by heavy dots. From the diagram, values of Delta Thermocline (ΔTH) and Seasonality were determined. These data, as well as the corresponding values for V19-29 (Appendix H, table 5; Figure IV.15) are presented in table 4.3.

Figure IV.28b illustrates the annual thermal structure variations for site B (in Figure IV.28c), a typical example of thermal structure PSW. Values for ΔTH and Seasonality

TABLE 4.3

Thermal Structure Variation at V19-29
and at Sites A & B of Figure IV.28

SITE A	V19-29 Recent
ΔTHw -- 3.1	ΔTHw -- 1.0
ΔTHs -- 4.5	ΔTHs -- 5.0
Ts-w -- 8.0	Ts-w -- 5.7

SITE B	V19-29 18,000 B.P.
ΔTHw -- 4.5	ΔTHw -- 3.8
ΔTHs -- 4.2	ΔTHs -- 4.4
Ts-w -- 5.0	Ts-w -- 5.2

for site B, and for 18,000 B.P. at site V19-29 (Appendix H) are shown in table 4.3. The data in the table indicates that similar variations occured between: 1) the samples representing the Recent and 18,000 B.P. in V19-29 and 2) the two present day sites, A and B. This implies either: a northerly shift of the boundary between thermal structure types PS and PSW, or the establishment of a separate regime of PSW in the vicinity of V19-29 during the last glacial episode. The first hypothesis suggests a compression of the eastern boundary current against the coasts of Peru and Ecuador, as well as limiting upwelling to the immediate coastal region (Figure IV.28d). As this seems unreasonable, in light of the findings of Moore et al. (1980), that upwelling increases due to Trade Wind intensification, the second alternative must be investigated (Figure IV.28e).

Subsurface Circulation Model

According to Wyrtki (1975) and Wyrtki et al. (1976), during the Recent, the onset of El Niño with its associated shift in the position of the Equatorial Pacific Front, and deepening of the thermal structure to the east of the Galapagos Islands, is related to times of an intensification, followed by a relaxation of the Trade Winds. This sequence of events permits: 1) the build up of excess surface water in the western Pacific due to increased flow of the South and North Equatorial Currents when the winds are intensified, and 2) the return of this excess water to the eastern Pacific via the Equatorial Counter Current and the Equatorial Undercurrent upon the relaxation of the winds. The CLIMAP sea-surface temperature reconstrution (Moore et al., 1980) suggested a general "spin up" of the gyral margin circulation of the Pacific Ocean at 18,000 B.P.. This intensified circulation would have resulted in an accumulation of surface waters in the western Pacific. During periods of fluctuating Trade Winds water could return to the eastern Pacific via increased flow of the Equatorial Undercurrent, a similar occurance as El Niño. However, this might not have resulted in excessively warm sea-surface temperatures off the coasts of Peru and Ecuador because of the general cooling and increased coastal upwelling induced by the intensified Trade Winds.

Molina-Cruz (1977a) studied radiolarian assemblages (derived through factor analysis) in the region from 110° W. longitude to the South American coast, between 5° N. and 40° S. latitude. Recent biogenic opal and eolian quartz distributions from this region were described by Molina-Cruz and Price (1977), and the data was incorporated with the radiolarian assembalge data to produce a series of transfer functions for estimating upwelling and Trade Wind strengths from down core samples of V19-29 (Molina-Cruz, 1977b). Intensified Trade Winds were found to be related to increased input of eolian quartz and increased upwelling in the waters of the Peru Current. Diminished wind activity was related to higher percentages of opal, and were interpreted to indicate a shoaling of the Equatorial Undercurrent and decreased coastal upwelling. He suggested that the oscillating summer and winter Trade Wind strengths he found between 45,000 and 35,000 years ago resulted in more frequent occurences of El Niño.

In order to investigate the relationships between the Trade Winds and the depth of the thermal structure, the data (read from Figure 7 of Molina Cruz, 1977b) for estimated summer and winter Trade Wind speed has been used to calculate what can be called the Delta Seasonal Trade Wind (winter wind speed minus summer wind speed: Ww-s). The results of these calculations have been plotted in Figure IV.29 alongside the curve for the winter estimates for the depth of the center of the euphotic thermoclinal layer (Dthw). It can be seen that each major pulse in Delta Seasonal Trade Wind preceeds a deepening of the thermocline by approximately 2,000 years. Following a drop in Delta Seasonal Trade Wind, the thermal structure slowly rises in

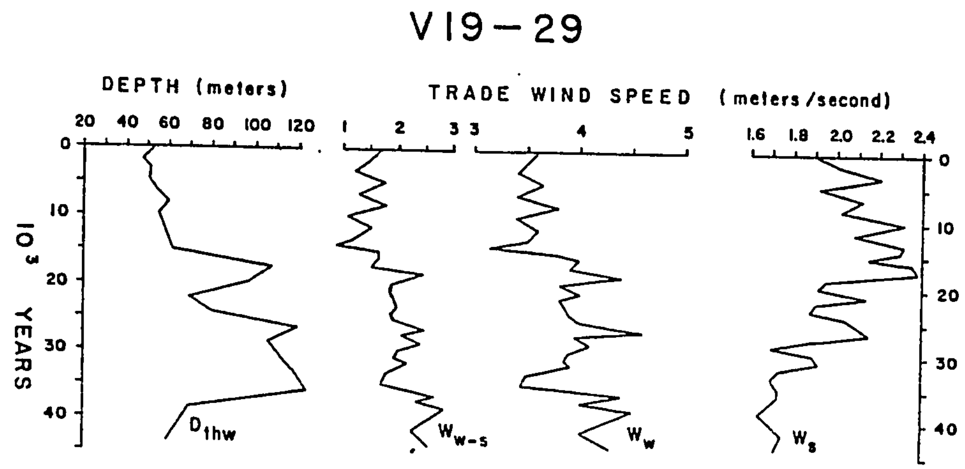


Figure IV.29 Comparison of the estimates of Trade Wind speeds and depths of the center of the euphotic thermoclinal layer for down core samples of V19-29. Trade wind intensity (Ww = winter; Ws = summer) replotted from Molina-Cruz (1977b). Delta Seasonal Trade Wind (Ww-s) is the difference in winter and summer wind . Thermal structure data from Figure IV.12.

the water column. Also, high Delta Seasonal Trade Wind and deep thermal structure generally occur during times of increased winter Trade Winds.

Figure IV.29 indicates that the winter Trade Winds intensified after 40,000 B.P. Thus, they would have enhanced upwelling off the coast of South America. Since this was also a period of increased Delta Seasonl Trade Wind, the expected increased return flow from the western Pacific, via the Equatorial Undercurrent would have converged with the intensified Peru Current. From 36,000 B.P. to 18,000 B.P. the area to the east of the Galapagos Islands would have become a region of convergence, especially whenever Delta Seasonal Trade Wind increased. This convergence would result in a sinking of water and the depression of the thermal structure. This interpretation is consistant with the findings of Wyrtki _et al_. (1976), who found a deepened thermocline along the South American coastline during El Niño of 1975.

The Equatorial Undercurrent was earlier postulated to be the mode of transport of _Globorotalia inflata_ into the eastern equatorial Pacific (see pages 117 - 119). If the Equatorial Undercurrent was intensified, it could have transported more specimens into the Panama Basin region. In core V21-29, located below the Undercurrent, only 0.662% of the Recent (core top) sample is G. inflata. This species averages about 7.9% of the fauna between 36,000 B.P. and 18,000 B.P..

Thompson (1976) noted that G. inflata was common in the eastern equatorial Pacific at 18,000 B.P. with maximum percentages in the vicinity of the Galapagos Islands (Figure IV.30). The abundance of this species diminished towards the east and along the equator towards the west until it became absent beyond 110°W. longitude. This distribution suggests that the population was centered and originated in the Panama Basin and must have later migrated at the surface within the South Equatorial Current. It is unlikely that G. inflata entered the region from either the east or west through the surface currents. Consequently the originating specimens must have been supplied by upwelling from the Equatorial Undercurrent in the vicinity of the Galapagos Islands.

Figure IV.29 illustrates a lag of 2,000 years between an increase in Delta Seasonal Trade Wind and the deepening of the thermocline, ie., the increase in abundance of G. inflata. This interval probably represents the time needed for sufficient depression of the thermal structure before this species could thrive. Once established, the population would be capable of survival, though with lowered abundance,

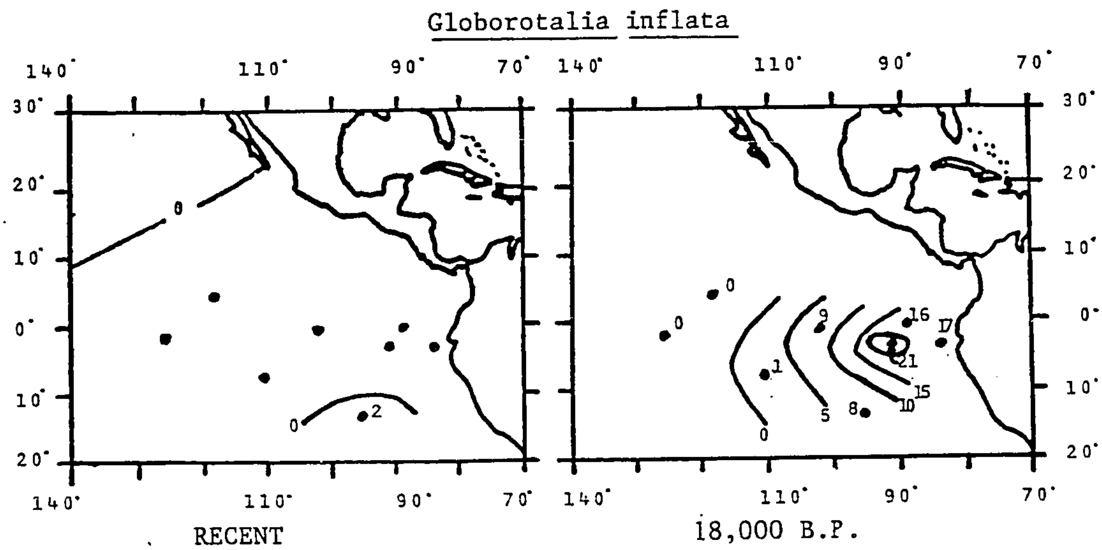


Figure IV.30 Biogeographic distribution of Globorotalia inflata during the Recent (left) and at 18,000 B. P. (right) according to Thompson (1976). Values plotted represent percentages of total planktonic foraminifera read from Thompson's Figure 9d with an Apple II * computer and a Bit Pad One ** digitizing tablet. Zero contour off Baja California on Recent map redrawn from Figure III.27.

* Registered trademark of Apple Computer, Inc.
** Registered trademark of Summagraphics, Inc.

during intervals of less seasonable Trade Winds, and an associated rise in the thermocline. Consequently each increase in Delta Seasonal Trade Wind, and rapid deepening of the thermocline is represented by a sharp increase in the abundance of G. inflata. The population density decreased slowly when the thermocline gradually rose in the water column.

Pedersen (in press) studied the $CaCO_3$ and organic carbon records in two deep-sea cores taken near V21-29 in the vicinity of the Galapagos Islands. He found a maximum for organic carbon during the last glacial maximum, coincident with increased sedimentation rates. In order to determine if this was due to better preservation of organic matter, or increased input of biogenic material the amount of iodine in the samples was determined. High iodine concentrations are expected when rapid burial occurs and preferentially preserves organic material. Because the Iodine : organic carbon ratio was not enriched during the glacial episode, despite the greater sedimentation rate, the organic carbon maximum was considered to represent higher levels of productivity. This is consistant with a shallow thermocline in this region due to increased upwelling in response to intensified atmospheric and oceanic circulation. The down-core estimates for 18,000 B.P. sea-surface temperature and depths and temperatures of the thermocline at site V21-29 were summarized in Figure IV.26. The figure suggests that the thermal structure of this site, located within the regime of the northern branch of the Equatorial Undercurrent, was slightly warmer and shallower than today.

To the north of the Pacific Equatorial Front, in the North Equatorial Counter Current, little change in thermal structure was found at site V21-212 (Figure IV.27) at 18,000 B.P.. The intensified circulation in the southern anticyclonic gyre margin, which caused a shoaling of the thermal structure near the Galapagos Islands and major depression of the thermocline further to the southeast of these islands, did not significantly influence the upper water column of the northern Panama Basin during the last glacial maximum.

Recently, Romine and Moore (1981) have expanded upon the radiolarian studies of Molina-Cruz (1977a, 1977b) and Moore (1978). They examined specimens in eastern equatorial Pacific and Panama Basin sediments in order to define four assemblages related to the present day sea-surface circulation as well as the flow of the Equatorial Undercurrent. The distribution of these assemblages in two deep sea cores, enabled them to suggest a history of the atomspheric and oceanic circulation of the region. Of particular interest are their Equatorial (Undercurrent) Assemblage, and Peru Upwelling Assemblage. A comparison of the distributions of these assemblages during the Recent and for various Pleistocene ages is presented by Romine (1982). During glacial events, ie., 65,000 B.P. and 18,000 B.P. the regime of the Peru Current Assemblage expanded. Near the Galapagos Islands Romine (1982) reports a secondary increase in Peru Current upwelling, and a permanent decrease in upwelling from the Equatorial Undercurrent at 36,000 B.P.. However, to the west of 100°W. longitude there was a westward expansion, along the equator, of Equatorial Undercurrent upwelling at this time. If this interpretation is correct then the development of a zone of convergence between the Peru Current and a "surfaced" Equatorial Undercurrent could not have occured. It is more likely that the westward expansion of the Equatorial radiolarian assemblage described by Romine (1982) reflects a true shoaling of the Undercurrent, and the lowered abundances of this assemblage in the Galapagos region is due to the localized deepening of the thermocline and mixed layer.

According to Romine (1982) the Undercurrent Assemblage lives in cool oxygen rich waters, that are related to the shallow mixed layer of the Panama Basin region. The average depth of the center of the thermocline is only 50 m in this area (Wyrtki, 1964b). Romine's (1982) Peru Current Assemblage is associated with cold, oxygen poor, nutrient rich waters where the thermocline is always deeper than 50 m (Wyrtki, 1964b). A convergence between a "surfaced" Undercurrent and the Peru Current would cause downwelling and replace the shallow mixed layer with a deep thermocline. Perhaps this significantly altered the normal habitat for the Undercurrent specimens that would prefer a shallow thermal structure. Without the evidence derived from planktonic foraminifera (especially Globorotalia inflata), increased upwelling, both from the Peru Current and the Equatorial Undercurrent, producing a unique region of downwelling to the southeast of the Galapagos Islands, could possibly have been misinterpreted as a cessation in upwelling from the Undercurrent.

Paleoceanographic Reconstrution of The Panama Basin Between 36,000 B. P. and 18,000 B. P.

Within the study area, today, Globorotalia inflata appears to be restricted to a region of oceanic convergence where surface water subsidence causes a deep mixed layer. It is rare to absent in the Recent Panama Basin region due to its extremely shallow thermal structure. However, down-core faunal data from core V19-29 indicates that *G. inflata* was an important faunal constituent of the region to the southeast of the Galapagos Islands between 36,000 and 18,000 B.P.

Paleoecologic equations derived from Recent faunal data from 52 core tops, in the eastern equatorial Pacific, by the Imbrie and Kipp (1971) transfer function method, produced estimates of Late Pleistocene and Holocene sea-surface temperatures and temperatures and depths of the thermal structure in deep sea-cores from the Panama Basin. The incursion of *G. inflata* between 36,000 B.P. and 18,000 B.P. in core V19-29 (3°35'S.; 83°56'W.) is interpreted to reflect a cooling of the sea-surface and a depression and cooling of the thermocline. This was an indirect result of an intensification of surficial circulation induced by increased Trade Wind activity. An intensified Equatorial Undercurrent, transporting excess western Pacific surface waters back to the eastern Pacific, most likely surfaced in the vicinity of the Galapagos Islands. This water, upon converging with the increased flow of the Peru and South Equatorial Currents resulted in subsidence of the surface waters in the extreme eastern equatorial Pacific. The down-welling waters would have produced a deep mixed layer and a depressed thermocline in the vicinity of the Galapagos

Islands (Figure IV.31). Evidence for this at the site of V19-29 is provided by this study. The data supplied by Thompson (1976) suggests that the effects of this phenomenon extended as far west as 110° W. longitude.

Abundant Globorotalia inflata was not found in similar glacial samples of cores V21-29 (0° 57'N.; 89° 21'W.) and V21-212 (2° 50'N.; 85° 8'W.) further to the north. Evidence for an 18,000 B. P. shoaling of the thermocline at V21-29 indicates an increased flow of the Equatorial Undercurrent to the northeast of the Galapagos Islands. These glacial mode paleoceanographic events were not found at V21-212.

Between 320,000 and 36,000 B. P. the fauna of site V19-29 remained relatively stable (Appendix G, Tables 3 and 4) suggesting that oceanic circulation and temperature fluctuated only slightly in this region. Sea-surface temperatures varied by approximately 3.5° C., while thermocline temperatures fluctuated about 2° C. (Figures IV.10, IV.13). Only minor shifts in the depth of the thermocline were estimated for this time interval (Figures IV.11, IV.12). This indicates that the oceanic convergence between the Galapagos Islands and Ecuador which existed between 36,000 - 18,000 B. P. was not present earlier.

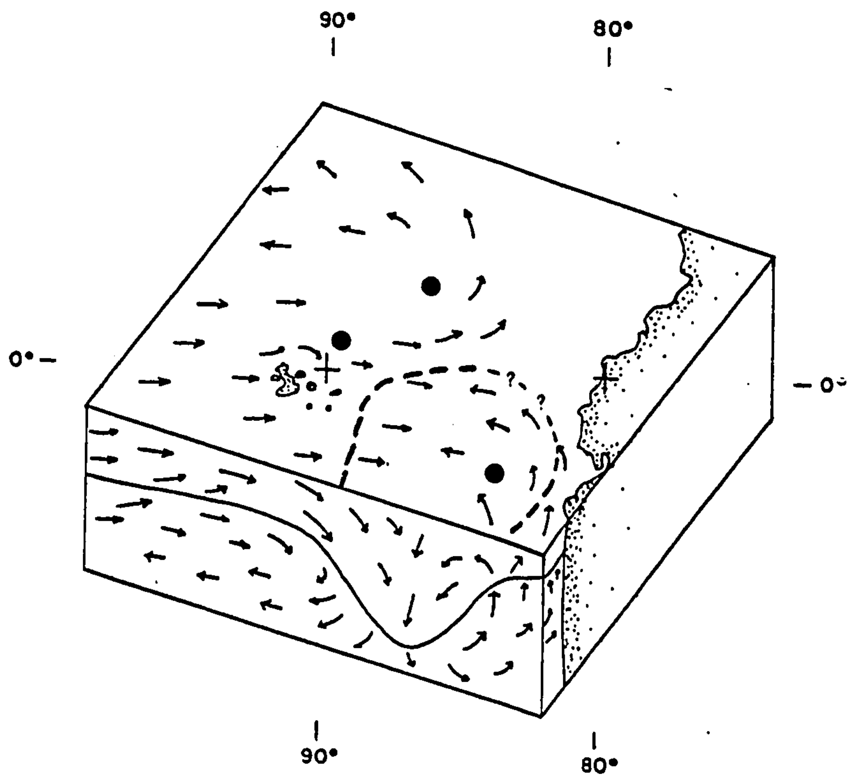


Figure IV.31 Paleoceanographic reconstruction of the southern Panama Basin between the Galapagos Islands and Ecuador from 36,000 B. P. to 18,000 B. P. An oceanic convergence between the surfaced Equatorial Undercurrent and the Peru Current developed. Surface waters within the region outlined by dashed lines sank and thereby depressed the thermal structure. The center of the thermocline is suggested by the solid curve. Current trajectories are indicated by arrows. Dots illustrate the locactions of cores V19-29, V21-29 and V21-212, see Figure IV.1.

V. SUMMARY AND CONCLUSIONS

The main goals of this dissertation were to: 1) study the ecology of planktonic foraminifera living in the eastern equatorial Pacific Ocean, 2) develop an ecologic model of the physical oceanography of this region based on these organisms, and 3) apply the model to down-core data from deep-sea cores from the Panama Basin in order to infer the Late Pleistocene and Holocene paleoceanographic history of the extreme eastern sector of the study area. This was accomplished by comparing the Recent water mass distributions, circulation patterns and thermal structure distributions of the study area to the areal and vertical distributions of planktonic foraminifera in the water column and sea-floor sediments. The conclusions derived from the study may best be described in tabular form below.

A. A survey of the physical oceanography of the eastern equatorial Pacific Ocean reveals its complexities in seasonal circulation patterns and water mass distributions.

1. From January to April the Intertropical Convergence Zone (ITCZ) is at or near its maximum southerly position. During this time interval the

following is true.

a. The California Current is the most powerfull near-surface flow within the study area, extending well into the tropcical Pacific.

b. Circulation in the Equatorial Counter Current is weak or totaly absent to the east of 120° W. longitude.

c. The waters to the east of the Galapagos Islands, along the equator are well stratified.

d. In this region the temperatures within the center of the euphotic portion of the thermocline are below 18°C.

2. From August to December there is a northward displacement of the ITCZ.

a. The South Equatorial Anticyclonic gyre is well developed.

b. Return flow in the Equatorial Counter Current and the Equatorial Undercurrent is intensified.

c. The thermocline in the equatorial region to the east of the Galapagos Islands rises in the water column.

d. The center of the euphotic porton of the thermocline in this region warms and the sea-surface cools so that the thermocline nearly vanishes.

3. During times of El Niño the above pattern is altered.

a. The Equatorial Undercurrent is intensified.

b. Increased upwelling and resulting water mass mixing occurs to the east of the Galapagos Islands.

c. The Pacific Equatorial Front, in the region to the east of the Galapagos Islands, is displaced southwards.

d. The thermocline in this region is depressed due to the accumulation of surface water.

e. This warm surface water spreads southwards along the coasts of Peru and Ecuador.

B. A survey of the planktonic foraminifera recovered at the various sampling stations of 5 ship tracks was used to describe the ecology of these organisms.

1. The distributions of the various species indicate their dependance on particular oceanic environments.

   a. Globigerinoides ruber was found in all regions of the study area.

   b. Globigerinoides sacculifer was found south of 20° N. latitude.

   c. Neogloboquadrina dutertrei was dominant within the upwelling waters of the California Current, the Peru and South Equatorial Currents, and the Panama Basin.

   d. Globigerina bulloides was found in the upwelling regions of the Panama Basin and the coast of Central America.

   e. The Globorotalia menardii-tumida complex prefers the waters of the North Equatorial Current.

   f. The species Orbulina universa and Hastigerina *pelagica* were found most often in the gyre margin currents.

2. The distributions of the various species of planktonic foraminifera within the eastern equatorial Pacific agrees with the previously established zonations of Bradshaw (1959) and Bé and Tolderlund (1971).

C. Observations of planktonic foraminifera from the Panama Basin indicate that the main habitat of these organisms extends from the sea-surface to the depths of the thermocline.

1. Protoplasm filled specimens of the spinose, symbiont bearing species, eg. *Globigerinoides ruber*, and *G. sacculifer* inhabit the mixed layer.

2 Most of the other species including *Neoglobguadrina dutertrei* and *Globorotalia theyeri* prefer the depths of the thermocline.

3. Foraminiferal shells from depths below the thermocline were either shown to be settling passively or were empty (=dead).

D. The portion of the thermocline within the euphotic zone plays a significant role in controlling the biogeographic distributions of the various species.

1. A shallow thermocline within the Panama Basin in July and August of 1979 permitted the deeper dwelling, cool water non-spinose species, (ie. N. dutertrei and G. theyeri) to proliferate within the food-rich euphotic zone.

2. In November and December a deep thermocline inhibited the proliferation of these species, but permited the continued growth of G. ruber, and G. sacculifer.

E. Discrepancies were discovered between the biogeographic distributions of planktonic foraminifera derived from plankton tows and those from the sea-floor sediments of the eastern equatorial Pacific. At this time a direct comparison is not possible over the entire study area.

1. The samples collected from the water column via plankton tows were inadequate temporally and spatially.

2. There are differences in the time frame each series of samples represent, ie. plankton tows represent the instaneous standing stock at a particular depth interval, whereas, sediments

ideally represent the average production of foraminifera from all depths over many years.

3. There has been non-ideal preservation of the fauna within the sediments.

4. It is possible to "buffer" paleocecologic equations by selecting only the most resistant species for sediment analysis (See Luz 1973; Thompson, 1976, 1977).

5. In the eastern equatorial Pacific the key resistant species are, for the most part, the ones which delineate oceanic provinces, while the more dissolution susceptable species are found throughout the study area.

F. Dispite the difficulties in correlating the sediment and water column distributions of planktonic foraminifera the biogeographic distributions of the various species have been shown to be related to the major circulation patterns as well as to the thermal structure variations in the study area.

1. Based on plankton tow and/or sediment distribution maps (Figures III.12 - III.28) the species may be segregated into 7 geographic groups (see Table

3.2, p. 69).

2. The distributions compare favorably to those reported by Bradshaw (1959) and Coulbourn et al. (1980).

3. Within the eastern equatorial Pacfic, today, Globortalia inflata appears to be restricted to a region of oceanic convergence where surface water subsidence causes a deep mixed layer. It is rare to absent in the Recent Panama Basin due to the extremely shallow thermal structure in this region.

4. The species Neogloboquadrina dutertrei var. 4 1/2 chambers and Globorotalia theyeri prefer the shallow thermal structue of the Panama Basin.

G. Down-core fossil foraminiferal data from core V19-29 indicates that G. inflata was an important faunal constituent of the region to the southeast of the Galapagos Islands between 36,000 and 18,000 B.P.

H. The Imbrie and Kipp (1971) transfer function method was used to estimate Late Pleistocene and Holocene sea-surface temperatures, and temperatures and depths of the thermal structure in the Panama Basin.

1. Paleoecologic equations were derived from the Recent faunal data from the 52 core tops in the eastern equatorial Pacific.

2. The results of the analysis indicate that 36,000 B.P. and 18,000 B.P., in the vicinity of core V19-29 (3°35'S.; 83°56'W.), there was a cooling of the sea-surface and a depression and cooling of the thermocline.

   a. This was was interpreted to have been an indirect result of an intensification of surficial circulation induced by increased Trade Wind activity.

   b. An intensified Equatorial Undercurrent, transporting excess western Pacific surface waters back to the eastern Pacific, most likely surfaced in the vicinity of the Galapagos Islands.

   c. This water, upon converging with the increased flow of the Peru and South Equatorial Currents resulted in subsidence of the surface waters in the extreme eastern equatorial Pacific.

i. The down-welling waters would have produced a deep mixed layer and a depressed thermocline in the vicinity of the Galapagos Islands (Figure IV.31).

ii. Data supplied by Thompson (1976) suggests that the secondary effects of this phenomenon extended as far west as 110°W. longitude.

3. Paleoecologic estimates based on glacial age sediments from further to the north in cores V21-29 (0°57'N.; 89°21'W.) and V21-212 (2°50'N.; 85°8'W.) do not indicate a deepening of the thermal structure.

a. Evidence for an 18,000 B. P. shoaling of the thermocline at V21-29 indicates an increased flow of the Equatorial Undercurrent to the northeast of the Galapagos Islands.

b. No glacial mode paleoceanographic thermal structure events were found in the vicinity of V21-212.

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DATA FOR BIOGEOGRAPHY PLANKTON TOWS

MAP NO.	SAMPLE NAME	LATITUDE	LONGITUDE	DEPTH	DATE	EXAMINER
1	V 18-236	5 56' S	131 8' W	10	Sep. 27, 1962	B
2	V 18-240	2 51' S	126 12' W	10	Sep. 30, 1962	B
3	V 18-248	7 12' N	111 24' W	10	Oct. 6, 1962	S
4	V 18-251	10 18' N	104 10' W	10	Oct. 8, 1962	S
5	V 18-254	15 8' N	95 43' W	10	Oct. 13, 1962	S
6	V 18-259	6 6' N	82 5' W	10	Oct. 23, 1962	S
7	V 21- 29	1 5' N	87 11' W	10	Mar. 17, 1965	S
8	V 21- 31	1 13' S	89 41' W	10	Mar. 18, 1965	B
9	V 21- 33	3 48' S	92 5' W	10	Mar. 19, 1965	B
10	V 21- 38	7 7' S	101 35' W	10	Mar. 23, 1965	B
11	V 21- 39	6 19' S	104 44' W	1058	Mar. 24, 1965	B
12	V 21- 41	4 43' S	109 25' W	300	Mar. 25, 1965	B
13	V 21- 43	4 57' S	114 1' W	200	Mar. 27, 1965	B
14	V 21- 44	6 10' S	116 59' W	200	Mar. 27, 1965	B
15	V 21- 45	7 8' S	119 54' W	200	Mar. 28, 1965	B
16	V 21- 46	8 6' S	122 22 W	200	Mar. 29, 1965	B
17	V 21-217	2 50' N	85 8' W	10	Nov. 5, 1965	S
18	V 24- 38	6 19' N	90 37' W	228	Feb. 25, 1967	B
19 *	V 24-COM	1 28' N	101 43' W	227	Feb. 28-9, 1967	S
20	V 24- 51	1 46' N	117 12' W	10	Mar. 5, 1967	B
21	V 24- 52	1 40' N	120 20' W	205	Mar. 6, 1967	B
22	V 24- 61	2 16' N	138 36' W	500	Mar. 11, 1967	S
23	RC 9- 2c	5 29' N	78 20' W	1000	Jan. 22, 1965	B
24	RC 9- 4e	2 26' N	79 20' W	250	Jan. 23, 1965	B
25	RC 9- 5f	1 50' N	80 39' W	1000	Jan. 25, 1965	B
26	RC 9- 6g	1 17' N	82 17' W	1000	Jan. 25, 1965	B
27	RC 9- 7h	1 20' S	81 16' W	1000	Jan. 25, 1965	B
28	RC 9- 8i	2 33' S	82 41' W	500	Jan. 26, 1965	B
29	RC 9- 9j	5 36' S	85 40' W	1000	Jan. 27, 1965	B
30	RC 10- 55	4 41' N	87 49' W	101	Jan. 31, 1966	B
31	RC 10- 98	0 6' S	134 19' W	250	Mar. 9, 1966	S
32	RC 10- 99	2 53' S	136 48' W	250	Mar. 10, 1966	S
33	RC 10-241	35 35' N	128 39' W	10	Aug. 20, 1966	S
34	RC 10-243	28 38' N	129 6' W	10	Aug. 22, 1966	S
35	RC 10-244	25 50' N	129 25' W	10	Aug. 23, 1966	S
36	RC 10-246	21 15' N	125 7' W	10	Aug. 25, 1966	S
37	RC 10-247	18 41' N	120 36' W	10	Aug. 26, 1966	S
38	RC 10-248	18 10' N	119 3' W	10	Aug. 27, 1966	B
39	RC 10-249	16 37' N	114 31' W	10	Aug. 28, 1966	B
40	RC 10-252	13 6' N	104 20' W	10	Aug. 31, 1966	B
41	RC 10-254	11 8' N	98 44' W	10	Sep. 2, 1966	B
42	RC 10-258	7 19' N	87 3' W	10	Sep. 5, 1966	B
43	RC 12- 31	10 26' N	91 16' W	10	Feb. 13, 1968	S
44	RC 12- 56	11 17' N	134 5' W	10	Mar. 5, 1968	S

45	RC 12- 60	8 21' N	138 47' W	200	Mar. 7, 1968	S
46	MOC-1-128	5 6' N	81 50' W	100	Aug. 5, 1979	S
47	V 20- 27	7 44' N	101 21' W	100	Mar. 24, 1964	S
48	V 20- 35	7 32' N	114 29' W	100	Mar. 29, 1964	S
49	V 20- 40	8 54' N	123 33' W	100	Apr. 1, 1964	S

* Data for sample V 24-COM is combined data for V 24- 42 (1 27'N.; 101 21'W.) and V 24- 43 (1 28'N.;102 4'W.). Location indicated above is mean value of latitude and longitude

DATA FOR CORE TOPS

MAP NO.	SAMPLE NAME	LATITUDE	LONGITUDE	DEPTH
1	V 15- 23	12 35' N	88 37' W	282
2	V 15- 29	6 21' N	85 17' W	1889
3	V 15- 30	4 15' N	85 6' W	3266
4	V 18-312	2 51' S	126 12' W	4614
5	V 18-318	3 10' N	118 28' W	4191
6	V 18-350	5 42' N	85 16' W	1838
7	V 18-353	6 6' N	82 5' W	3016
8	V 19- 25	22 80' N	81 42' W	2404
9	V 19- 27	2 80' S	82 4' W	1373
10	V 19- 29	3 35' S	83 56' W	3157
11	V 20- 15	6 57' N	84 17' W	1736
12	V 21- 26	4 36' N	82 44' W	3081
13	V 21- 28	1 5' N	87 17' W	2714
14	V 21- 29	0 57' N	89 21' W	712
15	V 21- 31	1 50' S	90 28' W	3334
16	V 21- 34	5 22' S	93 22' W	3081
17	V 21- 39	6 19' S	104 44' W	3541
18	V 21- 41	4 43' S	109 25' W	3435
19	V 21-210	2 44' N	90 19' W	2141
20	V 21-212	2 50' N	85 8' W	3338
21	V 21-214	3 50' N	80 38' W	2246
22	V 24- 48	1 43' N	109 20' W	3720
23	V 28-134	6 54' N	85 26' W	2434
24	V 28-144	5 18' N	87 18' W	1919
25	V 28-146	3 41' N	88 27' W	1968
26	V 28-147	3 2' N	86 16' W	1823
27	V 28-148	3 42' N	91 32' W	2834
28	V 28-152	7 18' N	100 11' W	3347
29	V 28-153	9 30' N	102 40' W	3272
30	V 28-168	13 30' N	119 42' W	545
31	V 32-102	2 32' N	136 12' W	4276
32	RC 8-102	1 25' S	86 51' W	2180
33	RC 8-103	1 16' N	85 10' W	2937
34	RC 9- 67	0 49' N	82 9' W	3091
35	RC 10- 52	3 52' N	83 56' W	2243
36	RC 10- 54	4 31' N	88 32' W	2492
37	RC 10- 56	1 49' N	91 15' W	2082
38	RC 11-230	8 48' S	110 48' W	3259
39	RC 11-238	1 31' S	85 49' W	2573
40	RC 12- 33	14 50' N	93 57' W	412
41	RC 12- 45	21 1' N	115 0' W	2626
42	RC 13-108	3 7' S	89 25' W	3308
43	RC 13-113	1 39' S	103 38' W	3195
44	RC 13-122A	10 3' N	107 0' W	3275
45	RC 13-136	4 59' N	94 28' W	3436

46	RC 13-138	1	49'	N	94	8'	W	2655
47	RC 13-140	2	52'	S	87	45'	W	2246
48	RC 18- 47	2	25'	S	85	59'	W	3203
49	SOB 31A	29	52'	N	116	49'	W	1270
50	FANHMS2G	30	17'	N	118	14'	W	2970
51	FANHMS4G	28	28'	N	118	1	W	3080
52	RIS 121V	27	53'	N	132	37'	W	3700

SPECIES DATA FOR PLANKTON TOWS EXPRESSED AS PERCENTAGE OF SAMPLE

SAMPLE NAME	UNIVERSA	CONGLOBT	RUBER	SACC	AEQUILAT	CALIDA
V 18236 10	0.9852	0.0000	15.7635	37.9310	21.6749	0.0000
V 18240 10	0.0000	0.0000	9.8214	30.3571	1.7857	0.0000
V 18248 10	3.1325	3.3735	23.1325	15.4217	21.4458	0.2410
V 18251 10	0.0000	3.9683	8.5317	0.1984	0.9921	1.5873
V 18254 10	0.0000	0.0000	33.2734	2.8777	1.9784	1.0791
V 18259 10	0.0000	0.2488	33.8308	13.6816	0.0000	0.0000
V 21 29 10	0.6734	0.6734	21.5488	14.1414	9.4276	0.0000
V 21 31 10	2.1505	0.0000	23.1183	8.6022	2.1505	0.0000
V 21 33 10	0.9859	0.0000	9.7183	65.0704	0.4225	0.0000
V 21 38 10	2.0727	0.2839	44.6053	0.0000	0.8802	0.0000
V 21 392100	0.7002	2.8644	28.7715	16.6773	4.6467	0.0000
V 21 411830	3.1461	0.7491	3.9700	17.3034	5.8427	0.0000
V 21 433050	0.0000	4.2520	20.1575	28.5039	0.7874	0.0000
V 21 441520	0.0000	1.3333	4.6667	16.0000	0.6667	0.0000
V 21 453050	2.3429	0.0000	10.3301	31.9489	3.4079	0.0000
V 21 463050	0.0000	0.0000	11.8367	48.1633	11.8367	0.0000
V 21217 100	0.0000	6.9277	9.9398	21.9880	2.7108	2.1084
V 24 38 222	4.0179	1.7857	20.0893	8.0357	0.0000	0.0000
V 24COM 228	0.0000	1.2346	8.6420	7.4074	1.2346	0.0000
V 24 51 10	2.4664	4.4843	29.5964	47.0852	6.2780	0.0000
V 24 52 205	0.0000	0.0000	12.7273	27.2727	0.0000	0.0000
V 24 61 500	0.0000	1.9231	10.5769	24.5192	10.0962	0.4808
RC 9 2C1000	1.9841	1.5873	20.4365	4.3651	34.3254	0.0000
RC 9 4E 250	0.7519	0.2506	20.8020	3.5088	3.5088	0.0000
RC 9 5F1000	6.6298	0.0000	5.5249	2.2099	6.0773	0.0000
RC 9 6G1000	4.9005	0.1531	12.5574	9.1884	6.4319	0.0000
RC 9 7H1000	8.1081	0.6757	6.7568	2.7027	11.0360	0.0000
RC 9 8I 500	3.5413	0.0000	1.7643	0.0063	0.3173	0.0000
RC 9 9J1000	18.9829	0.1742	17.0150	2.1247	6.6353	0.3657
RC 10 55 101	3.1128	0.0000	24.9027	53.4371	8.4306	0.0000
RC 10 98 250	0.4149	0.8299	1.6598	13.6929	4.5643	0.0000
RC 10 99 250	1.1696	1.1696	2.3392	30.4094	2.3392	0.0000
RC 10241 10	14.4772	2.4129	18.7668	0.8043	0.8043	0.0000
RC 10243 10	4.2194	2.1097	57.8059	1.6878	3.3755	0.0000
RC 10244 10	1.0152	0.0000	13.1980	2.0305	0.0000	0.0000
RC 10246 10	13.8686	2.9197	5.1095	29.9270	9.4891	0.0000
RC 10247 10	3.7037	9.6296	30.3704	28.1481	1.4815	0.0000
RC 10248 10	6.6440	5.4514	16.3543	0.0000	0.0000	0.0000
RC 10249 10	5.1852	8.1481	29.6296	23.7037	1.4815	0.0000
RC 10252 10	5.6159	2.3551	80.0725	7.2464	0.0000	0.0000
RC 10254 10	0.0000	3.7383	80.3738	0.9346	0.9346	0.0000
RC 10258 10	0.6006	17.4174	16.8168	3.9039	0.0000	0.0000
RC 12 31 200	0.0000	0.5900	9.7345	0.0000	0.2950	5.6047
RC 12 56 200	0.3759	8.2707	20.6767	20.6767	7.8947	1.5038

RC 12 60 200	0.6061	3.0303	11.2121	6.9697	8.1818	7.5758
STIE AUG 100	0.3302	5.0413	33.3841	11.0349	6.0063	3.3524
V 20 27 100	0.5970	6.2690	22.3880	19.7010	6.5670	2.8670
V 20 35 100	6.2200	7.6550	13.3970	19.1390	2.8710	0.0000
V 20 40 100	1.4160	10.0890	24.6020	12.5660	7.7880	0.0000

SAMPLE NAME	BULLOIDS	FALCON	DIGITATA	RUBESCNS	DUTERTRI	CONGLOMR
V 18236 10	1.4778	0.0000	0.0000	0.4926	9.8522	0.0000
V 18240 10	0.0000	0.0000	0.0000	0.0000	37.5000	0.0000
V 18248 10	10.1205	0.0000	0.0000	0.0000	8.1928	0.0000
V 18251 10	24.0079	0.0000	0.0000	0.9921	3.9683	0.1984
V 18254 10	17.6259	0.0000	0.0000	0.0000	1.6187	0.0000
V 18259 10	1.7413	0.0000	0.0000	0.0000	3.2338	0.0000
V 21 29 10	20.5387	0.0000	0.0000	0.0000	26.9360	0.0000
V 21 31 10	11.8280	0.0000	0.0000	1.6129	46.2366	0.0000
V 21 33 10	0.0000	0.0000	0.0000	1.5493	13.2394	0.0000
V 21 38 10	0.4543	0.0000	0.0000	2.3282	13.3447	0.0000
V 21 392100	0.0637	0.0000	0.0000	1.5277	13.1763	0.0000
V 21 411830	0.0000	0.0000	0.0000	0.8240	15.9551	0.0000
V 21 433050	0.1575	0.0000	0.0000	0.6299	15.1181	0.0000
V 21 441520	0.0000	0.0000	0.0000	0.0000	35.3333	0.0000
V 21 453050	0.0000	0.0000	0.0000	0.0000	15.9744	0.0000
V 21 463050	0.0000	0.0000	0.0000	0.0000	13.4694	0.0000
V 21217 100	0.3012	0.0000	0.0000	0.0000	30.1205	0.0000
V 24 38 222	0.0000	2.2321	0.4464	0.0000	28.5714	0.0000
V 24COM 228	1.2346	0.0000	3.7037	0.0000	40.7407	0.0000
V 24 51 10	0.4484	0.4484	0.0000	2.4664	2.9148	0.0000
V 24 52 205	0.0000	0.0000	0.0000	1.8182	45.4545	0.0000
V 24 61 500	0.9615	0.4808	0.0000	0.0000	9.1346	0.0000
RC 9 2C1000	2.7778	1.9841	0.0000	0.0000	6.1508	0.0000
RC 9 4E 250	12.5313	0.0000	0.0000	0.0000	21.3033	0.0000
RC 9 5F1000	0.5525	0.0000	0.0000	0.0000	9.3923	0.0000
RC 9 6G1000	9.9541	0.0000	0.0000	0.0000	6.8913	0.0000
RC 9 7H1000	5.8559	0.2252	1.3514	0.0000	15.0901	0.0000
RC 9 8I 500	36.5361	0.0000	0.0063	0.0000	53.0812	0.0000
RC 9 9J1000	12.1735	0.0174	0.0000	0.2264	22.8318	0.0000
RC 10 55 101	0.0000	0.0000	0.0000	0.0000	2.0752	0.1297
RC 10 98 250	0.0000	0.0000	0.0000	0.0000	1.2448	17.0124
RC 10 99 250	0.0000	0.0000	0.0000	0.0000	0.0000	33.9181
RC 10241 10	2.1448	0.0000	0.0000	0.0000	60.3217	0.0000
RC 10243 10	0.0000	2.1097	0.0000	2.1097	13.5021	5.9072
RC 10244 10	0.0000	0.0000	0.0000	0.0000	11.6751	0.0000
RC 10246 10	0.0000	0.0000	0.0000	0.0000	3.6496	0.0000
RC 10247 10	0.0000	0.0000	0.0000	0.0000	2.9630	0.0000
RC 10248 10	0.0000	0.8518	0.0000	0.0000	0.0000	0.0000
RC 10249 10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
RC 10252 10	0.0000	0.0000	0.0000	0.1812	0.0000	0.0000
RC 10254 10	0.0000	0.0000	0.0000	0.9346	0.0000	0.0000
RC 10258 10	0.0000	1.2012	0.0000	0.0000	3.6036	0.0000
RC 12 31 200	48.6726	0.0000	0.0000	0.0000	15.0442	0.0000
RC 12 56 200	4.8872	0.0000	0.0000	0.0000	1.1278	0.0000

RC 12 60 200	1.2121	0.0000	0.0000	0.0000	2.4242	1.2121
STIE AUG 100	2.2476	0.0000	0.0000	0.0000	20.2921	0.9651
V 20 27 100	0.0000	0.0000	0.2990	0.0000	16.7160	0.8960
V 20 35 100	4.7850	0.0000	0.0000	0.0000	11.4830	8.1340
V 20 40 100	7.9650	0.0000	0.0000	0.0000	11.6810	0.0000

SAMPLE NAME	HEXAGONA	OBLIQUIL	MENTUM	GLUTINAT	PELAGICA	THEYERI
V 18236 10	0.0000	3.9409	4.4335	3.4483	0.0000	0.0000
V 18240 10	0.0000	2.6786	16.0714	1.7857	0.0000	0.0000
V 18248 10	0.0000	2.4096	11.5663	0.9639	0.0000	0.0000
V 18251 10	0.0000	26.3889	0.3968	28.7698	0.0000	0.0000
V 18254 10	0.0000	7.1942	27.1583	6.8345	0.3597	0.0000
V 18259 10	0.0000	0.0000	45.5224	1.7413	0.0000	0.0000
V 21 29 10	0.0000	0.6734	0.3367	5.0505	0.0000	0.0000
V 21 31 10	0.0000	0.0000	1.0753	3.2258	0.0000	0.0000
V 21 33 10	0.0000	0.2817	4.9296	3.5211	0.2817	0.0000
V 21 38 10	0.0000	0.0000	9.0574	26.9733	0.0000	0.0000
V 21 392100	3.8192	0.0000	12.3488	13.6856	0.0000	1.7187
V 21 411830	0.0000	0.0749	46.7416	4.5693	0.0000	0.8240
V 21 433050	13.3858	0.3150	12.9134	3.7795	0.0000	0.0000
V 21 441520	2.0000	1.3333	30.0000	6.6667	0.0000	2.0000
V 21 453050	0.0000	5.4313	22.5772	6.3898	0.0000	1.5974
V 21 463050	0.0000	2.0408	2.8571	1.2245	0.4082	8.1633
V 21217 100	0.3012	1.2048	21.3855	1.8072	0.6024	0.6024
V 24 38 222	27.2321	0.0000	0.4464	2.2321	2.2321	2.6786
V 24COM 228	27.1605	0.0000	1.2346	0.0000	1.2346	6.1728
V 24 51 10	0.0000	0.0000	1.1211	2.6906	0.0000	0.0000
V 24 52 205	3.6364	0.0000	3.6364	1.8182	0.0000	3.6364
V 24 61 500	8.6538	22.1154	1.4423	7.6923	0.4808	1.4423
RC 9 2C1000	6.5476	0.0000	7.7381	0.0000	8.5317	3.5714
RC 9 4E 250	3.0075	0.0000	26.8170	1.2531	6.2657	0.0000
RC 9 5F1000	23.7569	0.0000	25.9669	1.6575	0.0000	18.2320
RC 9 6G1000	8.8821	0.0000	30.6279	1.0720	1.3783	7.9632
RC 9 7H1000	3.6036	0.0000	24.7748	0.0000	12.3874	7.4324
RC 9 8I 500	0.0317	0.0000	3.1732	0.5775	0.8695	0.0952
RC 9 9J1000	0.6270	0.2090	3.1696	2.5253	12.8352	0.0871
RC 10 55 101	0.0000	0.0000	5.4475	0.7782	0.0000	1.6861
RC 10 98 250	0.0000	0.0000	59.7510	0.0000	0.0000	0.8299
RC 10 99 250	0.0000	8.1871	17.5439	1.1696	0.5848	1.1696
RC 10241 10	0.0000	0.0000	0.0000	0.0000	0.2681	0.0000
RC 10243 10	0.0000	0.0000	0.4219	0.8439	5.9072	0.0000
RC 10244 10	0.0000	0.0000	0.0000	0.5076	71.5736	0.0000
RC 10246 10	0.0000	0.0000	0.0000	0.0000	35.0365	0.0000
RC 10247 10	0.0000	0.0000	0.0000	0.0000	23.7037	0.0000
RC 10248 10	0.0000	0.0000	0.0000	0.3407	70.3577	0.0000
RC 10249 10	0.0000	0.0000	0.0000	14.8148	17.0370	0.0000
RC 10252 10	0.0000	0.0000	0.0000	4.5290	0.0000	0.0000
RC 10254 10	0.0000	0.0000	2.8037	10.2804	0.0000	0.0000
RC 10258 10	0.0000	0.0000	31.2312	25.2252	0.0000	0.0000
RC 12 31 200	0.0000	0.2950	2.0649	17.6991	0.0000	0.0000
RC 12 56 200	3.3835	0.0000	27.8195	1.5038	1.8797	0.0000

RC 12 60 200	33.3333	0.3030	11.5152	0.3030	3.6364	8.4848
STIE AUG 100	0.3175	0.6349	0.6349	3.5175	4.9524	7.2889
V 20 27 100	5.6720	0.2990	15.8210	1.4920	0.2990	0.2990
V 20 35 100	9.0910	1.4350	6.6990	2.3920	6.6990	0.0000
V 20 40 100	0.0000	1.2390	20.0000	2.4780	0.1770	0.0000

RAW FORAMINIFERAL COUNTS FOR CORE TOPS

SAMPLE NAME		UNIVERSA	CONGLOBT	RUBER	TENELLUS	SACC	DEHISCNS
V 15 23	1	0.0000	0.0000	6.0000	0.0000	5.0000	0.0000
V 15 29	1	7.0000	1.0000	38.0000	2.0000	23.0000	1.0000
V 15 30	1	2.0000	0.0000	32.0000	1.0000	21.0000	3.0000
V 18312	1	1.0000	1.0000	7.0000	0.0000	2.0000	0.0000
V 18318	1	0.0000	2.0000	7.0000	1.0000	11.0000	3.0000
V 18350	1	0.0000	3.0000	5.0000	0.0000	0.0000	0.0000
V 18353	1	1.0000	0.0000	40.0000	0.0000	15.0000	0.0000
V 19 25	1	1.0000	0.0000	9.0000	1.0000	10.0000	0.0000
V 19 27	1	4.0000	1.0000	14.0000	1.0000	3.0000	0.0000
V 19 29	1	1.0000	0.0000	1.0000	0.0000	0.0000	0.0000
V 20 15	1	1.0000	0.0000	43.0000	2.0000	18.0000	0.0000
V 21 26	1	0.0000	0.0000	6.0000	0.0000	3.0000	0.0000
V 21 28	1	2.0000	0.0000	17.0000	3.0000	17.0000	0.0000
V 21 29	1	1.0000	0.0000	79.0000	4.0000	24.0000	0.0000
V 21 31	1	1.0000	0.0000	4.0000	0.0000	1.0000	0.0000
V 21 34	1	2.0000	0.0000	29.0000	1.0000	32.0000	0.0000
V 21 39	1	3.0000	1.0000	10.0000	1.0000	19.0000	1.0000
V 21 41	1	2.0000	1.0000	9.0000	0.0000	25.0000	0.0000
V 21210	1	1.0000	0.0000	22.0000	0.0000	40.0000	0.0000
V 21212	1	1.0000	2.0000	41.0000	0.0000	32.0000	0.0000
V 21214	1	5.0000	2.0000	40.0000	0.0000	50.0000	0.0000
V 24 48	1	0.0000	2.0000	1.0000	0.0000	9.0000	1.0000
V 28134	1	1.0000	0.0000	46.0000	1.0000	19.0000	0.0000
V 28144	1	2.0000	6.0000	29.0000	2.0000	10.0000	0.0000
V 28146	1	4.0000	1.0000	45.0000	2.0000	47.0000	1.0000
V 28147	1	2.0000	0.0000	69.0000	3.0000	34.0000	0.0000
V 28148	1	1.0000	3.0000	4.0000	1.0000	32.0000	2.0000
V 28152	1	0.0000	0.0000	5.0000	0.0000	4.0000	2.0000
V 28153	1	0.0000	1.0000	17.0000	0.0000	8.0000	0.0000
V 28168	1	12.0000	7.0000	140.0000	17.0000	97.0000	0.0000
V 32102	1	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000
RC 8102	1	2.0000	0.0000	19.0000	0.0000	3.0000	0.0000
RC 8103	1	0.0000	0.0000	4.0000	0.0000	6.0000	0.0000
RC 9 67	1	4.0000	0.0000	24.0000	0.0000	11.0000	0.0000
RC 10 52	1	4.0000	2.0000	85.0000	0.0000	41.0000	0.0000
RC 10 54	1	2.0000	9.0000	37.0000	0.0000	31.0000	2.0000
RC 10 56	1	2.0000	1.0000	19.0000	0.0000	13.0000	0.0000
RC 11230	1	7.0000	9.0000	117.0000	6.0000	116.0000	2.0000
RC 11238	1	0.0000	0.0000	7.0000	0.0000	14.0000	0.0000
RC 12 33	1	3.0000	0.0000	48.0000	6.0000	15.0000	0.0000
RC 12 45	1	27.0000	17.0000	43.0000	2.0000	44.0000	5.0000
RC 13108	1	0.0000	0.0000	4.0000	0.0000	2.0000	0.0000
RC 13113	1	1.0000	0.0000	5.0000	0.0000	8.0000	0.0000
RC 13122A	1	0.0000	2.0000	6.0000	0.0000	0.0000	0.0000

RC 13136	1	1.0000	0.0000	0.0000	0.0000	0.0000	2.0000
RC 13138	1	0.0000	2.0000	25.0000	0.0000	16.0000	0.0000
RC 13140	1	0.0000	6.0000	17.0000	0.0000	10.0000	1.0000
RC 18 47	1	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000
SOB 31A	1	3.0000	0.0000	18.0000	0.0000	0.0000	0.0000
FAN HMS 2G	1	1.0000	0.0000	2.0000	0.0000	0.0000	0.0000
FAN HMS 4G	1	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
RIS 121V	1	10.0000	7.0000	141.0000	0.0000	4.0000	0.0000

SAMPLE NAME	AEQUILAT	CALIDA	BULLOIDS	FALCON	DIGITATA	RUBESCNS
V 15 23 1	3.0000	0.0000	17.0000	0.0000	0.0000	3.0000
V 15 29 1	8.0000	0.0000	31.0000	0.0000	2.0000	0.0000
V 15 30 1	5.0000	1.0000	11.0000	0.0000	0.0000	1.0000
V 18312 1	6.0000	1.0000	8.0000	0.0000	1.0000	0.0000
V 18318 1	6.0000	0.0000	5.0000	0.0000	0.0000	1.0000
V 18350 1	5.0000	0.0000	18.0000	0.0000	0.0000	0.0000
V 18353 1	6.0000	1.0000	40.0000	0.0000	0.0000	0.0000
V 19 25 1	4.0000	0.0000	23.0000	0.0000	0.0000	1.0000
V 19 27 1	9.0000	2.0000	69.0000	0.0000	0.0000	0.0000
V 19 29 1	3.0000	2.0000	10.0000	0.0000	0.0000	0.0000
V 20 15 1	9.0000	1.0000	41.0000	0.0000	0.0000	0.0000
V 21 26 1	2.0000	0.0000	2.0000	0.0000	0.0000	0.0000
V 21 28 1	16.0000	4.0000	31.0000	0.0000	2.0000	2.0000
V 21 29 1	30.0000	5.0000	283.0000	3.0000	0.0000	14.0000
V 21 31 1	2.0000	1.0000	10.0000	0.0000	3.0000	0.0000
V 21 34 1	16.0000	3.0000	0.0000	2.0000	0.0000	0.0000
V 21 39 1	6.0000	1.0000	12.0000	0.0000	1.0000	0.0000
V 21 41 1	8.0000	0.0000	3.0000	0.0000	0.0000	0.0000
V 21210 1	13.0000	2.0000	23.0000	0.0000	0.0000	0.0000
V 21212 1	7.0000	0.0000	18.0000	0.0000	0.0000	0.0000
V 21214 1	8.0000	1.0000	18.0000	0.0000	7.0000	0.0000
V 24 48 1	3.0000	0.0000	3.0000	1.0000	2.0000	0.0000
V 28134 1	10.0000	2.0000	29.0000	0.0000	2.0000	5.0000
V 28144 1	17.0000	1.0000	34.0000	0.0000	0.0000	1.0000
V 28146 1	28.0000	3.0000	38.0000	0.0000	1.0000	0.0000
V 28147 1	28.0000	3.0000	70.0000	1.0000	6.0000	2.0000
V 28148 1	25.0000	0.0000	9.0000	0.0000	4.0000	0.0000
V 28152 1	3.0000	0.0000	3.0000	0.0000	2.0000	0.0000
V 28153 1	3.0000	3.0000	36.0000	1.0000	0.0000	0.0000
V 28168 1	22.0000	2.0000	47.0000	5.0000	4.0000	35.0000
V 32102 1	5.0000	0.0000	1.0000	0.0000	0.0000	0.0000
RC 8102 1	11.0000	1.0000	49.0000	1.0000	1.0000	1.0000
RC 8103 1	4.0000	2.0000	15.0000	0.0000	0.0000	0.0000
RC 9 67 1	7.0000	0.0000	48.0000	0.0000	0.0000	3.0000
RC 10 52 1	21.0000	0.0000	42.0000	0.0000	0.0000	2.0000
RC 10 54 1	24.0000	3.0000	24.0000	0.0000	2.0000	0.0000
RC 10 56 1	7.0000	0.0000	27.0000	0.0000	0.0000	1.0000
RC 11230 1	48.0000	7.0000	21.0000	1.0000	1.0000	0.0000
RC 11238 1	9.0000	2.0000	31.0000	0.0000	3.0000	1.0000
RC 12 33 1	5.0000	18.0000	141.0000	3.0000	1.0000	4.0000
RC 12 45 1	33.0000	0.0000	46.0000	3.0000	13.0000	0.0000
RC 13108 1	2.0000	1.0000	6.0000	1.0000	2.0000	0.0000
RC 13113 1	11.0000	0.0000	12.0000	0.0000	2.0000	0.0000
RC 13122A 1	1.0000	0.0000	19.0000	0.0000	3.0000	0.0000

RC 13136	1	3.0000	0.0000	0.0000	0.0000	1.0000	0.0000
RC 13138	1	9.0000	0.0000	36.0000	0.0000	2.0000	3.0000
RC 13140	1	12.0000	0.0000	26.0000	0.0000	3.0000	0.0000
RC 18 47	1	1.0000	0.0000	7.0000	0.0000	0.0000	0.0000
SOB 31A	1	1.0000	3.0000	46.0000	7.0000	4.0000	0.0000
FAN HMS 2G	1	2.0000	0.0000	12.0000	2.0000	4.0000	0.0000
FAN HMS 4G	1	1.0000	1.0000	1.0000	0.0000	3.0000	0.0000
RIS 121V	1	3.0000	3.0000	42.0000	3.0000	7.0000	4.0000

SAMPLE NAME		HUMILIS	QUINQLBA	PACHY L	PACHY R	CONGLOMR	HEXAGONA
V 15 23	1	0.0000	0.0000	0.0000	4.0000	0.0000	0.0000
V 15 29	1	0.0000	0.0000	0.0000	2.0000	3.0000	5.0000
V 15 30	1	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
V 18312	1	0.0000	0.0000	0.0000	2.0000	8.0000	0.0000
V 18318	1	0.0000	0.0000	0.0000	1.0000	3.0000	0.0000
V 18350	1	0.0000	0.0000	0.0000	9.0000	0.0000	1.0000
V 18353	1	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
V 19 25	1	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000
V 19 27	1	0.0000	0.0000	0.0000	6.0000	0.0000	3.0000
V 19 29	1	0.0000	1.0000	0.0000	4.0000	0.0000	2.0000
V 20 15	1	0.0000	0.0000	0.0000	0.0000	0.0000	7.0000
V 21 26	1	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
V 21 28	1	0.0000	0.0000	1.0000	4.0000	0.0000	1.0000
V 21 29	1	0.0000	11.0000	2.0000	28.0000	0.0000	17.0000
V 21 31	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 21 34	1	0.0000	3.0000	0.0000	12.0000	1.0000	5.0000
V 21 39	1	0.0000	0.0000	0.0000	12.0000	2.0000	4.0000
V 21 41	1	0.0000	0.0000	0.0000	6.0000	0.0000	7.0000
V 21210	1	0.0000	0.0000	0.0000	0.0000	1.0000	4.0000
V 21212	1	0.0000	0.0000	0.0000	0.0000	0.0000	2.0000
V 21214	1	0.0000	1.0000	0.0000	1.0000	2.0000	6.0000
V 24 48	1	0.0000	0.0000	0.0000	6.0000	4.0000	1.0000
V 28134	1	0.0000	2.0000	0.0000	0.0000	3.0000	12.0000
V 28144	1	0.0000	0.0000	0.0000	2.0000	0.0000	7.0000
V 28146	1	0.0000	0.0000	0.0000	3.0000	4.0000	10.0000
V 28147	1	0.0000	0.0000	0.0000	1.0000	2.0000	11.0000
V 28148	1	0.0000	0.0000	0.0000	3.0000	8.0000	6.0000
V 28152	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 28153	1	0.0000	1.0000	0.0000	0.0000	0.0000	5.0000
V 28168	1	0.0000	7.0000	0.0000	0.0000	1.0000	11.0000
V 32102	1	0.0000	36.0000	0.0000	0.0000	0.0000	0.0000
RC 8102	1	0.0000	0.0000	1.0000	53.0000	1.0000	2.0000
RC 8103	1	0.0000	0.0000	0.0000	1.0000	0.0000	4.0000
RC 9 67	1	0.0000	0.0000	0.0000	0.0000	1.0000	4.0000
RC 10 52	1	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000
RC 10 54	1	0.0000	0.0000	0.0000	5.0000	0.0000	18.0000
RC 10 56	1	0.0000	1.0000	0.0000	8.0000	0.0000	3.0000
RC 11230	1	1.0000	0.0000	1.0000	0.0000	34.0000	5.0000
RC 11238	1	0.0000	0.0000	1.0000	27.0000	0.0000	1.0000
RC 12 33	1	0.0000	0.0000	0.0000	3.0000	0.0000	3.0000
RC 12 45	1	0.0000	1.0000	1.0000	36.0000	5.0000	15.0000
RC 13108	1	0.0000	0.0000	0.0000	7.0000	1.0000	1.0000
RC 13113	1	0.0000	0.0000	1.0000	11.0000	7.0000	2.0000
RC 13122A	1	0.0000	0.0000	0.0000	1.0000	1.0000	2.0000

RC 13136	1	0.0000	0.0000	0.0000	2.0000	2.0000	0.0000
RC 13138	1	0.0000	0.0000	1.0000	25.0000	0.0000	13.0000
RC 13140	1	0.0000	0.0000	0.0000	2.0000	3.0000	1.0000
RC 18 47	1	0.0000	0.0000	0.0000	7.0000	0.0000	0.0000
SOB 31A	1	0.0000	3.0000	21.0000	165.0000	0.0000	7.0000
FAN HMS 26	1	0.0000	0.0000	15.0000	675.0000	0.0000	0.0000
FAN HMS 46	1	0.0000	0.0000	4.0000	192.0000	0.0000	0.0000
RIS 121V	1	0.0000	0.0000	3.0000	28.0000	11.0000	3.0000

SAMPLE NAME		OBLIQUIL	INFLATA	TRUNC L	TRUNC R	CRASSAFM	MENTUM
V 15 23	1	1.0000	0.0000	0.0000	0.0000	0.0000	49.0000
V 15 29	1	4.0000	0.0000	0.0000	0.0000	2.0000	287.0000
V 15 30	1	3.0000	0.0000	0.0000	0.0000	0.0000	32.0000
V 18312	1	54.0000	0.0000	0.0000	0.0000	9.0000	216.0000
V 18318	1	13.0000	1.0000	0.0000	0.0000	2.0000	90.0000
V 18350	1	0.0000	0.0000	0.0000	0.0000	0.0000	96.0000
V 18353	1	2.0000	0.0000	0.0000	0.0000	0.0000	40.0000
V 19 25	1	6.0000	0.0000	0.0000	0.0000	0.0000	23.0000
V 19 27	1	4.0000	0.0000	0.0000	0.0000	1.0000	70.0000
V 19 29	1	0.0000	0.0000	0.0000	0.0000	0.0000	8.0000
V 20 15	1	2.0000	0.0000	0.0000	0.0000	0.0000	35.0000
V 21 26	1	6.0000	0.0000	0.0000	0.0000	0.0000	15.0000
V 21 28	1	6.0000	0.0000	0.0000	0.0000	0.0000	31.0000
V 21 29	1	1.0000	4.0000	0.0000	0.0000	5.0000	43.0000
V 21 31	1	1.0000	0.0000	0.0000	0.0000	0.0000	17.0000
V 21 34	1	6.0000	3.0000	0.0000	0.0000	0.0000	51.0000
V 21 39	1	8.0000	0.0000	0.0000	0.0000	0.0000	141.0000
V 21 41	1	8.0000	0.0000	0.0000	0.0000	0.0000	33.0000
V 21210	1	5.0000	0.0000	0.0000	0.0000	0.0000	84.0000
V 21212	1	5.0000	0.0000	0.0000	0.0000	0.0000	80.0000
V 21214	1	11.0000	0.0000	0.0000	0.0000	0.0000	71.0000
V 24 48	1	16.0000	0.0000	0.0000	0.0000	0.0000	63.0000
V 28134	1	3.0000	0.0000	0.0000	0.0000	0.0000	74.0000
V 28144	1	2.0000	0.0000	0.0000	0.0000	1.0000	86.0000
V 28146	1	7.0000	0.0000	0.0000	0.0000	0.0000	84.0000
V 28147	1	5.0000	0.0000	0.0000	0.0000	1.0000	43.0000
V 28148	1	14.0000	0.0000	0.0000	0.0000	0.0000	151.0000
V 28152	1	3.0000	0.0000	0.0000	0.0000	0.0000	82.0000
V 28153	1	6.0000	0.0000	0.0000	0.0000	0.0000	25.0000
V 28168	1	11.0000	0.0000	0.0000	0.0000	0.0000	95.0000
V 32102	1	0.0000	0.0000	0.0000	0.0000	3.0000	216.0000
RC 8102	1	7.0000	5.0000	0.0000	0.0000	0.0000	39.0000
RC 8103	1	4.0000	0.0000	0.0000	0.0000	0.0000	35.0000
RC 9 67	1	5.0000	0.0000	0.0000	0.0000	0.0000	28.0000
RC 10 52	1	3.0000	0.0000	0.0000	0.0000	0.0000	59.0000
RC 10 54	1	5.0000	0.0000	0.0000	0.0000	1.0000	186.0000
RC 10 56	1	3.0000	3.0000	0.0000	0.0000	0.0000	36.0000
RC 11230	1	47.0000	1.0000	0.0000	0.0000	0.0000	85.0000
RC 11238	1	2.0000	0.0000	0.0000	0.0000	0.0000	34.0000
RC 12 33	1	0.0000	0.0000	0.0000	0.0000	0.0000	67.0000
RC 12 45	1	12.0000	1.0000	18.0000	6.0000	0.0000	196.0000
RC 13108	1	2.0000	0.0000	0.0000	0.0000	0.0000	45.0000
RC 13113	1	6.0000	0.0000	0.0000	0.0000	0.0000	41.0000
RC 13122A	1	15.0000	0.0000	0.0000	0.0000	0.0000	185.0000

RC 13136	1	4.0000	0.0000	0.0000	0.0000	0.0000	111.0000
RC 13138	1	0.0000	0.0000	0.0000	0.0000	0.0000	49.0000
RC 13140	1	4.0000	0.0000	0.0000	0.0000	0.0000	56.0000
RC 18 47	1	1.0000	0.0000	0.0000	0.0000	0.0000	19.0000
SOB 31A	1	0.0000	7.0000	1.0000	2.0000	1.0000	0.0000
FAN HMS 2G	1	0.0000	7.0000	0.0000	0.0000	0.0000	0.0000
FAN HMS 4G	1	0.0000	3.0000	0.0000	0.0000	0.0000	0.0000
RIS 121V	1	0.0000	144.0000	98.0000	73.0000	23.0000	10.0000

SAMPLE NAME		GLUTINAT	OUTER 5	OUTER 4	THEYERI
V 15 23	1	3.0000	119.0000	107.0000	0.0000
V 15 29	1	71.0000	372.0000	158.0000	2.0000
V 15 30	1	18.0000	65.0000	22.0000	5.0000
V 18312	1	13.0000	218.0000	21.0000	0.0000
V 18318	1	5.0000	149.0000	30.0000	2.0000
V 18350	1	30.0000	127.0000	18.0000	0.0000
V 18353	1	41.0000	205.0000	102.0000	7.0000
V 19 25	1	64.0000	196.0000	51.0000	1.0000
V 19 27	1	45.0000	375.0000	66.0000	2.0000
V 19 29	1	5.0000	295.0000	64.0000	0.0000
V 20 15	1	59.0000	47.0000	27.0000	13.0000
V 21 26	1	6.0000	100.0000	38.0000	0.0000
V 21 28	1	57.0000	167.0000	41.0000	3.0000
V 21 29	1	95.0000	451.0000	70.0000	27.0000
V 21 31	1	10.0000	325.0000	97.0000	3.0000
V 21 34	1	54.0000	321.0000	58.0000	0.0000
V 21 39	1	12.0000	278.0000	57.0000	0.0000
V 21 41	1	7.0000	115.0000	14.0000	0.0000
V 21210	1	76.0000	148.0000	36.0000	1.0000
V 21212	1	38.0000	161.0000	29.0000	5.0000
V 21214	1	55.0000	326.0000	69.0000	1.0000
V 24 46	1	4.0000	210.0000	57.0000	0.0000
V 28134	1	104.0000	128.0000	57.0000	6.0000
V 28144	1	43.0000	60.0000	7.0000	2.0000
V 28146	1	74.0000	94.0000	26.0000	4.0000
V 28147	1	200.0000	125.0000	21.0000	11.0000
V 28148	1	11.0000	166.0000	52.0000	0.0000
V 28152	1	10.0000	115.0000	26.0000	0.0000
V 28153	1	218.0000	37.0000	12.0000	0.0000
V 28168	1	115.0000	32.0000	3.0000	3.0000
V 32102	1	1.0000	179.0000	66.0000	0.0000
RC 8102	1	39.0000	377.0000	58.0000	2.0000
RC 8103	1	33.0000	324.0000	69.0000	1.0000
RC 9 67	1	63.0000	239.0000	47.0000	4.0000
RC 10 52	1	70.0000	94.0000	20.0000	11.0000
RC 10 54	1	48.0000	120.0000	66.0000	0.0000
RC 10 56	1	52.0000	266.0000	75.0000	1.0000
RC 11230	1	129.0000	86.0000	24.0000	1.0000
RC 11238	1	15.0000	345.0000	53.0000	2.0000
RC 12 33	1	107.0000	94.0000	23.0000	1.0000
RC 12 45	1	2.0000	237.0000	28.0000	1.0000
RC 13108	1	4.0000	530.0000	121.0000	0.0000
RC 13113	1	7.0000	443.0000	81.0000	0.0000
RC 13122A	1	1.0000	141.0000	26.0000	0.0000

RC 13136	1	Ø.ØØØØ	141.ØØØØ	53.ØØØØ	Ø.ØØØØ
RC 13138	1	48.ØØØØ	34Ø.ØØØØ	47.ØØØØ	3.ØØØØ
RC 1314Ø	1	38.ØØØØ	12Ø.ØØØØ	35.ØØØØ	1.ØØØØ
RC 18 47	1	3.ØØØØ	512.ØØØØ	113.ØØØØ	Ø.ØØØØ
SOB 31A	1	9.ØØØØ	52.ØØØØ	55.ØØØØ	4.ØØØØ
FAN HMS 26	1	Ø.ØØØØ	166.ØØØØ	38.ØØØØ	Ø.ØØØØ
FAN HMS 46	1	Ø.ØØØØ	111.ØØØØ	19.ØØØØ	Ø.ØØØØ
RIS 121V	1	1.ØØØØ	17.ØØØØ	6.ØØØØ	1.ØØØØ

SPECIES DATA FOR CORE TOPS EXPRESSED AS % SAMPLE

SAMPLE NAME		UNIVERSA	CONGLOBT	RUBER	TENELLUS	SACC	DEHISCEN
V 15 23	1	0.0000	0.0000	1.8927	0.0000	1.5773	0.0000
V 15 29	1	0.6869	0.0981	3.7291	0.1963	2.2571	0.0981
V 15 30	1	0.8969	0.0000	14.3498	0.4484	9.4170	1.3453
V 18312	1	0.1761	0.1761	1.2324	0.0000	0.3521	0.0000
V 18318	1	0.0000	0.6024	2.1084	0.3012	3.3133	0.9036
V 18350	1	0.0000	0.9615	1.6026	0.0000	0.0000	0.0000
V 18353	1	0.1996	0.0000	7.9840	0.0000	2.9940	0.0000
V 19 25	1	0.2545	0.0000	2.2901	0.2545	2.5445	0.0000
V 19 27	1	0.5926	0.1481	2.0741	0.1481	0.4444	0.0000
V 19 29	1	0.2525	0.0000	0.2525	0.0000	0.0000	0.0000
V 20 15	1	0.3279	0.0000	14.0984	0.6557	5.9016	0.0000
V 21 26	1	0.0000	0.0000	3.2086	0.0000	1.6043	0.0000
V 21 28	1	0.4938	0.0000	4.1975	0.7407	4.1975	0.0000
V 21 29	1	0.0835	0.0000	6.5998	0.3342	2.0050	0.0000
V 21 31	1	0.2105	0.0000	0.8421	0.0000	0.2105	0.0000
V 21 34	1	0.3339	0.0000	4.8414	0.1669	5.3422	0.0000
V 21 39	1	0.5272	0.1757	1.7575	0.1757	3.3392	0.1757
V 21 41	1	0.8403	0.4202	3.7815	0.0000	10.5042	0.0000
V 21210	1	0.2193	0.0000	4.8246	0.0000	8.7719	0.0000
V 21212	1	0.2375	0.4751	9.7387	0.0000	7.6010	0.0000
V 21214	1	0.7418	0.2967	5.9347	0.0000	7.4184	0.0000
V 24 48	1	0.0000	0.5222	0.2611	0.0000	2.3499	0.2611
V 28134	1	0.1984	0.0000	9.1270	0.1984	3.7698	0.0000
V 28144	1	0.6410	1.9231	9.2949	0.6410	3.2051	0.0000
V 28146	1	0.8403	0.2101	9.4538	0.4202	9.8740	0.2101
V 28147	1	0.3135	0.0000	10.8150	0.4702	5.3292	0.0000
V 28148	1	0.2033	0.6098	0.8130	0.2033	6.5041	0.4065
V 28152	1	0.0000	0.0000	1.9608	0.0000	1.5686	0.7843
V 28153	1	0.0000	0.2681	4.5576	0.0000	2.1448	0.0000
V 28168	1	1.8018	1.0511	21.0210	2.5526	14.5646	0.0000
V 32102	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.5882
RC 8102	1	0.2976	0.0000	2.8274	0.0000	0.4464	0.0000
RC 8103	1	0.0000	0.0000	0.7968	0.0000	1.1952	0.0000
RC 9 67	1	0.8197	0.0000	4.9180	0.0000	2.2541	0.0000
RC 10 52	1	0.8791	0.4396	18.6813	0.0000	9.0110	0.0000
RC 10 54	1	0.3431	1.5437	6.3465	0.0000	5.3173	0.3431
RC 10 56	1	0.3861	0.1931	3.6680	0.0000	2.5097	0.0000
RC 11230	1	0.9346	1.2016	15.6208	0.8011	15.4873	0.2670
RC 11238	1	0.0000	0.0000	1.2797	0.0000	2.5594	0.0000
RC 12 33	1	0.5535	0.0000	8.8561	1.1070	2.7675	0.0000
RC 12 45	1	3.4048	2.1438	5.4224	0.2522	5.5485	0.6305
RC 13108	1	0.0000	0.0000	0.5487	0.0000	0.2743	0.0000
RC 13113	1	0.1567	0.0000	0.7837	0.0000	1.2539	0.0000
RC 13122A	1	0.0000	0.4963	1.4888	0.0000	0.0000	0.0000

RC 13136	1	0.3125	0.0000	0.0000	0.0000	0.0000	0.6250
RC 13138	1	0.0000	0.3231	4.0388	0.0000	2.5848	0.0000
RC 13140	1	0.0000	1.7910	5.0746	0.0000	2.9851	0.2985
RC 18 47	1	0.0000	0.0000	0.0000	0.0000	0.1504	0.1504
SOB 31A	1	0.7335	0.0000	4.4010	0.0000	0.0000	0.0000
FAN HMS 2G	1	0.1082	0.0000	0.2165	0.0000	0.0000	0.0000
FAN HMS 4G	1	0.2976	0.0000	0.0000	0.0000	0.0000	0.0000
RIS 121V	1	1.5552	1.0886	21.9285	0.0000	0.6221	0.0000

SAMPLE	NAME	AEQUILAT	CALIDA	BULLOIDS	FALCON	DIGITATA	RUBESCNS
V 15 23	1	0.9464	0.0000	5.3628	0.0000	0.0000	0.9464
V 15 29	1	0.7851	0.0000	3.0422	0.0000	0.1963	0.0000
V 15 30	1	2.2422	0.4484	4.9327	0.0000	0.0000	0.4484
V 18312	1	1.0563	0.1761	1.4085	0.0000	0.1761	0.0000
V 18318	1	1.8072	0.0000	1.5060	0.0000	0.0000	0.3012
V 18350	1	1.6026	0.0000	5.7692	0.0000	0.0000	0.0000
V 18353	1	1.1976	0.1996	7.9840	0.0000	0.0000	0.0000
V 19 25	1	1.0178	0.0000	5.8524	0.0000	0.0000	0.2545
V 19 27	1	1.3333	0.2963	10.2222	0.0000	0.0000	0.0000
V 19 29	1	0.7576	0.5051	2.5253	0.0000	0.0000	0.0000
V 20 15	1	2.9508	0.3279	13.4426	0.0000	0.0000	0.0000
V 21 26	1	1.0695	0.0000	1.0695	0.0000	0.0000	0.0000
V 21 28	1	3.9506	0.9877	7.6543	0.0000	0.4938	0.4938
V 21 29	1	2.5063	0.4177	23.6424	0.2506	0.0000	1.1696
V 21 31	1	0.4211	0.2105	2.1053	0.0000	0.6316	0.0000
V 21 34	1	2.6711	0.5008	0.0000	0.3339	0.0000	0.0000
V 21 39	1	1.0545	0.1757	2.1090	0.0000	0.1757	0.0000
V 21 41	1	3.3613	0.0000	1.2605	0.0000	0.0000	0.0000
V 21210	1	2.8509	0.4386	5.0439	0.0000	0.0000	0.0000
V 21212	1	1.6627	0.0000	4.2755	0.0000	0.0000	0.0000
V 21214	1	1.1869	0.1484	2.6706	0.0000	1.0386	0.0000
V 24 48	1	0.7833	0.0000	0.7833	0.2611	0.5222	0.0000
V 28134	1	1.9841	0.3968	5.7540	0.0000	0.3968	0.9921
V 28144	1	5.4487	0.3205	10.8974	0.0000	0.0000	0.3205
V 28146	1	5.8824	0.6303	7.9832	0.0000	0.2101	0.0000
V 28147	1	4.3887	0.4702	10.9718	0.1567	0.9404	0.3135
V 28148	1	5.0813	0.0000	1.8293	0.0000	0.8130	0.0000
V 28152	1	1.1765	0.0000	1.1765	0.0000	0.7843	0.0000
V 28153	1	0.8043	0.8043	9.6515	0.2681	0.0000	0.0000
V 28168	1	3.3033	0.3003	7.0571	0.7508	0.6006	5.2553
V 32102	1	0.9804	0.0000	0.1961	0.0000	0.0000	0.0000
RC 8102	1	1.6369	0.1488	7.2917	0.1488	0.1488	0.1488
RC 8103	1	0.7968	0.3984	2.9880	0.0000	0.0000	0.0000
RC 9 67	1	1.4344	0.0000	9.8361	0.0000	0.0000	0.6148
RC 10 52	1	4.6154	0.0000	9.2308	0.0000	0.0000	0.4396
RC 10 54	1	4.1166	0.5146	4.1166	0.0000	0.3431	0.0000
RC 10 56	1	1.3514	0.0000	5.2124	0.0000	0.0000	0.1931
RC 11230	1	6.4085	0.9346	2.8037	0.1335	0.1335	0.0000
RC 11238	1	1.6453	0.3656	5.6673	0.0000	0.5484	0.1828
RC 12 33	1	0.9225	3.3210	26.0148	0.5535	0.1845	0.7380
RC 12 45	1	4.1614	0.0000	5.8008	0.3783	1.6393	0.0000
RC 13108	1	0.2743	0.1372	0.8230	0.1372	0.2743	0.0000
RC 13113	1	1.7241	0.0000	1.8809	0.0000	0.3135	0.0000
RC 13122A	1	0.2481	0.0000	4.7146	0.0000	0.7444	0.0000

RC 13136	1	0.9375	0.0000	0.0000	0.0000	0.3125	0.0000
RC 13138	1	1.4540	0.0000	5.8158	0.0000	0.3231	0.4847
RC 13140	1	3.5821	0.0000	7.7612	0.0000	0.8955	0.0000
RC 18 47	1	0.1504	0.0000	1.0526	0.0000	0.0000	0.0000
SOB 31A	1	0.2445	0.7335	11.2469	1.7115	0.9780	0.0000
FAN HMS 26	1	0.2165	0.0000	1.2987	0.2165	0.4329	0.0000
FAN HMS 46	1	0.2976	0.2976	0.2976	0.0000	0.8929	0.0000
RIS 121V	1	0.4666	0.4666	6.5319	0.4666	1.0886	0.6221

SAMPLE NAME		HUMILIS	QUINQLBA	PACHY L	PACHY R	CONGLOMR	HEXAGONA
V 15 23	1	0.0000	0.0000	0.0000	1.2618	0.0000	0.0000
V 15 29	1	0.0000	0.0000	0.0000	0.1963	0.2944	0.4907
V 15 30	1	0.0000	0.0000	0.0000	0.4484	0.0000	0.0000
V 18312	1	0.0000	0.0000	0.0000	0.3521	1.4085	0.0000
V 18318	1	0.0000	0.0000	0.0000	0.3012	0.9036	0.0000
V 18350	1	0.0000	0.0000	0.0000	2.8846	0.0000	0.3205
V 18353	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.1996
V 19 25	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.7634
V 19 27	1	0.0000	0.0000	0.0000	0.8889	0.0000	0.4444
V 19 29	1	0.0000	0.2525	0.0000	1.0101	0.0000	0.5051
V 20 15	1	0.0000	0.0000	0.0000	0.0000	0.0000	2.2951
V 21 26	1	0.0000	0.0000	0.0000	0.0000	0.5348	0.0000
V 21 28	1	0.0000	0.0000	0.2469	0.9877	0.0000	0.2469
V 21 29	1	0.0000	0.9190	0.1671	2.3392	0.0000	1.4202
V 21 31	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 21 34	1	0.0000	0.5008	0.0000	2.0033	0.1669	0.8347
V 21 39	1	0.0000	0.0000	0.0000	2.1090	0.3515	0.7030
V 21 41	1	0.0000	0.0000	0.0000	2.5210	0.0000	2.9412
V 21210	1	0.0000	0.0000	0.0000	0.0000	0.2193	0.8772
V 21212	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.4751
V 21214	1	0.0000	0.1484	0.0000	0.1484	0.2967	0.8902
V 24 48	1	0.0000	0.0000	0.0000	1.5666	1.0444	0.2611
V 28134	1	0.0000	0.3968	0.0000	0.0000	0.5952	2.3810
V 28144	1	0.0000	0.0000	0.0000	0.6410	0.0000	2.2436
V 28146	1	0.0000	0.0000	0.0000	0.6303	0.8403	2.1008
V 28147	1	0.0000	0.0000	0.0000	0.1567	0.3135	1.7241
V 28148	1	0.0000	0.0000	0.0000	0.6098	1.6260	1.2195
V 28152	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 28153	1	0.0000	0.2681	0.0000	0.0000	0.0000	1.3405
V 28168	1	0.0000	1.0511	0.0000	0.0000	0.1502	1.6517
V 32102	1	0.0000	7.0588	0.0000	0.0000	0.0000	0.0000
RC 8102	1	0.0000	0.0000	0.1488	7.8869	0.1488	0.2976
RC 8103	1	0.0000	0.0000	0.0000	0.1992	0.0000	0.7968
RC 9 67	1	0.0000	0.0000	0.0000	0.0000	0.2049	0.8197
RC 10 52	1	0.0000	0.2198	0.0000	0.0000	0.0000	0.0000
RC 10 54	1	0.0000	0.0000	0.0000	0.8576	0.0000	3.0875
RC 10 56	1	0.0000	0.1931	0.0000	1.5444	0.0000	0.5792
RC 11230	1	0.1335	0.0000	0.1335	0.0000	4.5394	0.6676
RC 11238	1	0.0000	0.0000	0.1828	4.9360	0.0000	0.1828
RC 12 33	1	0.0000	0.0000	0.0000	0.5535	0.0000	0.5535
RC 12 45	1	0.0000	0.1261	0.1261	4.5397	0.6305	1.8916
RC 13108	1	0.0000	0.0000	0.0000	0.9602	0.1372	0.1372
RC 13113	1	0.0000	0.0000	0.1567	1.7241	1.0972	0.3135
RC 13122A	1	0.0000	0.0000	0.0000	0.2481	0.2481	0.4963

RC 13136	1	0.0000	0.0000	0.0000	0.6250	0.6250	0.0000
RC 13138	1	0.0000	0.0000	0.1616	4.0388	0.0000	2.1002
RC 13140	1	0.0000	0.0000	0.0000	0.5970	0.8955	0.2985
RC 18 47	1	0.0000	0.0000	0.0000	1.0526	0.0000	0.0000
SOB 31A	1	0.0000	0.7335	5.1345	40.3423	0.0000	1.7115
FAN HMS 2G	1	0.0000	0.0000	1.6234	73.0519	0.0000	0.0000
FAN HMS 4G	1	0.0000	0.0000	1.1905	57.1429	0.0000	0.0000
RIS 121V	1	0.0000	0.0000	0.4666	4.3546	1.7107	0.4666

SAMPLE NAME		OBLIQUIL	INFLATA	TRUNC L	TRUNC R	CRASSAFM	MENTUM
V 15 23	1	0.3155	0.0000	0.0000	0.0000	0.0000	15.4574
V 15 29	1	0.3925	0.0000	0.0000	0.0000	0.1963	28.1649
V 15 30	1	1.3453	0.0000	0.0000	0.0000	0.0000	14.3498
V 18312	1	9.5070	0.0000	0.0000	0.0000	1.5845	38.0282
V 18318	1	3.9157	0.3012	0.0000	0.0000	0.6024	27.1084
V 18350	1	0.0000	0.0000	0.0000	0.0000	0.0000	30.7692
V 18353	1	0.3992	0.0000	0.0000	0.0000	0.0000	7.9840
V 19 25	1	1.5267	0.0000	0.0000	0.0000	0.0000	5.8524
V 19 27	1	0.5926	0.0000	0.0000	0.0000	0.1481	10.3704
V 19 29	1	0.0000	0.0000	0.0000	0.0000	0.0000	2.0202
V 20 15	1	0.6557	0.0000	0.0000	0.0000	0.0000	11.4754
V 21 26	1	3.2086	0.0000	0.0000	0.0000	0.0000	8.0214
V 21 28	1	1.4815	0.0000	0.0000	0.0000	0.0000	7.6543
V 21 29	1	0.0835	0.3342	0.0000	0.0000	0.4177	3.5923
V 21 31	1	0.2105	0.0000	0.0000	0.0000	0.0000	3.5789
V 21 34	1	1.0017	0.5008	0.0000	0.0000	0.0000	8.5142
V 21 39	1	1.4060	0.0000	0.0000	0.0000	0.0000	24.7803
V 21 41	1	3.3613	0.0000	0.0000	0.0000	0.0000	13.8655
V 21210	1	1.0965	0.0000	0.0000	0.0000	0.0000	18.4211
V 21212	1	1.1876	0.0000	0.0000	0.0000	0.0000	19.0024
V 21214	1	1.6320	0.0000	0.0000	0.0000	0.0000	10.5341
V 24 48	1	4.1775	0.0000	0.0000	0.0000	0.0000	16.4491
V 28134	1	0.5952	0.0000	0.0000	0.0000	0.0000	14.6825
V 28144	1	0.6410	0.0000	0.0000	0.0000	0.3205	27.5641
V 28146	1	1.4706	0.0000	0.0000	0.0000	0.0000	17.6471
V 28147	1	0.7837	0.0000	0.0000	0.0000	0.1567	6.7398
V 28148	1	2.8455	0.0000	0.0000	0.0000	0.0000	30.6911
V 28152	1	1.1765	0.0000	0.0000	0.0000	0.0000	32.1569
V 28153	1	1.6086	0.0000	0.0000	0.0000	0.0000	6.7024
V 28168	1	1.6517	0.0000	0.0000	0.0000	0.0000	14.2643
V 32102	1	0.0000	0.0000	0.0000	0.0000	0.5882	42.3529
RC 8102	1	1.0417	0.7440	0.0000	0.0000	0.0000	5.8036
RC 8103	1	0.7968	0.0000	0.0000	0.0000	0.0000	6.9721
RC 9 67	1	1.0246	0.0000	0.0000	0.0000	0.0000	5.7377
RC 10 52	1	0.6593	0.0000	0.0000	0.0000	0.0000	12.9670
RC 10 54	1	0.8576	0.0000	0.0000	0.0000	0.1715	31.9039
RC 10 56	1	0.5792	0.5792	0.0000	0.0000	0.0000	6.9498
RC 11230	1	6.2750	0.1335	0.0000	0.0000	0.0000	11.3485
RC 11238	1	0.3656	0.0000	0.0000	0.0000	0.0000	6.2157
RC 12 33	1	0.0000	0.0000	0.0000	0.0000	0.0000	12.3616
RC 12 45	1	1.5132	0.1261	2.2699	0.7566	0.0000	24.7163
RC 13108	1	0.2743	0.0000	0.0000	0.0000	0.0000	6.1728
RC 13113	1	0.9404	0.0000	0.0000	0.0000	0.0000	6.4263
RC 13122A	1	3.7221	0.0000	0.0000	0.0000	0.0000	45.9057

RC 13136	1	1.2500	0.0000	0.0000	0.0000	0.0000	34.6875
RC 13138	1	0.0000	0.0000	0.0000	0.0000	0.0000	7.9160
RC 13140	1	1.1940	0.0000	0.0000	0.0000	0.0000	16.7164
RC 18 47	1	0.1504	0.0000	0.0000	0.0000	0.0000	2.8571
SOB 31A	1	0.0000	1.7115	0.2445	0.4890	0.2445	0.0000
FAN HMS 2G	1	0.0000	0.7576	0.0000	0.0000	0.0000	0.0000
FAN HMS 4G	1	0.0000	0.8929	0.0000	0.0000	0.0000	0.0000
RIS 121V	1	0.0000	22.3950	15.2411	11.3530	3.5770	1.5552

SAMPLE NAME		GLUTINAT	OUTER 5	OUTER 4	THEYERI	OTHERS
V 15 23	1	0.9464	37.5394	33.7539	0.0000	0.0000
V 15 29	1	6.9676	36.5064	15.5054	0.1963	0.0000
V 15 30	1	8.0717	29.1480	9.8655	2.2422	0.0000
V 18312	1	2.2887	38.3803	3.6972	0.0000	0.0000
V 18318	1	1.5060	44.8795	9.3361	0.6024	0.0000
V 18350	1	9.6154	40.7051	5.7692	0.0000	0.0000
V 18353	1	8.1836	40.9182	20.3593	1.3972	0.0000
V 19 25	1	16.2850	49.8728	12.9771	0.2545	0.0000
V 19 27	1	6.6667	55.5556	9.7778	0.2963	0.0000
V 19 29	1	1.2626	74.4949	16.1616	0.0000	0.0000
V 20 15	1	19.3443	15.4098	8.8525	4.2623	0.0000
V 21 26	1	3.2086	57.7540	20.3209	0.0000	0.0000
V 21 28	1	14.0741	41.2346	10.1235	0.7407	0.0000
V 21 29	1	7.9365	37.6775	5.8480	2.2556	0.0000
V 21 31	1	2.1053	68.4211	20.4211	0.6316	0.0000
V 21 34	1	9.0150	53.5893	9.6828	0.0000	0.0000
V 21 39	1	2.1090	48.8576	10.0176	0.0000	0.0000
V 21 41	1	2.9412	48.3193	5.8824	0.0000	0.0000
V 21210	1	16.6667	32.4561	7.8947	0.2193	0.0000
V 21212	1	9.0261	38.2423	6.8884	1.1876	0.0000
V 21214	1	8.1602	48.3680	10.2374	0.1484	0.0000
V 24 48	1	1.0444	54.8303	14.8825	0.0000	0.0000
V 28134	1	20.6349	25.3968	11.3095	1.1905	0.0000
V 28144	1	13.7821	19.2308	2.2436	0.6410	0.0000
V 28146	1	15.5462	19.7479	5.4622	0.8403	0.0000
V 28147	1	31.3480	19.5925	3.2915	1.7241	0.0000
V 28148	1	2.2358	33.7398	10.5691	0.0000	0.0000
V 28152	1	3.9216	45.0980	10.1961	0.0000	0.0000
V 28153	1	58.4450	9.9196	3.2172	0.0000	0.0000
V 28168	1	17.2673	4.8048	0.4505	0.4505	0.0000
V 32102	1	0.1961	35.0980	12.9412	0.0000	0.0000
RC 8102	1	5.8036	56.1012	8.6310	0.2976	0.0000
RC 8103	1	6.5737	64.5418	13.7450	0.1992	0.0000
RC 9 67	1	12.9098	48.9754	9.6311	0.8197	0.0000
RC 10 52	1	15.3846	20.6593	4.3956	2.4176	0.0000
RC 10 54	1	8.2333	20.5832	11.3208	0.0000	0.0000
RC 10 56	1	10.0386	51.3513	14.4788	0.1931	0.0000
RC 11230	1	17.2230	11.4820	3.2043	0.1335	0.0000
RC 11238	1	2.7422	63.0713	9.6892	0.3656	0.0000
RC 12 33	1	19.7417	17.3432	4.2435	0.1845	0.0000
RC 12 45	1	0.2522	29.8865	3.5309	0.1261	0.1261
RC 13108	1	0.5487	72.7023	16.5981	0.0000	0.0000
RC 13113	1	1.0972	69.4357	12.6959	0.0000	0.0000
RC 13122A	1	0.2481	34.9876	6.4516	0.0000	0.0000

RC 13136	1	0.0000	44.0625	16.5625	0.0000	0.0000
RC 13138	1	7.7544	54.9273	7.5929	0.4847	0.0000
RC 13140	1	11.3433	35.8209	10.4478	0.2985	0.0000
RC 18 47	1	0.4511	76.9925	16.9925	0.0000	0.0000
SOB 31A	1	2.2005	12.7139	13.4474	0.9780	0.0000
FAN HMS 2G	1	0.0000	17.9654	4.1126	0.0000	0.0000
FAN HMS 4G	1	0.0000	33.0357	5.6548	0.0000	0.0000
RIS 121V	1	0.1555	2.6439	0.9331	0.1555	0.1555

SAMPLE DATA FOR STIE/CFATE SAMPLES

MOCNESS PLANKTON TOWS

SAMPLE NAME	UNIVERSA	CONGLOBT	RUBER	SACC	AEQUILAT	CALIDA
MOC 126 0	0.5068	2.7590	60.4730	13.8514	1.6329	0.0000
MOC 126 12.5	0.5814	2.3256	47.0930	16.4729	3.8760	0.0000
MOC 126 25	2.0979	2.4476	5.9441	12.2378	24.8252	0.0000
MOC 126 37.5	2.2222	2.2222	1.8519	4.0741	35.5556	0.3704
MOC 126 50	0.2762	0.0000	5.8011	1.3812	10.2210	6.9061
MOC 126 70	0.0000	0.0000	2.2222	0.0000	0.5556	3.3333
MOC 126 75	0.0000	0.0000	1.5480	0.6192	0.3096	12.0743
MOC 126 87.5	0.0000	0.0000	2.1531	0.2392	1.6746	5.7416
MOC 127 0	1.6209	3.3042	53.6783	21.5711	3.5536	0.0000
MOC 127 25	2.3684	2.1053	16.8421	12.1053	22.1053	0.0000
MOC 127 50	0.5495	0.8242	2.1978	0.8242	11.8132	6.8681
MOC 127 75	0.0000	1.7192	1.7192	0.2865	1.1461	6.0172
MOC 127 100	0.0000	0.2577	0.5155	0.2577	1.2887	11.0825
MOC 127 118	0.7874	1.5748	1.9685	0.7874	1.9685	6.6929
MOC 127 150	0.0000	0.0000	0.0000	3.5714	1.7857	0.0000
MOC 127 175	0.0000	1.0870	4.3478	0.0000	4.3478	0.0000
MOC 128 0	0.3236	0.9709	34.1424	12.1359	7.1197	3.5599
MOC 128 100	0.0000	0.5249	1.5748	0.2625	1.0499	2.0997
MOC 128 200	0.0000	0.0000	0.9788	0.3263	0.0000	0.1631
MOC 128 300	0.0000	0.3425	1.0274	0.0000	1.0274	0.0000
MOC 128 400	0.0000	0.0000	0.4902	0.4902	0.4902	0.0000
MOC 128 550	1.0417	0.0000	10.4167	1.0417	0.0000	0.0000
MOC 128 700	0.9259	0.0000	7.4074	2.7778	1.8519	0.0000
MOC 128 850	1.8692	1.8692	8.4112	5.6075	1.8692	2.8037
MOC 131 0	2.6052	0.6012	36.2725	5.6112	2.2044	0.6012
MOC 131 240	2.0761	1.3841	15.2249	1.3841	13.1488	0.3460
MOC 131 500	0.1577	0.0000	1.1830	0.3943	4.7319	0.2366
MOC 131 745	0.9009	0.9009	20.7207	6.3063	7.2072	1.8018
MOC 131 1000	0.0000	0.6667	29.3333	6.6667	7.3333	3.3333
MOC 131 1250	0.0000	0.0000	27.2727	4.5455	7.5758	3.0303
MOC 131 1500	0.0000	2.0408	16.3265	8.1633	2.0408	2.0408
MOC 131 1750	0.0000	2.6432	20.2643	3.0837	4.8458	0.4405

SAMPLE NAME	BULLOIDS	DIGITATA	RUBESCNS	QUINQLBA	PACHY R	DUTERTRI
MOC 126 0	0.0000	0.0000	0.0563	0.0000	0.0000	13.0068
MOC 126 12.5	0.0000	0.0000	0.0000	0.0000	0.0000	20.9302
MOC 126 25	0.0000	0.0000	0.0000	0.0000	0.0000	31.8182
MOC 126 37.5	0.0000	0.0000	0.0000	0.0000	0.0000	40.3704
MOC 126 50	0.0000	0.0000	0.0000	0.0000	0.0000	56.6298
MOC 126 70	0.0000	0.0000	0.0000	0.0000	0.0000	55.5556
MOC 126 75	0.0000	0.0000	0.0000	0.0000	0.0000	27.8638
MOC 126 87.5	0.0000	0.0000	0.0000	0.0000	0.0000	24.4019
MOC 127 0	2.1197	0.0000	0.0000	0.0000	0.0000	9.1022
MOC 127 25	0.7895	0.0000	0.0000	0.0000	0.0000	24.7368
MOC 127 50	0.2747	0.0000	0.0000	0.0000	0.0000	45.8791
MOC 127 75	1.4327	0.0000	0.0000	0.0000	0.0000	28.3668
MOC 127 100	0.0000	0.0000	0.0000	0.0000	0.0000	21.3918
MOC 127 118	0.0000	0.0000	0.0000	0.0000	0.0000	29.1339
MOC 127 150	0.0000	0.0000	0.0000	0.0000	0.0000	25.0000
MOC 127 175	0.0000	0.0000	0.0000	0.0000	0.0000	19.5652
MOC 128 0	2.4272	0.0000	0.0000	0.0000	0.0000	20.5502
MOC 128 100	0.0000	0.0000	0.0000	0.0000	0.0000	22.5722
MOC 128 200	0.0000	0.0000	0.0000	0.0000	0.0000	0.4894
MOC 128 300	0.0000	0.0000	0.0000	0.0000	0.0000	5.1370
MOC 128 400	0.0000	0.0000	0.0000	0.0000	0.0000	16.1765
MOC 128 550	0.0000	0.0000	0.0000	0.0000	0.0000	29.1667
MOC 128 700	0.0000	0.0000	0.0000	0.0000	0.0000	19.4444
MOC 128 850	0.0000	0.0000	0.0000	0.0000	0.0000	8.4112
MOC 131 0	4.4688	0.2004	0.0000	0.0000	0.0000	18.2365
MOC 131 240	1.3841	0.0000	0.0000	0.0000	0.0000	9.6886
MOC 131 500	0.0789	0.0000	0.0000	0.0000	0.0000	1.0252
MOC 131 745	1.8018	0.0000	0.0000	0.0000	0.0000	11.7117
MOC 131 1000	0.0000	1.3333	0.0000	0.0000	0.6667	15.3333
MOC 131 1250	0.0000	0.0000	0.0000	0.0000	0.0000	24.2424
MOC 131 1500	4.0816	0.0000	0.0000	0.0000	0.0000	18.3673
MOC 131 1750	1.3216	0.4405	0.0000	0.0000	0.0000	6.1674

SAMPLE NAME	CONGLOMR	HEXAGONA	OBLIQUIL	INFLATA	MENTUM	GLUTINAT
MOC 126 0	0.0000	0.0000	0.0000	0.0000	0.3941	6.3626
MOC 126 12.5	0.0000	0.0000	0.0000	0.0000	0.1938	3.8760
MOC 126 25	0.0000	0.0000	0.3497	0.0000	2.0979	1.7483
MOC 126 37.5	0.0000	0.7407	0.7407	0.0000	3.7037	2.2222
MOC 126 50	0.0000	0.0000	0.2762	0.0000	3.3149	0.0000
MOC 126 70	0.0000	0.0000	0.0000	0.0000	2.7778	5.0000
MOC 126 75	0.0000	0.0000	0.0000	0.0000	0.6192	0.0000
MOC 126 87.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.2392
MOC 127 0	0.0000	0.0000	0.0623	0.0000	0.3117	3.5536
MOC 127 25	0.0000	0.0000	0.2632	0.0000	1.3158	2.3684
MOC 127 50	0.0000	0.0000	0.8242	0.0000	3.0220	3.8462
MOC 127 75	0.0000	0.0000	0.0000	0.0000	0.2865	4.8711
MOC 127 100	0.0000	0.7732	0.0000	0.0000	0.0000	2.3196
MOC 127 118	0.0000	0.3937	0.0000	0.0000	0.7874	6.2992
MOC 127 150	0.0000	0.0000	0.0000	0.0000	0.0000	16.0714
MOC 127 175	0.0000	0.0000	1.0870	0.0000	1.0870	2.1739
MOC 128 0	0.9709	0.3236	0.6472	0.0000	0.6472	3.5599
MOC 128 100	0.5249	1.8373	0.0000	0.0000	0.2625	0.2625
MOC 128 200	0.0000	0.3263	0.0000	0.0000	0.6525	0.4894
MOC 128 300	0.0000	3.4247	0.0000	0.0000	0.6849	0.0000
MOC 128 400	0.0000	5.3922	0.0000	0.0000	1.4706	0.0000
MOC 128 550	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MOC 128 700	0.0000	0.0000	0.0000	0.0000	0.0000	0.9259
MOC 128 850	0.0000	0.0000	0.0000	0.0000	0.9346	0.9346
MOC 131 0	3.2004	4.2084	0.0000	0.0000	0.4008	3.4068
MOC 131 240	0.0000	42.9066	0.3460	0.0000	0.3460	2.4221
MOC 131 500	0.0394	0.8675	0.0394	0.0000	0.1972	0.3155
MOC 131 745	0.0000	3.6036	0.0000	0.0000	0.0000	0.9009
MOC 131 1000	0.0000	2.6667	0.0000	0.0000	4.0000	2.6667
MOC 131 1250	0.0000	0.0000	0.0000	0.0000	1.5152	0.0000
MOC 131 1500	0.0000	4.0816	0.0000	0.0000	0.0000	10.2041
MOC 131 1750	0.0000	0.0000	0.4405	0.0000	0.0000	3.0837

SAMPLE NAME	IOTA	PUMILIO	PELAGICA	H. DIGIT	UVULA	THEYERI
MOC 126 0	0.0000	0.0000	0.5068	0.0000	0.0000	0.4505
MOC 126 12.5	0.0000	0.0000	4.0698	0.0000	0.0000	0.5814
MOC 126 25	0.0000	0.0000	15.7343	0.0000	0.0000	0.6993
MOC 126 37.5	0.0000	0.0000	4.4444	0.0000	0.0000	1.4815
MOC 126 50	0.0000	0.0000	0.8287	0.0000	0.0000	14.3646
MOC 126 70	0.0000	0.0000	1.1111	0.0000	0.0000	29.4444
MOC 126 75	0.0000	0.0000	2.4768	0.0000	0.0000	54.4892
MOC 126 87.5	0.0000	0.0000	0.4785	0.0000	0.0000	65.0718
MOC 127 0	0.0000	0.0000	0.2494	0.0000	0.0000	0.8728
MOC 127 25	0.0000	0.0000	12.6316	0.0000	0.0000	2.3684
MOC 127 50	0.0000	0.0000	2.4725	0.0000	0.0000	20.6044
MOC 127 75	0.0000	0.0000	2.0057	0.0000	0.0000	52.1490
MOC 127 100	0.0000	0.0000	3.0928	0.0000	0.0000	58.5052
MOC 127 118	0.0000	0.0000	2.7559	0.0000	0.0000	46.8504
MOC 127 150	0.0000	0.0000	0.0000	0.0000	0.0000	53.5714
MOC 127 175	0.0000	0.0000	1.0870	0.0000	0.0000	65.2174
MOC 128 0	0.0000	0.0000	5.1780	0.0000	0.0000	7.4434
MOC 128 100	0.0000	0.0000	0.2625	0.0000	0.0000	68.7664
MOC 128 200	0.0000	0.0000	0.0000	0.0000	0.0000	96.5742
MOC 128 300	0.0000	0.0000	0.3425	0.0000	0.0000	88.0137
MOC 128 400	0.0000	0.0000	0.0000	0.0000	0.0000	75.4902
MOC 128 550	0.0000	0.0000	0.0000	0.0000	0.0000	58.3333
MOC 128 700	0.0000	0.0000	0.0000	0.0000	0.0000	66.6667
MOC 128 850	0.0000	0.0000	0.0000	0.0000	0.0000	67.2897
MOC 131 0	0.0000	0.0000	5.8116	0.8016	0.0000	14.2285
MOC 131 240	0.0000	0.0000	0.6920	1.3841	0.0000	6.9204
MOC 131 500	0.0000	0.0000	0.0394	0.0000	0.0000	90.6940
MOC 131 745	0.0000	0.0000	0.0000	0.0000	0.0000	44.1441
MOC 131 1000	0.0000	0.0000	1.3333	0.0000	0.0000	24.6667
MOC 131 1250	0.0000	0.0000	0.0000	0.0000	0.0000	31.8182
MOC 131 1500	0.0000	0.0000	0.0000	0.0000	0.0000	32.6531
MOC 131 1750	0.0000	0.0000	0.0000	0.0000	0.0000	57.2687

SAMPLE NAME	CAVERNUL	OTHERS
MOC 126 0	0.0000	0.0000
MOC 126 12.5	0.0000	0.0000
MOC 126 25	0.0000	0.0000
MOC 126 37.5	0.0000	0.0000
MOC 126 50	0.0000	0.0000
MOC 126 70	0.0000	0.0000
MOC 126 75	0.0000	0.0000
MOC 126 87.5	0.0000	0.0000
MOC 127 0	0.0000	0.0000
MOC 127 25	0.0000	0.0000
MOC 127 50	0.0000	0.0000
MOC 127 75	0.0000	0.0000
MOC 127 100	0.5155	0.0000
MOC 127 118	0.0000	0.0000
MOC 127 150	0.0000	0.0000
MOC 127 175	0.0000	0.0000
MOC 128 0	0.0000	0.0000
MOC 128 100	0.0000	0.0000
MOC 128 200	0.0000	0.0000
MOC 128 300	0.0000	0.0000
MOC 128 400	0.0000	0.0000
MOC 128 550	0.0000	0.0000
MOC 128 700	0.0000	0.0000
MOC 128 850	0.0000	0.0000
MOC 131 0	0.2004	0.0000
MOC 131 240	0.3460	0.0000
MOC 131 500	0.0000	0.0000
MOC 131 745	0.0000	0.0000
MOC 131 1000	0.0000	0.0000
MOC 131 1250	0.0000	0.0000
MOC 131 1500	0.0000	0.0000
MOC 131 1750	0.0000	0.0000

OBLIQUE Ø - 2ØØ M PLANKTON TOWS

SAMPLE	NAME	UNIVERSA	CONGLOBT	RUBER	SACC	AEQUILAT	CALIDA
DT 1	Ø	2.381Ø	Ø.1984	1Ø.3175	8.73Ø2	6.746Ø	Ø.9921
DT 2	Ø	1.5453	Ø.ØØØØ	11.2583	5.5188	5.7395	Ø.883Ø
DT 3	Ø	Ø.6757	Ø.ØØØØ	9.7973	5.Ø676	3.3784	Ø.9ØØ9
DT 4	Ø	Ø.7194	Ø.3Ø83	1Ø.483Ø	5.1387	2.1583	Ø.8222
DT 6	Ø	Ø.3578	Ø.1789	5.1878	4.83Ø1	2.8623	1.4311
DT 7	Ø	3.1746	Ø.ØØØØ	9.2Ø63	3.8Ø95	1.2698	Ø.9524
RT 1	Ø	Ø.738Ø	1.476Ø	23.2472	1Ø.3321	16.9742	2.952Ø
RT 3	Ø	2.1687	Ø.9639	21.4458	14.9398	13.7349	Ø.ØØØØ
RT 8	Ø	Ø.9Ø63	1.8127	14.8Ø36	13.2931	2Ø.8459	3.3233
RT13	Ø	6.5Ø41	1.626Ø	26.8293	9.7561	18.6992	Ø.ØØØØ

SAMPLE	NAME	BULLOIDS	DIGITATA	RUBESCNS	QUINQLBA	PACHY R	DUTERTRI
DT 1	Ø	Ø.7937	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	14.6825
DT 2	Ø	Ø.22Ø8	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	13.9Ø73
DT 3	Ø	1.2387	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	19.8198
DT 4	Ø	Ø.4111	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	33.9157
DT 6	Ø	Ø.1789	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	33.4526
DT 7	Ø	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	33.Ø159
RT 1	Ø	1.476Ø	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	9.5941
RT 3	Ø	Ø.7229	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	7.71Ø8
RT 8	Ø	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.3Ø21	4.5317
RT13	Ø	Ø.813Ø	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	2.439Ø

SAMPLE	NAME	CONGLOMR	HEXAGONA	OBLIQUIL	INFLATA	MENTUM	GLUTINAT
DT 1	0	0.0000	0.5952	0.0000	0.1984	2.3810	1.7857
DT 2	0	0.0000	0.4415	0.2208	0.0000	3.7528	0.6623
DT 3	0	0.0000	0.5631	0.0000	0.0000	1.4640	4.7297
DT 4	0	0.0000	0.2055	0.1028	0.0000	0.8222	1.6444
DT 6	0	0.0000	0.1789	0.0000	0.0000	1.6100	0.0000
DT 7	0	0.0000	0.0000	0.0000	0.0000	0.9524	0.0000
RT 1	0	0.0000	0.3690	1.4760	0.0000	9.9631	0.3690
RT 3	0	0.0000	0.2410	6.2651	0.0000	22.1687	0.7229
RT 8	0	0.3021	0.6042	2.1148	0.0000	16.3142	1.5106
RT13	0	1.6260	0.0000	4.8780	0.0000	12.1951	1.6260

SAMPLE	NAME	IOTA	PUMILIO	PELAGICA	H. DIGIT	UVULA	THEYERI
DT 1	0	0.0000	0.0000	5.9524	0.0000	0.0000	44.0476
DT 2	0	0.0000	0.0000	0.0000	4.4150	0.0000	51.4349
DT 3	0	0.0000	0.0000	2.1396	0.0000	0.0000	49.6622
DT 4	0	0.0000	0.0000	2.8777	0.0000	0.0000	39.9794
DT 6	0	0.0000	0.0000	1.4311	0.0000	0.0000	47.5850
DT 7	0	0.0000	0.0000	0.0000	0.0000	0.0000	47.3016
RT 1	0	0.0000	0.0000	11.8081	0.0000	0.7380	8.4871
RT 3	0	0.0000	0.0000	8.4337	0.0000	0.0000	0.4819
RT 8	0	0.0000	0.0000	17.2205	0.0000	0.0000	2.1148
RT13	0	0.0000	0.0000	9.7561	0.0000	0.0000	3.2520

SAMPLE	NAME	CAVERNUL	OTHERS
DT 1	0	0.1984	0.0000
DT 2	0	0.0000	0.0000
DT 3	0	0.5631	0.0000
DT 4	0	0.4111	0.0000
DT 6	0	0.7156	0.0000
DT 7	0	0.3175	0.0000
RT 1	0	0.0000	0.0000
RT 3	0	0.0000	0.0000
RT 8	0	0.0000	0.0000
RT13	0	0.0000	0.0000

FLOATING TRAPS

SAMPLE	NAME	UNIVERSA	CONGLOBT	RUBER	SACC	AEQUILAT	CALIDA
FT 5	30	0.0000	0.0000	16.3462	5.7692	2.8846	0.9615
FT 8	305	5.5556	0.0000	13.8889	5.5556	2.7778	0.0000
FT 9	105	0.0000	2.8571	0.0000	8.5714	2.8571	0.0000
FT11	305	1.1905	0.5952	5.3571	4.7619	5.3571	0.0000

SAMPLE	NAME	BULLOIDS	DIGITATA	RUBESCNS	QUINQLBA	PACHY R	DUTERTRI
FT 5	30	9.6154	0.9615	0.0000	0.0000	0.0000	23.0769
FT 8	305	8.3333	0.0000	0.0000	0.0000	0.0000	22.2222
FT 9	105	5.7143	0.0000	0.0000	0.0000	0.0000	20.0000
FT11	305	1.1905	0.0000	0.0000	0.0000	0.0000	61.3095

SAMPLE	NAME	CONGLOMR	HEXAGONA	OBLIQUIL	INFLATA	MENTUM	GLUTINAT
FT 5	30	0.0000	4.8077	0.0000	0.0000	0.0000	22.1154
FT 8	305	0.0000	8.3333	0.0000	0.0000	0.0000	27.7778
FT 9	105	0.0000	0.0000	0.0000	0.0000	2.8571	11.4286
FT11	305	0.0000	0.5952	1.7857	0.0000	4.1667	13.0952

SAMPLE	NAME	IOTA	PUMILIO	PELAGICA	H. DIGIT	UVULA	THEYERI
FT 5	30	0.0000	0.0000	0.0000	0.0000	0.0000	13.4615
FT 8	305	0.0000	0.0000	0.0000	0.0000	0.0000	5.5556
FT 9	105	0.0000	0.0000	0.0000	0.0000	0.0000	42.8571
FT11	305	0.0000	0.0000	0.0000	0.0000	0.0000	0.5952

SAMPLE	NAME	CAVERNUL	OTHERS
FT 5	30	0.0000	0.0000
FT 8	305	0.0000	0.0000
FT 9	105	2.8571	0.0000
FT11	305	0.0000	0.0000

MOORED TRAPS

SAMPLE	NAME	UNIVERSA	CONGLOBT	RUBER	SACC	AEQUILAT	CALIDA
MT 665	665	2.4691	Ø.ØØØØ	11.1111	1.2346	8.642Ø	1.2346
MT 935	935	Ø.ØØØØ	Ø.ØØØØ	4.9383	1.2346	11.1111	Ø.ØØØØ
MT177Ø	177Ø	1.8519	Ø.ØØØØ	5.5556	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ

SAMPLE	NAME	BULLOIDS	DIGITATA	RUBESCNS	QUINQLBA	PACHY R	DUTERTRI
MT 665	665	11.1111	Ø.ØØØØ	1.2346	Ø.ØØØØ	Ø.ØØØØ	16.Ø494
MT 935	935	16.Ø494	2.4691	Ø.ØØØØ	2.4691	Ø.ØØØØ	22.2222
MT177Ø	177Ø	5.5556	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	9.2593

SAMPLE	NAME	CONGLOMR	HEXAGONA	OBLIQUIL	INFLATA	MENTUM	GLUTINAT
MT 665	665	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	4.9383	24.6914
MT 935	935	Ø.ØØØØ	1.2346	Ø.ØØØØ	Ø.ØØØØ	1.2346	29.6296
MT177Ø	177Ø	Ø.ØØØØ	1.8519	3.7Ø37	Ø.ØØØØ	5.5556	42.5926

SAMPLE	NAME	IOTA	PUMILIO	PELAGICA	H. DIGIT	UVULA	THEYERI
MT 665	665	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	16.Ø494
MT 935	935	1.2346	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	4.9383
MT177Ø	177Ø	1.8519	1.8519	Ø.ØØØØ	Ø.ØØØØ	Ø.ØØØØ	2Ø.37Ø4

SAMPLE	NAME	CAVERNUL	OTHERS
MT 665	665	1.2346	Ø.ØØØØ
MT 935	935	1.2346	Ø.ØØØØ
MT177Ø	177Ø	Ø.ØØØØ	Ø.ØØØØ

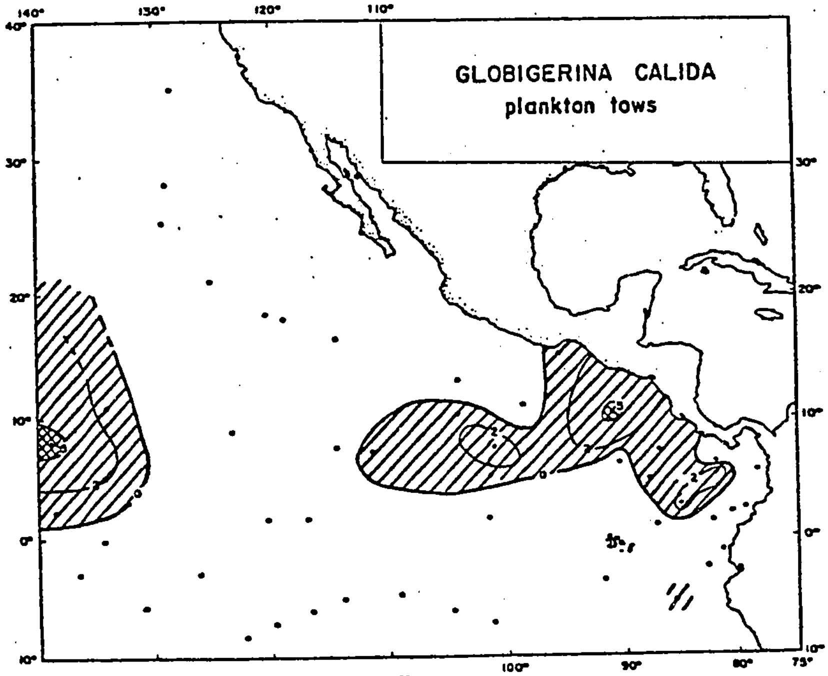
CORE TOP SEDIMENTS

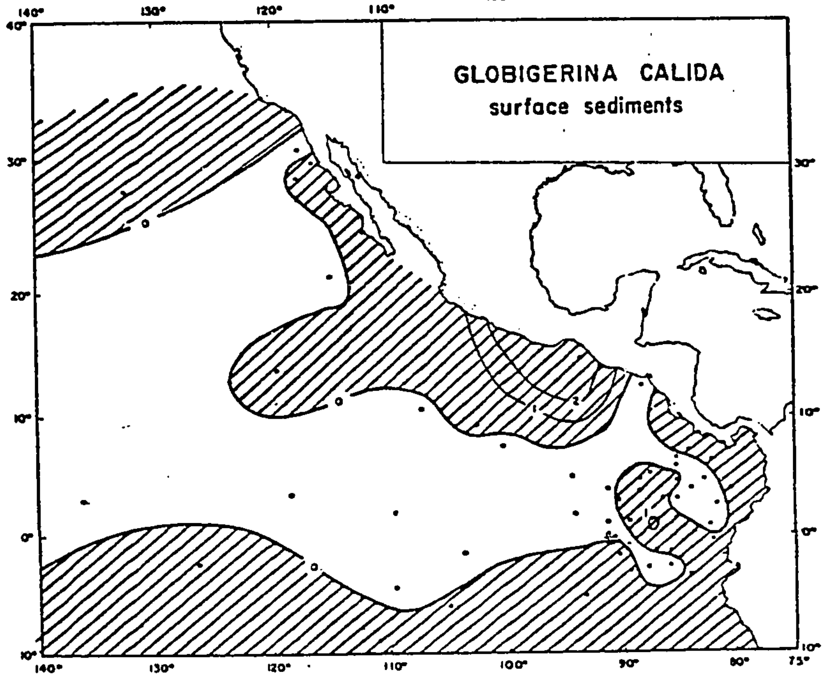
V18 353
V21 26
V21 214

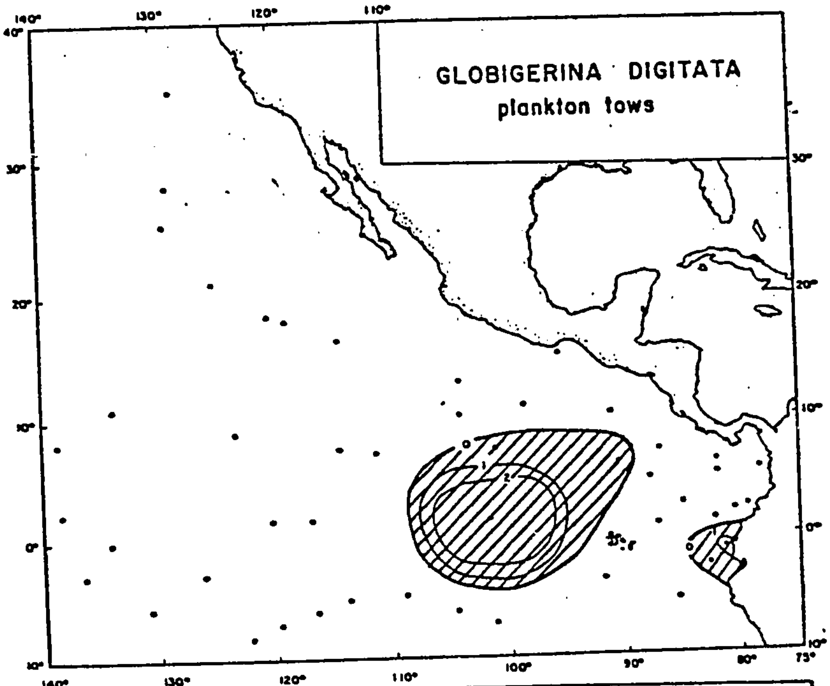
See Appendix B, tables 2 and 3.

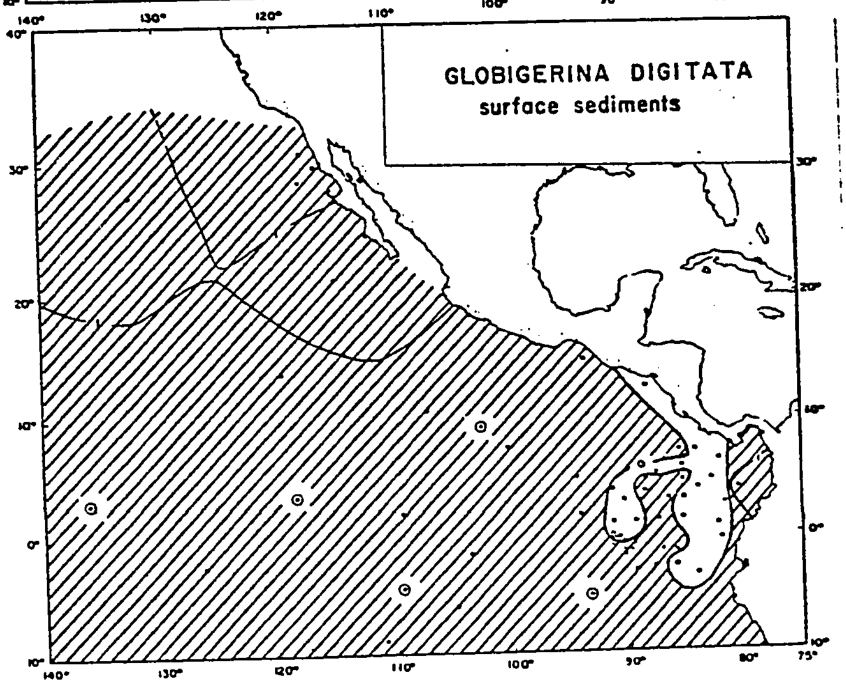
BIOGEOGRAPHIC DISTRIBUTIONS OF RARE SPECIES

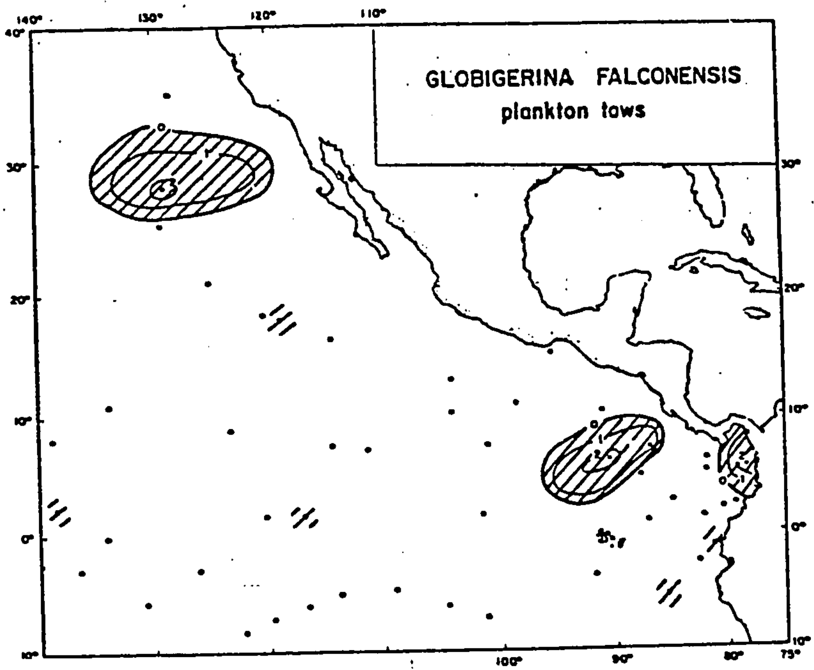
Those species (presented alphabetically) that never exceeded 15% of the total planktonic foraminiferal population have their distribution maps presented in this appendix. Species listed in appendix B with abundances consistantly below 2% are not illustrated. Contours and shading represent the percentages of total planktonic foraminifera: diagonals, Ø-2%; cross hacthed 2-5%.


GLOBIGERINA CALIDA
plankton tows
140°
130°
120°
110°
100°
90°
80°
75°
40°
30°
20°
10°
0°
10°


GLOBIGERINA CALIDA
surface sediments
140°
130°
120°
110°
100°
90°
80°
75°
40°
30°
20°
10°
0°
10°


GLOBIGERINA DIGITATA
plankton tows


GLOBIGERINA DIGITATA
surface sediments


GLOBIGERINA FALCONENSIS
plankton tows
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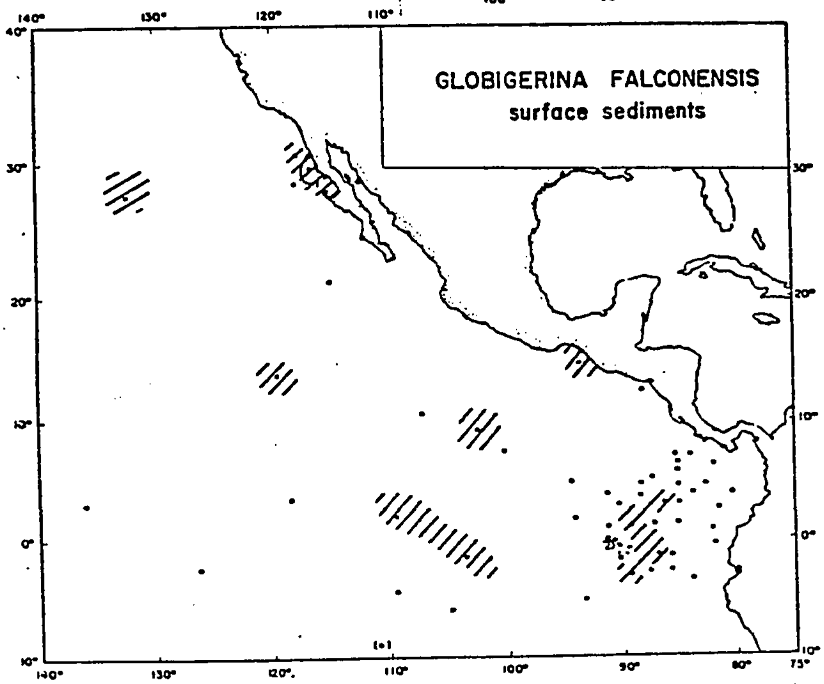
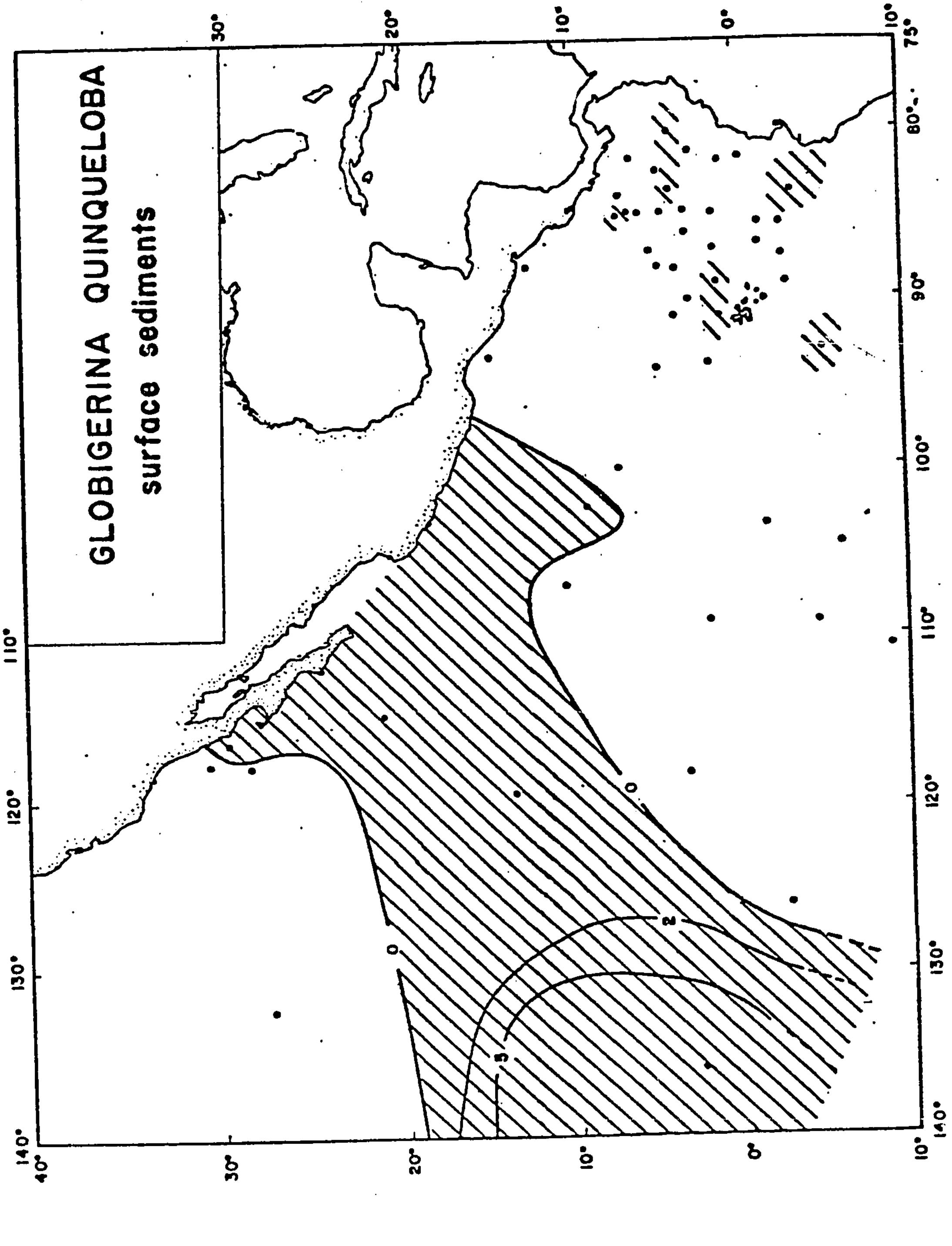
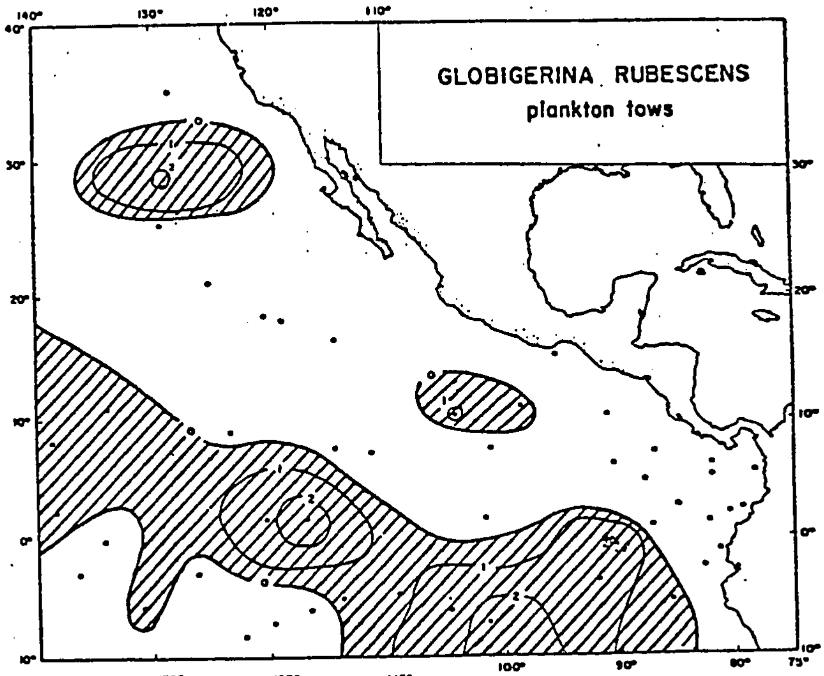
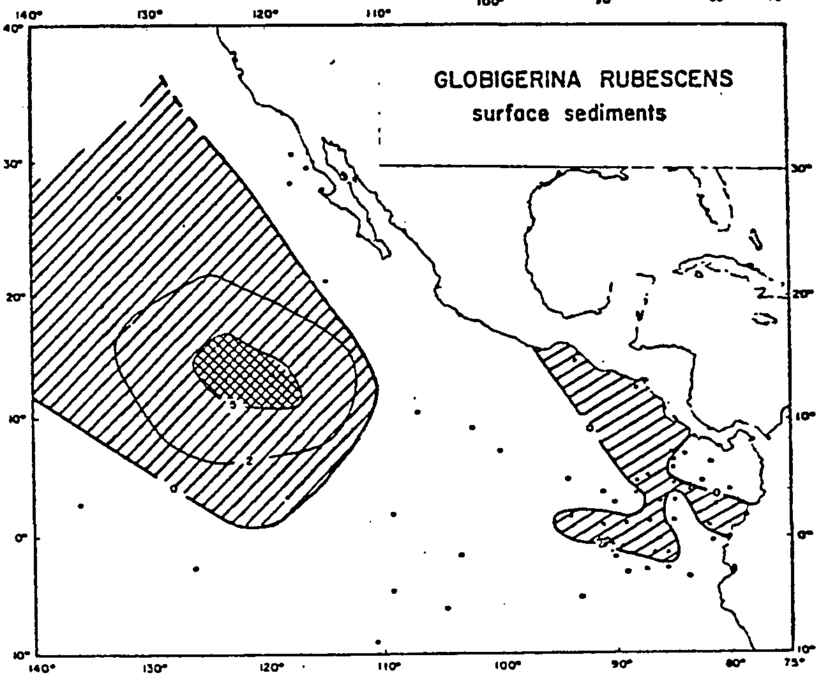
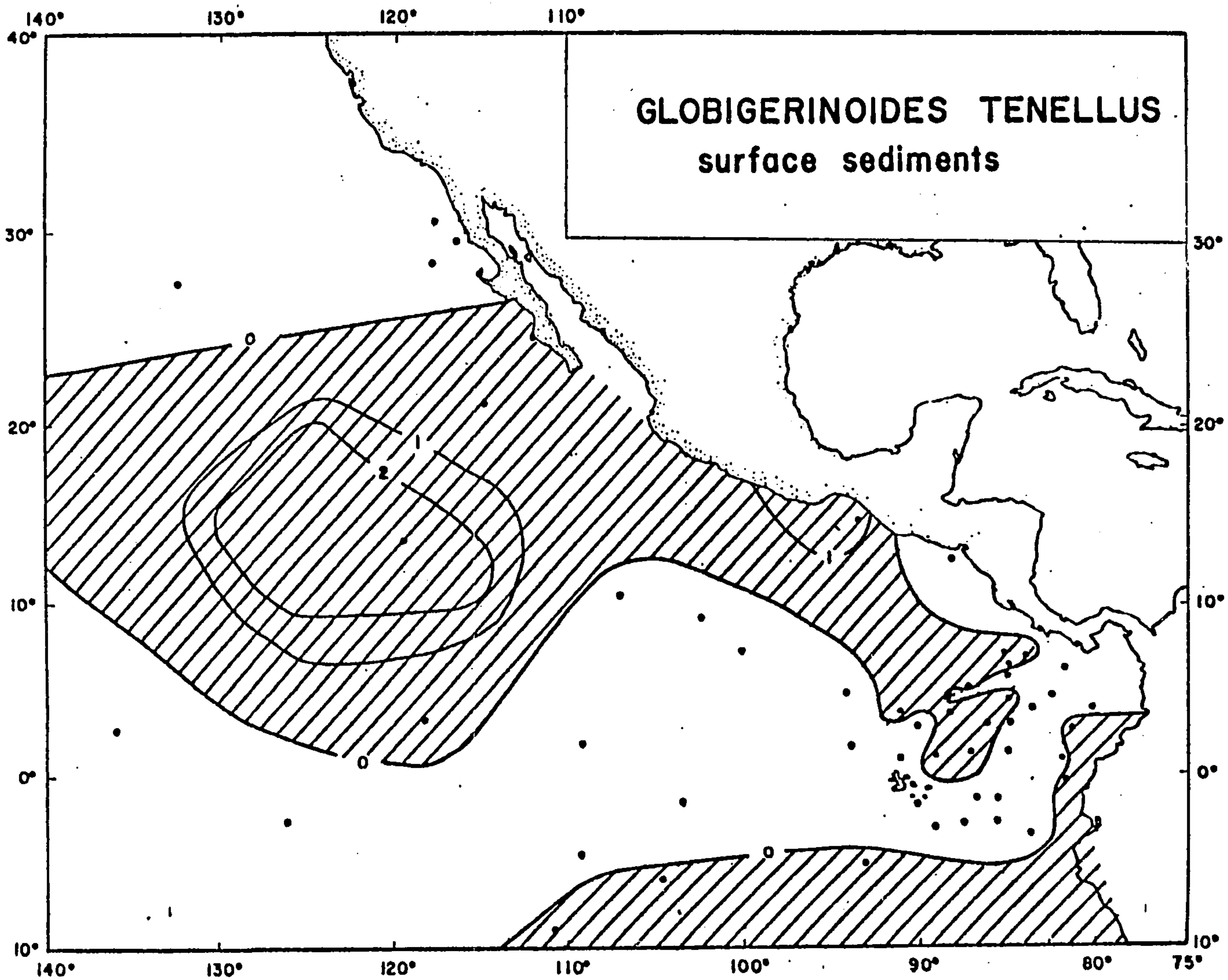
130°
120°
110°
100°
90°
80°
75°
40°
30°
20°
10°
0°
10°

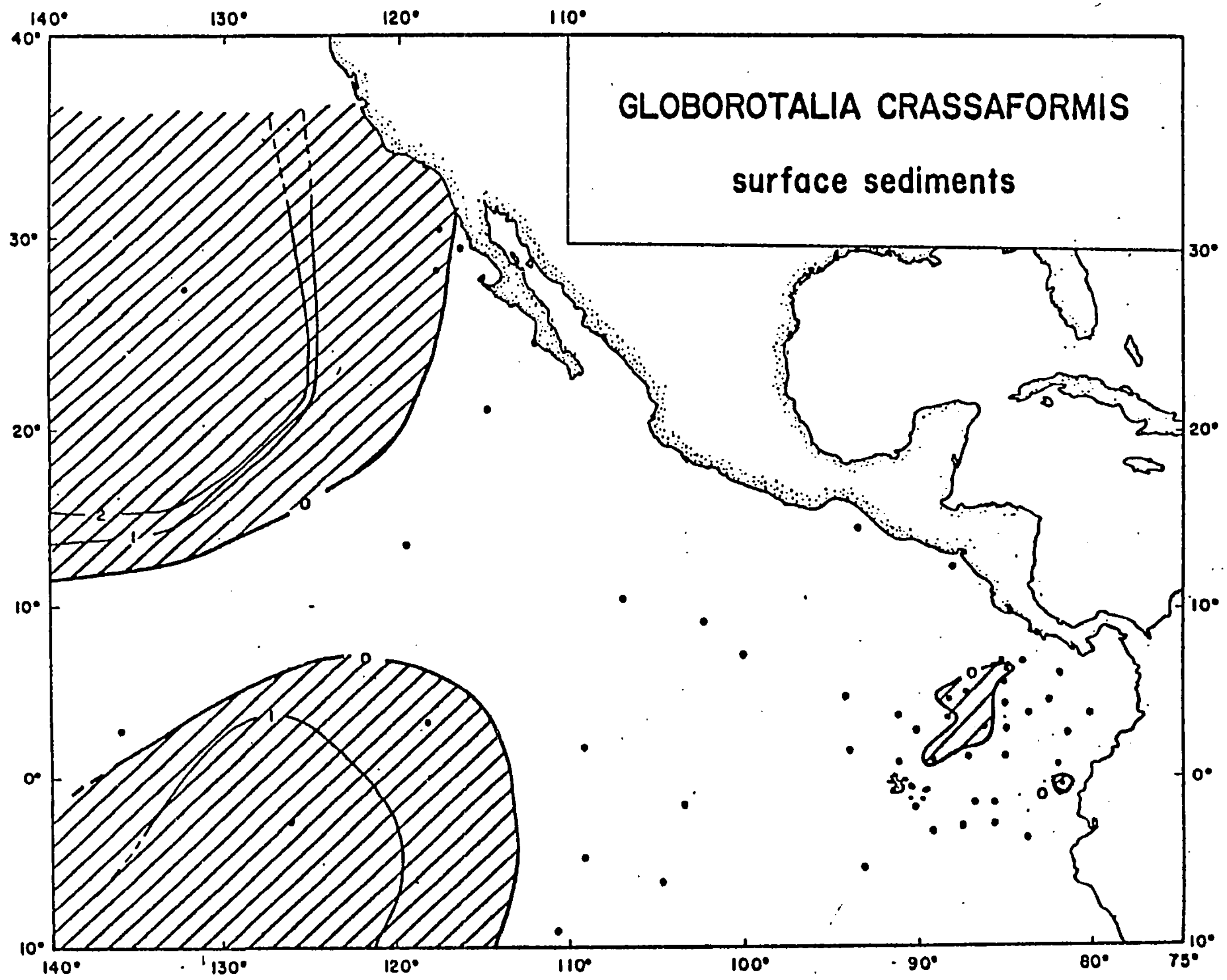

GLOBIGERINA FALCONENSIS
surface sediments
140°
130°
120°
110°
100°
90°
80°
75°
40°
30°
20°
10°
0°
10°


GLOBIGERINA QUINQUELOBA
surface sediments


GLOBIGERINA RUBESCENS
plankton tows


GLOBIGERINA RUBESCENS
surface sediments


GLOBIGERINOIDES TENELLUS
surface sediments
140°
130°
120°
110°
100°
90°
80°
75°
40°
30°
20°
10°
0°
10°
0
1
2


GLOBOROTALIA CRASSAFORMIS
surface sediments
140°
130°
120°
110°
100°
90°
80°
75°
40°
30°
20°
10°
0°
10°

WINTER SEA-SURFACE TEMPERATURES (Tw)

Sample	Observed *	Predicted	Residual
V 15 23	26.60	26.84	-0.24
V 15 29	26.50	26.37	0.13
V 15 30	25.80	25.58	0.22
V 18312	24.60	25.00	-0.40
V 18318	25.00	25.17	-0.17
V 18350	26.30	24.88	1.42
V 18353	26.70	25.34	1.36
V 19 25	25.60	23.88	1.72
V 19 27	24.30	23.65	0.65
V 19 29	20.70	23.10	-2.40
V 20 15	26.53	26.83	-0.30
V 21 26	26.20	24.47	1.73
V 21 28	25.20	24.03	1.17
V 21 29	23.50	22.86	0.64
V 21 31	21.30	23.76	-2.46
V 21 34	21.70	23.45	-1.75
V 21 39	23.33	24.85	-1.52
V 21 41	23.33	23.59	-0.26
V 21210	25.20	25.35	-0.15
V 21212	25.40	24.85	0.55
V 21214	26.20	24.06	2.14
V 24 48	25.00	24.61	0.39
V 28134	26.60	26.23	0.37
V 28144	26.10	25.24	0.86
V 28146	25.50	25.78	-0.28
V 28147	25.30	24.28	1.02
V 28148	25.70	25.98	-0.28
V 28152	27.20	25.50	1.70
V 28153	27.50	25.84	1.66
V 28168	24.00	24.92	-0.92
V 32102	26.43	26.29	0.14
RC 8102	22.40	22.51	-0.11
RC 8103	24.80	23.55	1.25
RC 9 67	25.00	23.51	1.49
RC 10 52	25.80	25.31	0.49
RC 10 54	25.80	26.58	-0.78
RC 10 56	24.70	23.97	0.73
RC 11230	24.25	25.25	-1.00
RC 11238	22.30	22.78	-0.48
RC 12 33	25.40	25.47	-0.07
RC 12 45	21.50	24.53	-3.03
RC 13108	21.30	23.48	-2.18
RC 13113	22.22	23.19	-0.97
RC 13122A	27.50	25.56	1.94

RC 13136	26.2Ø	26.17	Ø.Ø3
RC 13138	24.3Ø	22.95	1.35
RC 1314Ø	21.1Ø	25.29	-4.19
RC 18 47	21.4Ø	23.17	-1.77
SOB 31A	16.77	17.36	-Ø.59
FANHMS2G	15.96	15.Ø8	Ø.88
FANHMS4G	16.75	16.68	Ø.Ø9
RIS 121V	18.55	18.38	Ø.17

* Data from D. Hahn (unpublished), Geophysical Fluid Dynamics Laboratory, Princeton University

SUMMER SEA-SURFACE TEMPERATURES (Ts)

Sample	Observed *	Predicted	Residual
V 15 23	27.70	27.78	-0.08
V 15 29	28.20	27.82	0.38
V 15 30	27.90	27.46	0.44
V 18312	25.28	27.35	-2.07
V 18318	26.20	27.36	-1.16
V 18350	28.20	27.11	1.08
V 18353	27.70	27.31	0.39
V 19 25	26.60	26.78	-0.18
V 19 27	26.10	26.67	-0.57
V 19 29	26.50	26.41	0.09
V 20 15	27.92	27.99	-0.07
V 21 26	27.60	26.99	0.61
V 21 28	27.80	26.78	1.02
V 21 29	27.00	26.16	0.84
V 21 31	26.10	26.70	-0.60
V 21 34	26.10	26.49	-0.39
V 21 39	26.11	27.12	-1.01
V 21 41	26.00	26.57	-0.57
V 21210	27.90	27.45	0.45
V 21212	27.50	27.26	0.24
V 21214	26.50	26.88	-0.38
V 24 48	26.30	27.01	-0.71
V 28134	27.90	27.75	0.15
V 28144	27.90	27.43	0.47
V 28146	28.00	27.57	0.43
V 28147	27.70	26.98	0.72
V 28148	28.20	27.67	0.53
V 28152	27.35	27.54	-0.19
V 28153	28.00	27.64	0.36
V 28168	28.00	27.39	0.61
V 32102	26.82	27.85	-1.03
RC 8102	25.50	25.75	-0.25
RC 8103	26.90	26.65	0.25
RC 9 67	26.50	26.65	-0.15
RC 10 52	27.70	27.45	0.25
RC 10 54	27.90	27.89	0.01
RC 10 56	27.70	26.69	1.01
RC 11230	26.11	27.39	-1.28
RC 11238	26.40	26.09	0.31
RC 12 33	28.20	27.43	0.77
RC 12 45	27.00	26.66	0.34
RC 13108	25.20	26.58	-1.38
RC 13113	26.00	26.43	-0.43
RC 13122	28.33	27.59	0.74

RC 13136	27.50	27.74	-0.24
RC 13138	27.40	26.19	1.21
RC 13140	26.50	27.35	-0.85
RC 18 47	26.50	26.44	0.06
SOB 31A	20.16	20.75	-0.59
FANHMS2G	20.19	19.74	0.45
FANHMS4G	20.70	20.80	-0.10
RIS 121V	21.20	21.16	0.04

* Data from D. Hahn (unpublished), Geophysical Fluid Dynamics Laboratory, Princeton University

WINTER MIXED LAYER DEPTHS (Dmw)

Sample	Observed *	Predicted	Residual
V 15 23	26.00	19.57	6.43
V 15 29	30.00	38.45	-8.45
V 15 30	32.00	35.40	-3.40
V 18312	72.00	55.51	16.49
V 18318	60.00	43.50	16.50
V 18350	30.00	49.44	-19.44
V 18353	23.00	23.59	-0.59
V 19 25	30.00	30.79	-0.79
V 19 27	21.00	35.88	-14.88
V 19 29	41.00	31.55	9.45
V 20 15	20.00	33.31	-13.31
V 21 26	37.00	27.71	9.29
V 21 28	31.00	33.02	-2.02
V 21 29	27.00	36.50	-9.50
V 21 31	25.00	28.22	-3.22
V 21 34	50.00	35.82	14.18
V 21 39	70.00	41.44	28.56
V 21 41	70.50	41.19	29.31
V 21210	38.00	40.50	-2.50
V 21212	36.00	41.58	-5.58
V 21214	28.00	34.68	-6.68
V 24 48	40.00	34.46	5.54
V 28134	20.50	33.35	-12.85
V 28144	35.00	60.06	-25.06
V 28146	37.00	46.77	-9.77
V 28147	36.00	39.19	-3.19
V 28148	40.50	45.63	-5.13
V 28152	50.00	44.19	5.81
V 28153	49.00	40.43	8.57
V 28168	68.00	70.57	-2.57
V 32102	83.00	48.69	34.31
RC 8102	20.00	38.62	-18.62
RC 8103	39.00	32.68	6.32
RC 9 67	40.00	33.54	6.46
RC 10 52	31.00	42.97	-11.97
RC 10 54	38.00	49.70	-11.70
RC 10 56	21.00	30.93	-9.93
RC 11230	81.00	52.15	28.85
RC 11238	19.50	36.82	-17.32
RC 12 33	28.00	43.88	-15.88
RC 12 45	60.00	54.35	5.65
RC 13108	44.00	31.81	12.19
RC 13113	30.00	34.29	-4.29
RC 13122	50.00	56.35	-6.35

RC 13136	43.50	40.59	2.91
RC 13138	28.00	38.03	-10.03
RC 13140	42.00	36.65	5.35
RC 18 47	30.00	31.53	-1.53
SOB 31A	68.00	64.52	3.48
FANHMS2G	74.00	79.63	-5.63
FANHMS4G	76.00	68.49	-7.51
RIS 121V	95.00	95.95	-0.95

* Data from Wyrtki (1964b)

SUMMER MIXED LAYER DEPTHS (Dms)

Sample	Observed *	Predicted	Residual
V 15 23	11.00	11.92	-0.92
V 15 29	21.00	26.81	-5.81
V 15 30	22.50	23.59	-1.09
V 18312	69.00	37.71	31.29
V 18318	55.00	29.32	25.68
V 18350	20.50	32.96	-12.46
V 18353	19.00	13.79	5.21
V 19 25	20.50	17.49	3.01
V 19 27	9.50	21.15	-11.65
V 19 29	9.50	16.67	-7.17
V 20 15	19.00	23.37	-4.37
V 21 26	21.00	15.89	5.11
V 21 28	18.00	19.41	-1.41
V 21 29	18.00	20.01	-2.01
V 21 31	19.00	15.13	3.87
V 21 34	29.00	20.63	8.37
V 21 39	41.00	27.14	13.86
V 21 41	48.00	25.06	22.94
V 21210	21.00	27.32	-6.32
V 21212	20.50	27.51	-7.01
V 21214	19.50	20.94	-1.44
V 24 48	26.50	21.43	5.07
V 28134	19.50	22.84	-3.34
V 28144	21.50	40.81	-19.31
V 28146	21.50	32.20	-10.70
V 28147	21.00	24.83	-3.83
V 28148	23.00	31.64	-8.64
V 28152	29.50	30.24	-0.74
V 28153	29.00	27.79	1.21
V 28168	34.00	46.98	-12.98
V 32102	80.00	34.03	45.97
RC 8102	14.00	20.60	-6.60
RC 8103	17.00	18.46	-1.46
RC 9 67	15.00	19.11	-4.11
RC 10 52	22.00	29.12	-7.12
RC 10 54	22.00	34.54	-12.54
RC 10 56	19.00	17.52	1.48
RC 11230	59.90	34.98	24.92
RC 11238	11.00	20.04	-9.04
RC 12 33	18.00	29.77	-11.77
RC 12 45	20.50	35.65	-15.15
RC 13108	19.00	17.56	1.44
RC 13113	23.00	19.02	3.98
RC 13122	40.00	38.74	1.26

RC 13136	24.00	28.17	-4.17
RC 13138	21.00	21.35	-0.35
RC 13140	15.00	24.20	-9.20
RC 18 47	11.00	16.77	-5.77
SOB 31A	27.00	22.53	4.47
FANHMS2G	28.00	29.86	-1.86
FANHMS4G	28.00	26.40	-1.60
RIS 121V	50.00	50.40	-0.40

* Data from Wyrtki (1964b).

WINTER DEPTHS OF THE CENTER OF THE EUPHOTIC PORTION OF THE THERMOCLINE (Dthw)

Sample	Observed *	Predicted	Residual
V 15 23	39.50	35.93	3.57
V 15 29	53.00	64.46	-11.46
V 15 30	54.00	59.91	-5.91
V 18312	120.00	87.07	32.92
V 18318	95.00	71.60	23.40
V 18350	51.00	79.35	-28.35
V 18353	48.00	41.46	6.54
V 19 25	50.00	50.59	-0.59
V 19 27	38.00	58.30	-20.30
V 19 29	51.00	50.43	0.57
V 20 15	49.50	57.10	-7.60
V 21 26	49.50	46.79	2.71
V 21 28	46.00	54.60	-8.60
V 21 29	50.00	58.89	-8.89
V 21 31	38.00	46.30	-8.30
V 21 34	73.50	58.60	14.90
V 21 39	95.00	68.26	26.74
V 21 41	95.00	66.48	28.52
V 21210	60.00	67.02	-7.02
V 21212	52.00	68.07	-16.07
V 21214	48.00	56.99	-8.99
V 24 48	64.00	57.79	6.21
V 28134	50.00	57.32	-7.32
V 28144	58.50	92.08	-33.58
V 28146	59.00	75.86	-16.86
V 28147	52.00	64.19	-12.19
V 28148	67.00	74.30	-7.30
V 28152	90.00	72.10	17.90
V 28153	70.00	67.03	2.97
V 28168	90.00	102.63	-12.63
V 32102	121.00	77.67	43.33
RC 8102	50.00	62.44	-12.44
RC 8103	42.00	52.99	-10.99
RC 9 67	40.00	54.21	-14.21
RC 10 52	55.00	70.37	-15.37
RC 10 54	71.00	78.27	-7.27
RC 10 56	64.00	51.88	12.12
RC 11230	141.00	82.36	58.64
RC 11238	49.00	58.78	-9.78
RC 12 33	49.00	71.83	-22.83
RC 12 45	91.00	89.40	1.60
RC 13108	55.00	51.63	3.37
RC 13113	70.00	55.16	14.84
RC 13122	80.50	87.47	-6.97

RC 13136	73.00	67.44	5.56
RC 13138	65.00	60.92	4.08
RC 13140	51.00	61.64	-10.64
RC 18 47	70.00	50.55	19.45
SOB 31A	89.00	90.69	-1.69
FANHMS2G	99.00	106.68	-7.68
FANHMS4G	110.00	96.50	13.50
RIS 121V	195.00	196.64	-1.64

* Data from Wyrtki (1964b).

SUMMER DEPTHS OF THE CENTER OF THE
EUPHOTIC PORTION OF THE THERMOCLINE (Dths)

Sample	Observed *	Predicted	Residual
V 15 23	38.50	28.07	10.43
V 15 29	51.00	57.89	-6.89
V 15 30	47.00	51.47	-4.47
V 18312	120.00	77.44	42.56
V 18318	92.00	62.19	29.81
V 18350	50.00	68.82	-18.82
V 18353	39.50	31.55	7.95
V 19 25	40.50	37.88	2.62
V 19 27	31.00	45.04	-14.04
V 19 29	28.00	35.31	-7.31
V 20 15	40.00	51.36	-11.36
V 21 26	41.00	35.16	5.84
V 21 28	42.00	41.92	0.08
V 21 29	39.00	41.75	-2.75
V 21 31	34.00	32.87	1.13
V 21 34	42.00	43.69	-1.69
V 21 39	89.00	57.87	31.13
V 21 41	90.00	52.77	37.23
V 21210	56.00	58.56	-2.56
V 21212	45.00	58.64	-13.64
V 21214	40.50	45.03	-4.53
V 24 48	61.00	46.47	14.53
V 28134	46.00	50.28	-4.28
V 28144	50.00	82.72	-32.72
V 28146	49.00	67.76	-18.76
V 28147	45.00	52.94	-7.94
V 28148	58.00	66.78	-8.78
V 28152	54.00	64.16	-10.16
V 28153	49.00	59.61	-10.61
V 28168	80.00	92.05	-12.05
V 32102	120.00	70.96	49.04
RC 8102	20.00	42.50	-22 50
RC 8103	41.00	39.47	-1.53
RC 9 67	38.00	40.75	-2.75
RC 10 52	45.00	61.96	-16.96
RC 10 54	50.50	71.39	-20.89
RC 10 56	40.00	37.90	2.10
RC 11230	139.00	71.32	67.68
RC 11238	21.00	41.85	-20.85
RC 12 33	48.00	63.20	-15.20
RC 12 45	88.00	72.91	15.09
RC 13108	36.00	37.60	-1.60
RC 13113	51.00	40.20	10.80
RC 13122	62.00	79.30	-17.30

RC 13136	54.ØØ	6Ø.43	-6.43
RC 13138	48.ØØ	44.69	3.31
RC 1314Ø	32.ØØ	52.48	-2Ø.49
RC 18 47	4Ø.ØØ	35.61	4.39
SOB 31A	39.ØØ	33.Ø7	5.93
FANHMS2G	41.ØØ	44.85	-3.85
FANHMS4G	44.ØØ	42.55	1.45
RIS 121V	7Ø.ØØ	72.44	-2.44

* Data from Wyrtki (1964b).

WINTER TEMPERATURES AT THE CENTER OF THE EUPHOTIC PORTION OF THE THERMOCLINE (Tthw)

Sample	"Observed" *	Predicted	Residual
V 15 23	18.08	19.06	-0.98
V 15 29	18.00	17.80	0.20
V 15 30	17.00	17.66	-0.66
V 18312	15.96	16.86	-0.90
V 18318	18.34	17.19	1.15
V 18350	18.76	16.85	1.91
V 18353	18.95	18.37	0.58
V 19 25	16.60	17.69	-1.09
V 19 27	15.56	17.31	-1.75
V 19 29	19.70	17.57	2.13
V 20 15	17.68	18.20	-2.52
V 21 26	20.20	17.96	2.24
V 21 28	17.72	17.50	0.22
V 21 29	17.24	17.07	0.17
V 21 31	19.09	17.87	1.22
V 21 34	17.24	17.22	0.02
V 21 39	14.47	17.15	-2.68
V 21 41	16.16	16.92	-0.76
V 21210	17.75	17.39	0.36
V 21212	15.74	17.23	-1.49
V 21214	18.10	17.45	0.65
V 24 48	18.42	17.48	0.94
V 28134	18.05	17.96	0.09
V 28144	16.79	16.93	-0.14
V 28146	17.58	17.28	0.30
V 28147	18.10	17.21	0.89
V 28148	18.40	17.41	0.99
V 28152	15.20	17.31	-2.11
V 28153	20.65	17.56	3.09
V 28168	18.34	17.07	1.27
V 32102	18.45	17.55	0.90
RC 8102	18.30	16.74	1.56
RC 8103	16.65	17.53	-0.88
RC 9 67	17.76	17.48	0.28
RC 10 52	15.96	17.29	-1.33
RC 10 54	13.92	17.73	-3.81
RC 10 56	17.35	17.60	0.25
RC 11230	16.38	17.22	-0.84
RC 11238	11.96	17.04	-5.08
RC 12 33	16.43	17.26	-0.83
RC 12 45	16.88	16.33	0.55
RC 13108	19.93	17.56	2.37
RC 13113	16.60	17.35	-0.75
RC 13122	18.38	17.11	1.27

RC 13136	18.09	17.64	0.45
RC 13138	17.74	16.98	0.76
RC 13140	19.98	17.52	2.46
RC 18 47	15.29	17.57	-2.28
SOB 31A	14.88	14.86	0.02
FANHMS2G	14.04	13.94	0.10
FANHMS4G	14.23	14.20	0.03
RIS 121V	12.57	12.61	-0.04

* The "observed" themocline temperatures were calculated from sea-surface temperature data of Hahn (unpublished) and thermal structure data of Wyrtki (1964b). See page 19 and figure II.8.

SUMMER TEMPERATURES AT THE CENTER OF THE
EUPHOTIC PORTION OF THE THERMOCLINE (Tths)

Sample	"Observed" *	Predicted	Residual
V 15 23	21.88	21.84	0.04
V 15 29	18.57	19.61	-1.04
V 15 30	18.10	19.94	-1.84
V 18312	16.10	18.45	-2.35
V 18318	18.70	19.26	-0.56
V 18350	19.58	18.64	0.94
V 18353	21.44	21.57	-0.13
V 19 25	17.60	21.16	-3.56
V 19 27	20.70	20.54	0.16
V 19 29	21.32	21.40	-0.08
V 20 15	21.62	20.11	1.51
V 21 26	21.70	21.32	0.38
V 21 28	21.24	20.69	0.55
V 21 29	19.84	20.64	-0.80
V 21 31	22.50	21.58	0.92
V 21 34	24.02	20.54	3.48
V 21 39	20.01	19.40	0.61
V 21 41	19.33	19.78	-0.45
V 21210	18.82	19.53	-0.71
V 21212	17.72	19.53	-1.81
V 21214	18.20	20.56	-2.36
V 24 48	20.80	20.27	0.53
V 28134	19.95	20.11	-0.16
V 28144	16.95	18.25	-1.30
V 28146	17.83	18.89	-1.06
V 28147	18.74	19.92	-1.18
V 28148	18.55	19.01	-0.46
V 28152	20.02	18.18	0.84
V 28153	20.70	19.48	1.22
V 28168	19.38	18.32	1.06
V 32102	20.52	18.95	1.57
RC 8102	22.40	20.22	2.18
RC 8103	23.80	21.05	2.75
RC 9 67	25.00	20.97	4.03
RC 10 52	18.04	19.31	-1.27
RC 10 54	17.93	18.99	-1.06
RC 10 56	20.14	20.98	-0.84
RC 11230	17.58	19.05	-1.47
RC 11238	21.87	20.56	1.31
RC 12 33	22.11	19.12	2.99
RC 12 45	16.94	18.06	-1.12
RC 13108	21.29	21.15	0.14
RC 13113	18.02	20.92	-2.90
RC 13122	21.75	18.46	3.29

RC 13136	19.10	19.40	-0.30
RC 13138	19.70	20.34	-0.64
RC 13140	21.64	19.86	1.77
RC 18 47	18.64	21.36	-2.71
SOB 31A	18.42	19.19	-0.77
FANHMS2G	18.11	18.46	-0.35
FANHMS4G	19.26	18.34	0.92
RIS 121V	19.60	19.51	0.09

* The "observed" themocline temperatures were calculated from sea-surface temperature data of Hahn (unpublished) and thermal structure data of Wyrtki (1964b). See page 19 and figure II.8.

SPECIES DATA FOR CORE TOPS
EXPRESSED AS PERCENT OF RESISTANT FAUNA

SAMPLE NAME		PACHY L	PACHY R	CONGLOMR	OBLIQUIL	INFLATA	TRUNC L
V 15 23	1	0.0000	1.4286	0.0000	0.3571	0.0000	0.0000
V 15 29	1	0.0000	0.2415	0.3623	0.4831	0.0000	0.0000
V 15 30	1	0.0000	0.8130	0.0000	2.4390	0.0000	0.0000
V 18312	1	0.0000	0.3788	1.5152	10.2273	0.0000	0.0000
V 18318	1	0.0000	0.3460	1.0381	4.4983	0.3460	0.0000
V 18350	1	0.0000	3.6000	0.0000	0.0000	0.0000	0.0000
V 18353	1	0.0000	0.0000	0.0000	0.5731	0.0000	0.0000
V 19 25	1	0.0000	0.0000	0.0000	2.1739	0.0000	0.0000
V 19 27	1	0.0000	1.1494	0.0000	0.7663	0.0000	0.0000
V 19 29	1	0.0000	1.0782	0.0000	0.0000	0.0000	0.0000
V 20 15	1	0.0000	0.0000	0.0000	1.8018	0.0000	0.0000
V 21 26	1	0.0000	0.0000	0.5952	3.5714	0.0000	0.0000
V 21 28	1	0.4000	1.6000	0.0000	2.4000	0.0000	0.0000
V 21 29	1	0.3311	4.6358	0.0000	0.1656	0.6623	0.0000
V 21 31	1	0.0000	0.0000	0.0000	0.2273	0.0000	0.0000
V 21 34	1	0.0000	2.6549	0.2212	1.3274	0.6637	0.0000
V 21 39	1	0.0000	2.4096	0.4016	1.6064	0.0000	0.0000
V 21 41	1	0.0000	3.4091	0.0000	4.5455	0.0000	0.0000
V 21210	1	0.0000	0.0000	0.3650	1.8248	0.0000	0.0000
V 21212	1	0.0000	0.0000	0.0000	1.8182	0.0000	0.0000
V 21214	1	0.0000	0.2083	0.4167	2.2917	0.0000	0.0000
V 24 48	1	0.0000	1.6854	1.1236	4.4944	0.0000	0.0000
V 28134	1	0.0000	0.0000	1.1321	1.1321	0.0000	0.0000
V 28144	1	0.0000	1.2658	0.0000	1.2658	0.0000	0.0000
V 28146	1	0.0000	1.3761	1.8349	3.2110	0.0000	0.0000
V 28147	1	0.0000	0.5051	1.0101	2.5253	0.0000	0.0000
V 28148	1	0.0000	0.7614	2.0305	3.5533	0.0000	0.0000
V 28152	1	0.0000	0.0000	0.0000	1.3274	0.0000	0.0000
V 28153	1	0.0000	3.0000	0.0000	7.5000	0.0000	0.0000
V 28168	1	0.0000	0.0000	0.7042	7.7465	0.0000	0.0000
V 32102	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
RC 8102	1	0.1848	9.7967	0.1848	1.2939	0.9242	0.0000
RC 8103	1	0.0000	0.2309	0.0000	0.9238	0.0000	0.0000
RC 9 67	1	0.0000	0.0000	0.3125	1.5625	0.0000	0.0000
RC 10 52	1	0.0000	0.0000	0.0000	1.7045	0.0000	0.0000
RC 10 54	1	0.0000	1.3055	0.0000	1.3055	0.0000	0.0000
RC 10 56	1	0.0000	2.0460	0.0000	0.7673	0.7673	0.0000
RC 11230	1	0.3597	0.0000	12.2302	16.9065	0.3597	0.0000
RC 11238	1	0.2165	5.8442	0.0000	0.4329	0.0000	0.0000
RC 12 33	1	0.0000	1.6043	0.0000	0.0000	0.0000	0.0000
RC 12 45	1	0.1852	6.6667	0.9259	2.2222	0.1852	3.3333
RC 13108	1	0.0000	0.9915	0.1416	0.2833	0.0000	0.0000
RC 13113	1	0.1695	1.8644	1.1864	1.0169	0.0000	0.0000
RC 13122A	1	0.0000	0.2710	0.2710	4.0650	0.0000	0.0000

RC 13136	1	0.0000	0.6390	0.6390	1.2780	0.0000	0.0000
RC 13138	1	0.2165	5.4113	0.0000	0.0000	0.0000	0.0000
RC 13140	1	0.0000	0.9091	1.3636	1.8182	0.0000	0.0000
RC 18 47	1	0.0000	1.0736	0.0000	0.1534	0.0000	0.0000
SOB 31A	1	6.9079	54.2763	0.0000	0.0000	2.3026	0.3289
FAN HMS 2G	1	1.6648	74.9168	0.0000	0.0000	0.7769	0.0000
FAN HMS 4G	1	1.2158	58.3587	0.0000	0.0000	0.9119	0.0000
RIS 121V	1	0.7264	6.7797	2.6634	0.0000	34.8668	23.7288

SAMPLE NAME		TRUNC R	CRASSAFM	MENTUM	OUTER 5	OUTER 4
V 15 23	1	0.0000	0.0000	17.5000	42.5000	38.2143
V 15 29	1	0.0000	0.2415	34.6618	44.9275	19.0821
V 15 30	1	0.0000	0.0000	26.0163	52.8455	17.8862
V 18312	1	0.0000	1.7045	40.9091	41.2879	3.9773
V 18318	1	0.0000	0.6920	31.1419	51.5571	10.3806
V 18350	1	0.0000	0.0000	38.4000	50.8000	7.2000
V 18353	1	0.0000	0.0000	11.4613	58.7393	29.2264
V 19 25	1	0.0000	0.0000	8.3333	71.0145	18.4783
V 19 27	1	0.0000	0.1916	13.4100	71.8391	12.6437
V 19 29	1	0.0000	0.0000	2.1563	79.5148	17.2507
V 20 15	1	0.0000	0.0000	31.5315	42.3423	24.3243
V 21 26	1	0.0000	0.0000	8.9286	64.2857	22.6190
V 21 28	1	0.0000	0.0000	12.4000	66.8000	16.4000
V 21 29	1	0.0000	0.8278	7.1192	74.6689	11.5894
V 21 31	1	0.0000	0.0000	3.8636	73.8636	22.0455
V 21 34	1	0.0000	0.0000	11.2832	71.0177	12.8319
V 21 39	1	0.0000	0.0000	28.3133	55.8233	11.4458
V 21 41	1	0.0000	0.0000	18.7500	65.3409	7.9545
V 21210	1	0.0000	0.0000	30.6569	54.0146	13.1387
V 21212	1	0.0000	0.0000	29.0909	58.5455	10.5455
V 21214	1	0.0000	0.0000	14.7917	67.9167	14.3750
V 24 48	1	0.0000	0.0000	17.6966	58.9888	16.0112
V 28134	1	0.0000	0.0000	27.9245	48.3019	21.5094
V 28144	1	0.0000	0.6329	54.4304	37.9747	4.4304
V 28146	1	0.0000	0.0000	38.5321	43.1193	11.9266
V 28147	1	0.0000	0.5951	21.7172	63.1313	10.6061
V 28148	1	0.0000	0.0000	38.3249	42.1320	13.1980
V 28152	1	0.0000	0.0000	36.2832	50.8850	11.5044
V 28153	1	0.0000	0.0000	31.2500	46.2500	15.0000
V 28168	1	0.0000	0.0000	66.9014	22.5352	2.1127
V 32102	1	0.0000	0.6466	46.5517	38.5776	14.2241
RC 8102	1	0.0000	0.0000	7.2089	69.6858	10.7209
RC 8103	1	0.0000	0.0000	8.0831	74.8268	15.9353
RC 9 67	1	0.0000	0.0000	8.7500	74.6875	14.6875
RC 10 52	1	0.0000	0.0000	33.5227	53.4091	11.3636
RC 10 54	1	0.0000	0.2611	48.5640	31.3316	17.2324
RC 10 56	1	0.0000	0.0000	9.2072	68.0307	19.1816
RC 11230	1	0.0000	0.0000	30.5755	30.9353	8.6331
RC 11238	1	0.0000	0.0000	7.3593	74.6753	11.4719
RC 12 33	1	0.0000	0.0000	35.8289	50.2674	12.2995
RC 12 45	1	1.1111	0.0000	36.2963	43.8889	5.1852
RC 13108	1	0.0000	0.0000	6.3739	75.0708	17.1388
RC 13113	1	0.0000	0.0000	6.9492	75.0847	13.7288
RC 13122A	1	0.0000	0.0000	50.1355	38.2114	7.0461

RC 13136	1	0.0000	0.0000	35.4633	45.0479	16.9329
RC 13138	1	0.0000	0.0000	10.6061	73.5931	10.1732
RC 13140	1	0.0000	0.0000	25.4545	54.5455	15.9091
RC 18 47	1	0.0000	0.0000	2.9141	78.5276	17.3313
SOB 31A	1	0.6579	0.3289	0.0000	17.1053	18.0921
FAN HMS 2G	1	0.0000	0.0000	0.0000	18.4240	4.2175
FAN HMS 4G	1	0.0000	0.0000	0.0000	33.7386	5.7751
RIS 121V	1	17.6755	5.5690	2.4213	4.1162	1.4528

EASTERN EQUATORIAL PACIFIC VARIMAX FACTOR MATRIX

SAMPLE NAME	COMMUN.	FACT I	FACT II	FACT III	FACT IV	FACT V
V 15 23 1	1.0000	0.6710	0.5220	0.1490	0.0240	0.5040
V 15 29 1	0.9980	0.5840	0.7840	0.1020	0.0270	0.1780
V 15 30 1	1.0000	0.7240	0.6650	0.1210	0.0290	0.1340
V 18312 1	0.9900	0.4640	0.8730	0.0750	0.0310	-0.0750
V 18318 1	0.9990	0.6670	0.7370	0.1000	0.0360	0.0140
V 18350 1	0.9960	0.5830	0.7970	0.1400	0.0290	-0.0340
V 18353 1	1.0000	0.8410	0.4410	0.1260	0.0290	0.2840
V 19 25 1	1.0000	0.9060	0.3950	0.1180	0.0310	0.0860
V 19 27 1	1.0000	0.8810	0.4540	0.1260	0.0330	0.0050
V 19 29 1	1.0000	0.9390	0.3120	0.1300	0.0320	0.0490
V 20 15 1	1.0000	0.5880	0.7520	0.1050	0.0250	0.2790
V 21 26 1	0.9980	0.8860	0.4120	0.1220	0.0310	0.1650
V 21 28 1	1.0000	0.8770	0.4540	0.1380	0.0320	0.0680
V 21 29 1	1.0000	0.9110	0.3720	0.1720	0.0420	-0.0150
V 21 31 1	1.0000	0.9260	0.3340	0.1220	0.0310	0.1240
V 21 34 1	1.0000	0.8900	0.4300	0.1480	0.0400	0.0080
V 21 39 1	0.9990	0.7180	0.6810	0.1370	0.0310	0.0210
V 21 41 1	0.9990	0.8260	0.5380	0.1520	0.0330	-0.0540
V 21210 1	1.0000	0.6900	0.7140	0.0990	0.0300	0.0530
V 21212 1	0.9990	0.7270	0.6780	0.0990	0.0300	0.0020
V 21214 1	1.0000	0.8670	0.4820	0.1150	0.0320	0.0370
V 24 48 1	0.9980	0.8210	0.5450	0.1390	0.0330	0.0830
V 28134 1	1.0000	0.6760	0.6970	0.1090	0.0290	0.2110
V 28144 1	0.9950	0.3090	0.9440	0.0740	0.0230	-0.0470
V 28146 1	1.0000	0.5230	0.8430	0.1080	0.0280	0.0600
V 28147 1	1.0000	0.8060	0.5800	0.1120	0.0330	-0.0070
V 28148 1	1.0000	0.5180	0.8450	0.0990	0.0280	0.0850
V 28152 1	0.9980	0.6150	0.7810	0.0910	0.0280	0.0350
V 28153 1	0.9930	0.6270	0.7610	0.0970	0.0280	0.1030
V 28168 1	0.9990	0.0310	0.9970	0.0250	0.0140	-0.0500
V 32102 1	0.9950	0.4020	0.9030	0.0760	0.0240	0.1090
RC 8102 1	1.0000	0.8920	0.3750	0.2460	0.0460	-0.0240
RC 8103 1	1.0000	0.9130	0.3860	0.1180	0.0320	0.0430
RC 9 67 1	1.0000	0.9100	0.3950	0.1140	0.0320	0.0270
RC 10 52 1	0.9990	0.6580	0.7450	0.0950	0.0290	0.0270
RC 10 54 1	0.9980	0.2950	0.9330	0.0910	0.0200	0.1760
RC 10 56 1	1.0000	0.8940	0.4080	0.1470	0.0400	0.1040
RC 11230 1	0.8670	0.4310	0.8210	0.0700	0.0440	0.0270
RC 11238 1	1.0000	0.9070	0.3740	0.1880	0.0340	-0.0190
RC 12 33 1	0.9970	0.6130	0.7770	0.1180	0.0280	0.0490
RC 12 45 1	0.9970	0.5330	0.8170	0.1910	0.0710	-0.0590
RC 13108 1	1.0000	0.9200	0.3650	0.1300	0.0320	0.0580
RC 13113 1	1.0000	0.9170	0.3720	0.1380	0.0340	0.0130
RC 13122A 1	0.9990	0.3540	0.9320	0.0670	0.0230	-0.0100

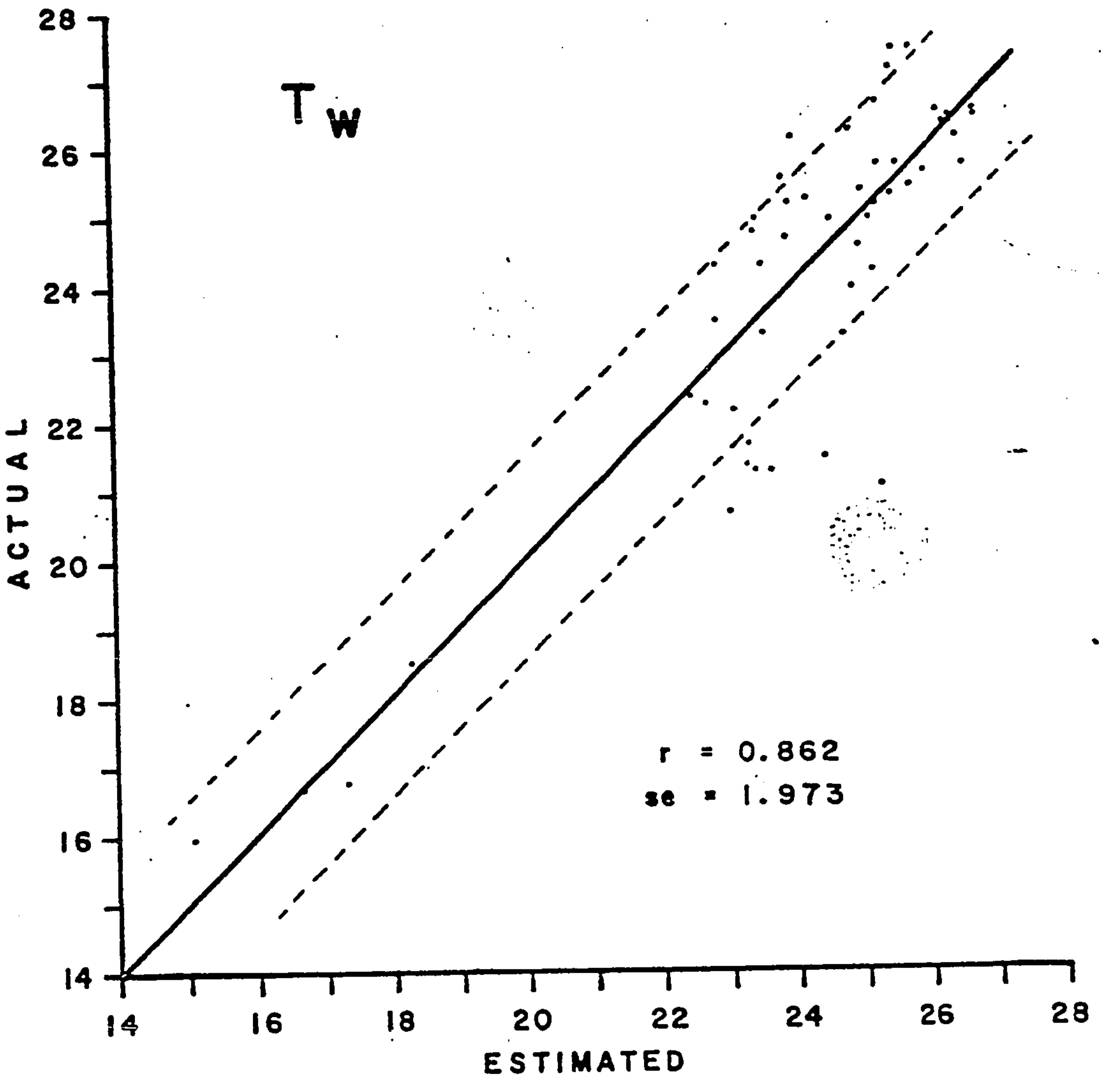
RC 13136	1	Ø.999Ø	Ø.577Ø	Ø.797Ø	Ø.1Ø6Ø	Ø.Ø27Ø	Ø.141Ø
RC 13138	1	Ø.999Ø	Ø.891Ø	Ø.414Ø	Ø.181Ø	Ø.Ø34Ø	-Ø.Ø33Ø
RC 1314Ø	1	1.ØØØØ	Ø.74ØØ	Ø.654Ø	Ø.121Ø	Ø.Ø31Ø	Ø.Ø97Ø
RC 18 47	1	1.ØØØØ	Ø.936Ø	Ø.321Ø	Ø.131Ø	Ø.Ø32Ø	Ø.Ø52Ø
SOB 31A	1	Ø.996Ø	Ø.2Ø7Ø	Ø.Ø77Ø	Ø.953Ø	Ø.Ø7ØØ	Ø.186Ø
FAN HMS 2G	1	Ø.999Ø	Ø.123Ø	Ø.Ø46Ø	Ø.998Ø	Ø.Ø41Ø	-Ø.Ø56Ø
FAN HMS 4G	1	Ø.999Ø	Ø.384Ø	Ø.123Ø	Ø.911Ø	Ø.Ø49Ø	-Ø.Ø6ØØ
RIS 121V	1	1.ØØØØ	Ø.Ø3ØØ	Ø.Ø61Ø	Ø.126Ø	Ø.99ØØ	Ø.Ø14Ø

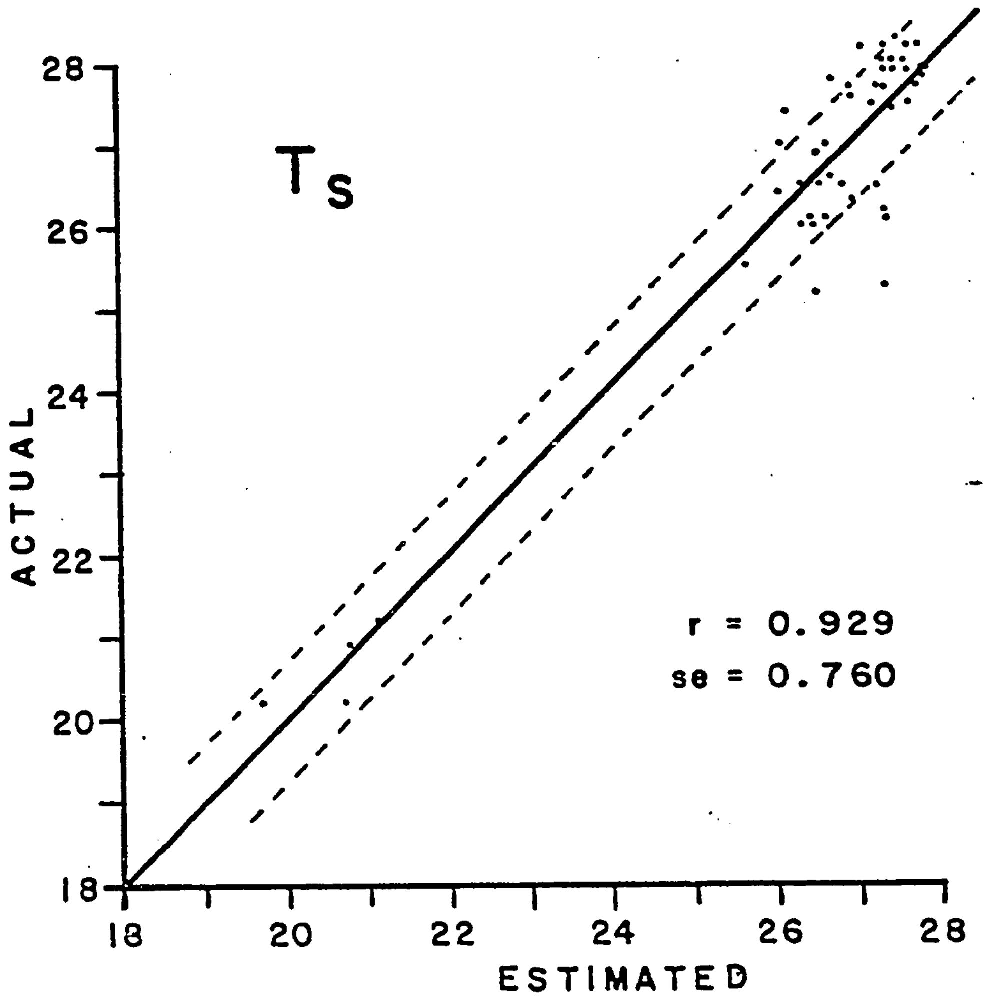
EASTERN EQUATORIAL PACIFIC MATRIX OF FACTOR SCORES

SPECIES NAME	FACT I	FACT II	FACT III	FACT IV	FACT V
PACHY L	-0.0090	-0.0030	0.0550	0.0110	0.0260
PACHY R	-0.1120	-0.0250	0.9890	0.0260	-0.0740
CONGLOMR	-0.0110	0.0300	-0.0050	0.0620	-0.0180
OBLIQUIL	-0.0170	0.0900	-0.0070	0.0030	-0.0770
INFLATA	-0.0190	-0.0130	-0.0160	0.7530	0.0140
TRUNC L	-0.0140	-0.0040	-0.0220	0.5150	-0.0030
TRUNC R	-0.0100	-0.0050	-0.0150	0.3830	0.0050
CRASSAFM	-0.0040	0.0030	-0.0040	0.1200	-0.0060
MENTUM	-0.2860	0.9530	-0.0100	0.0030	-0.0210
DUTER 5	0.9410	0.2780	0.1010	0.0330	-0.1610
DUTER 4	0.1390	0.0720	0.0890	-0.0020	0.9800

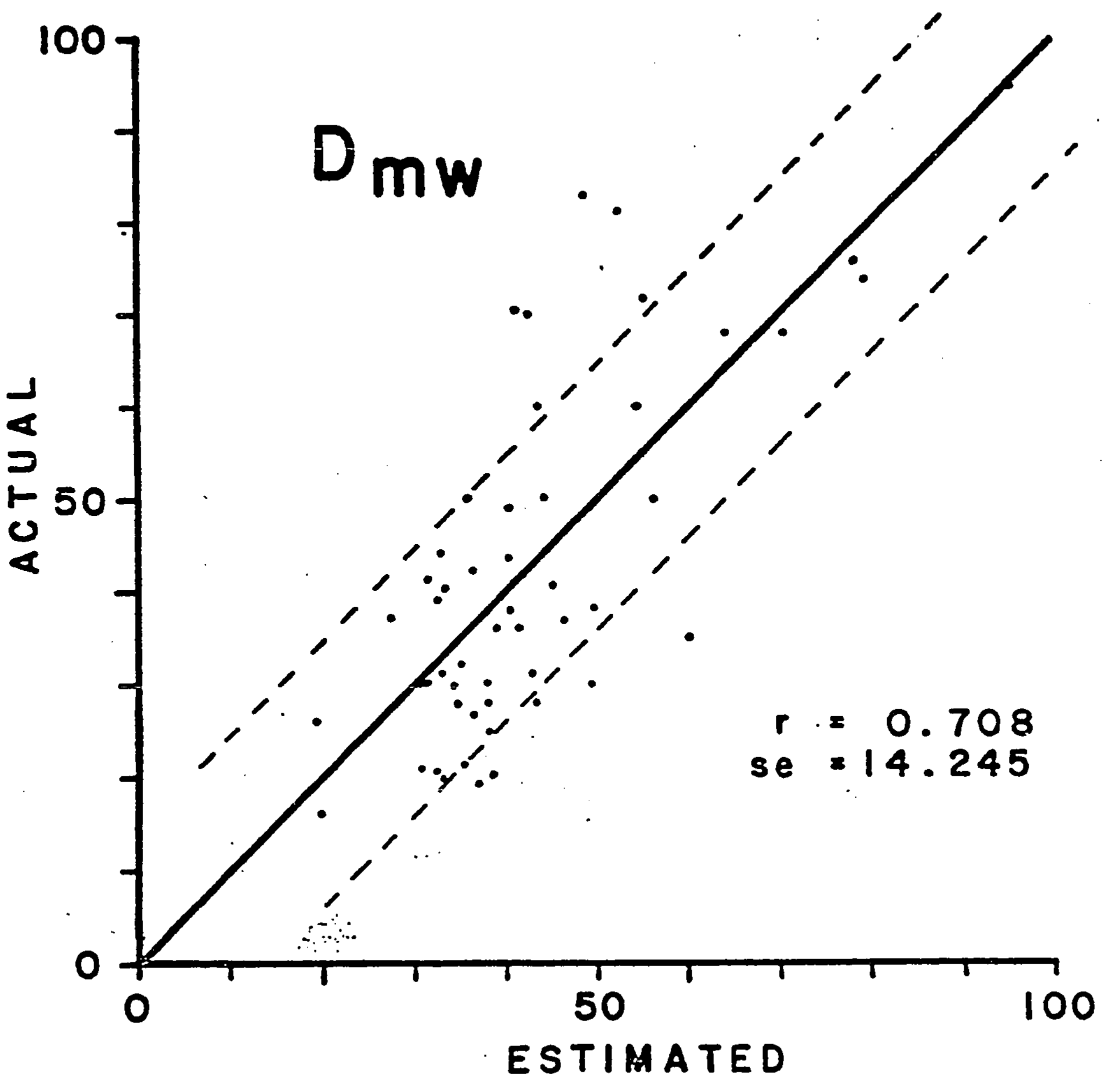
ANALYSIS OF TRANSFER FUNCTION RESIDUALS

Scatter plots of observed vs. predicted values for each core site in each paleoecologic equation (transfer function) discussed in the text. Non-random scatter suggests regions of incorrect estimations. The regions of either over-prediction or under-prediction by each equation are shown on a series of maps. Only residuals which exceed plus or minus one standard error of estimate have been plotted. Positive values indicate regions of underestimation, and negative values indicate overestimations.

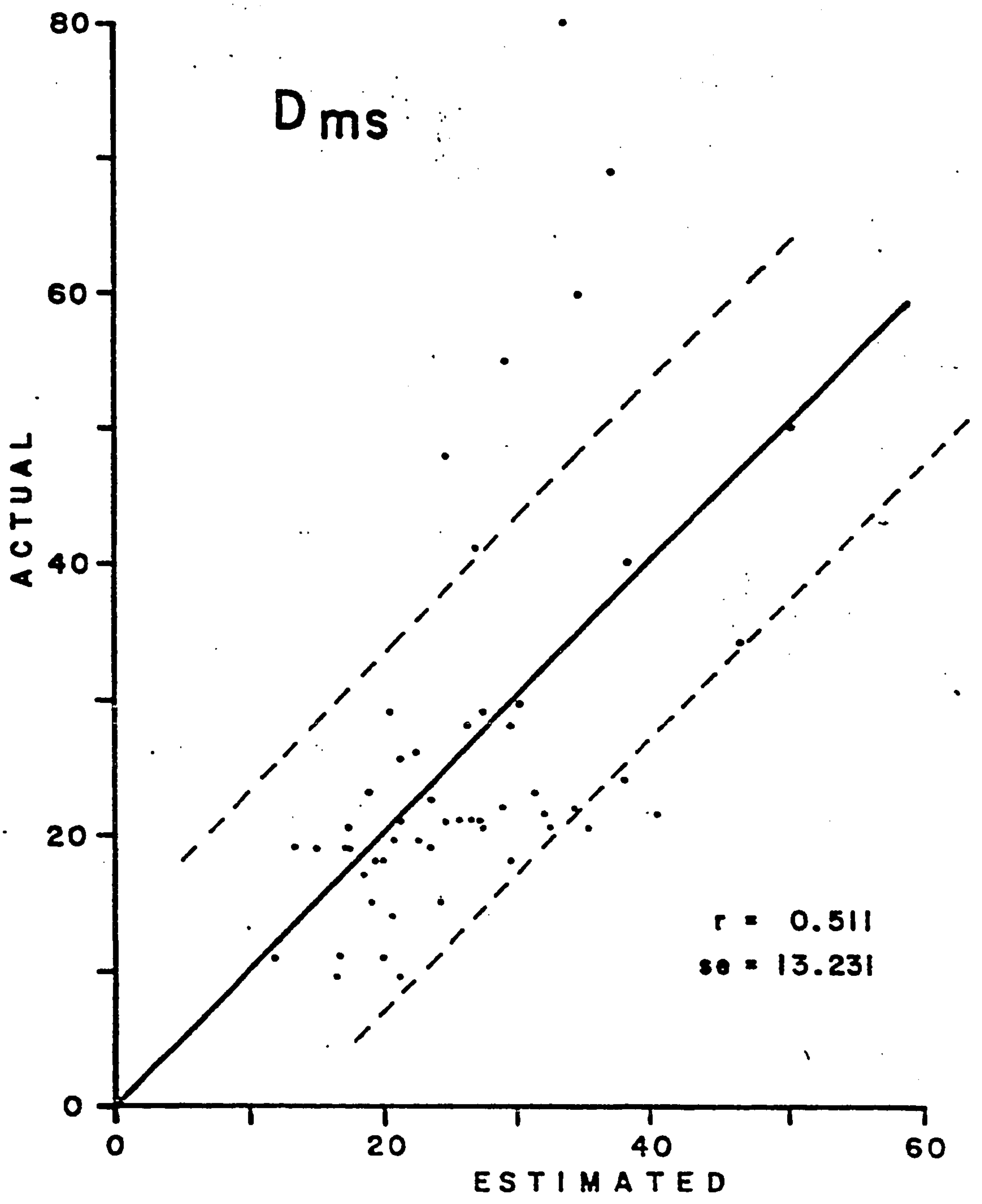

T w
r = 0.862
se = 1.973
ACTUAL
ESTIMATED
28
26
24
22
20
18
16
14
14
16
18
20
22
24
26
28

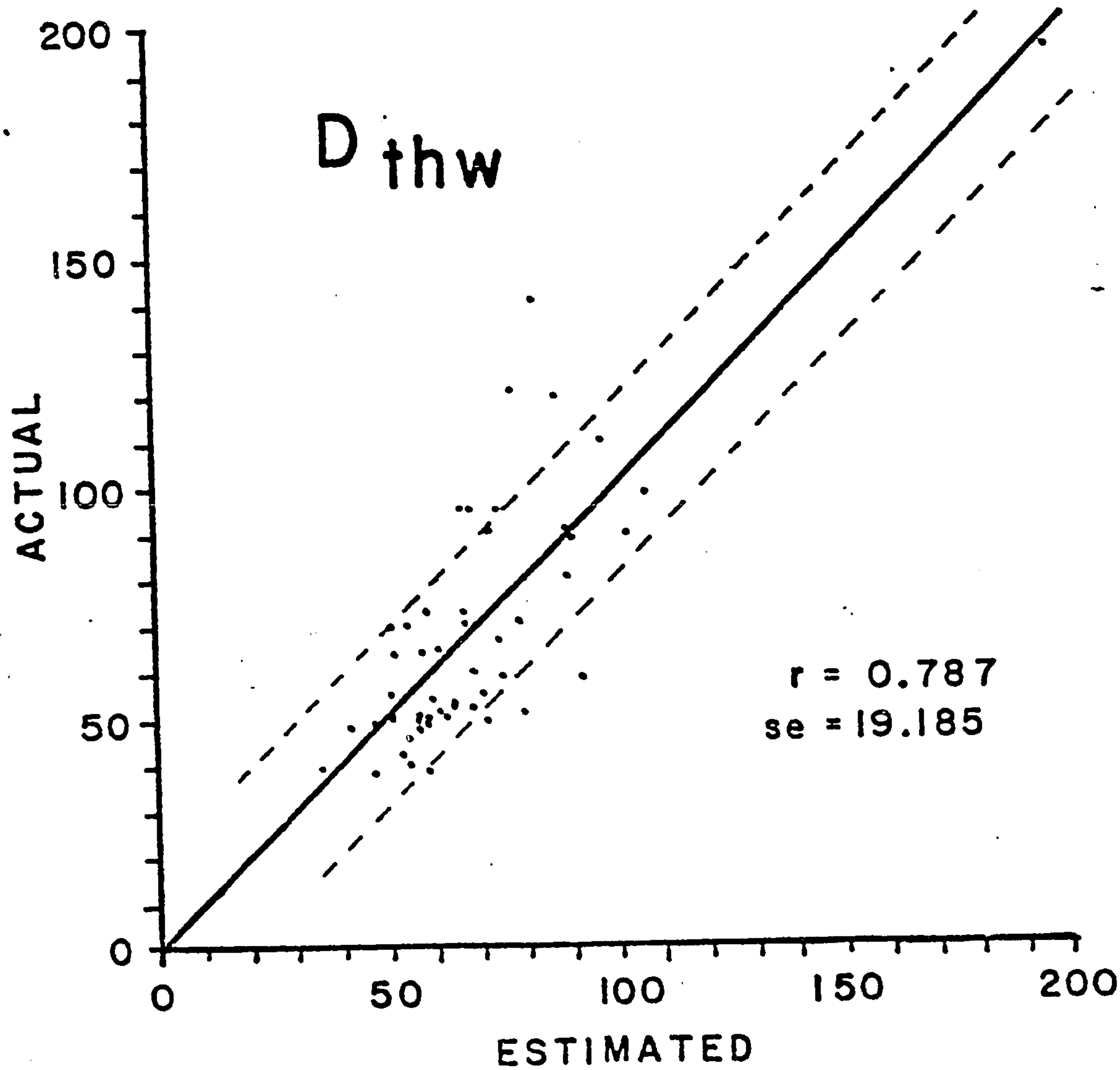


Ts
r = 0.929
se = 0.760
ACTUAL
ESTIMATED
18
20
22
24
26
28

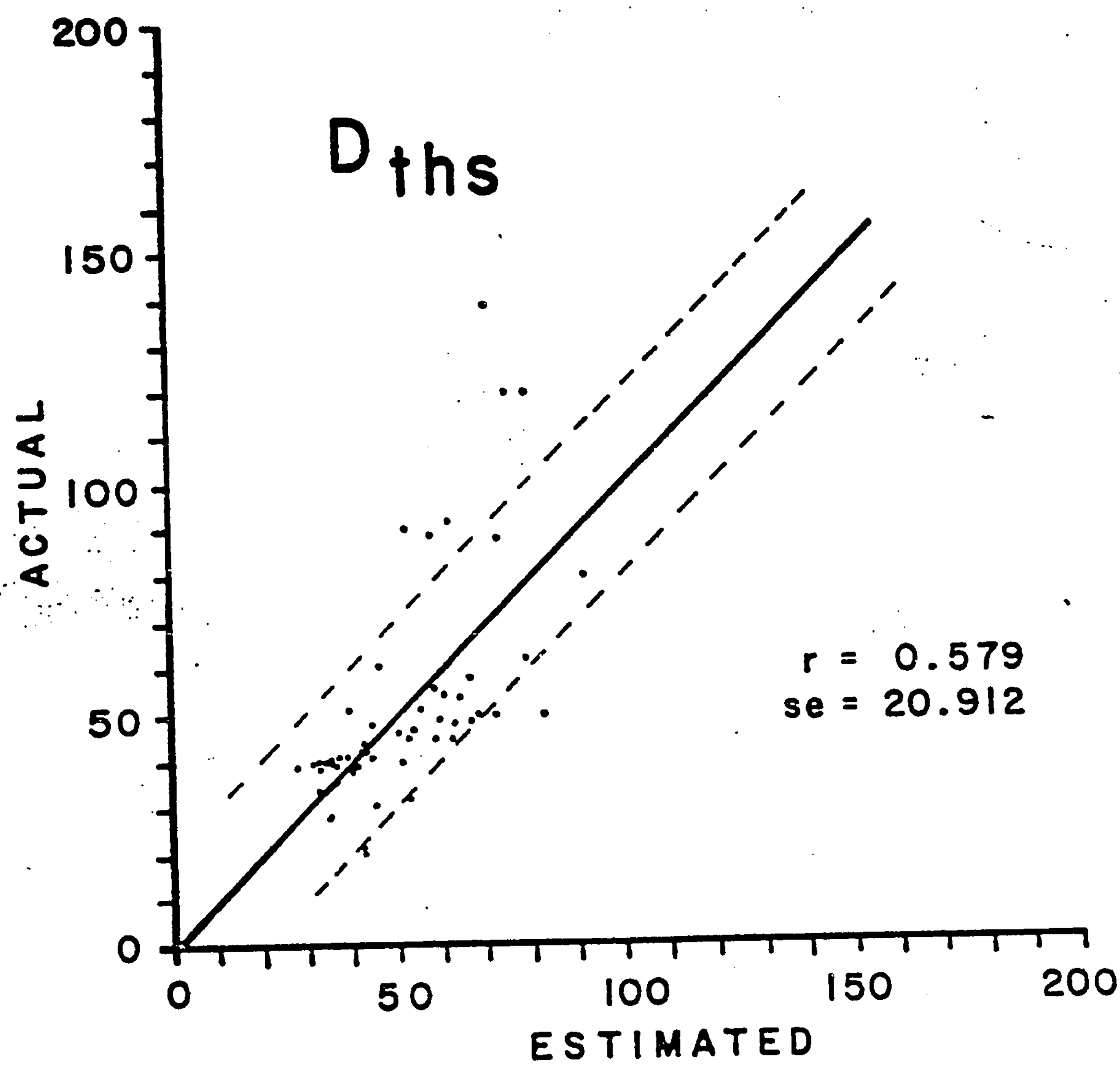


Dmw
ACTUAL
ESTIMATED
100
50
0
0
50
100
r = 0.708
se = 14.245

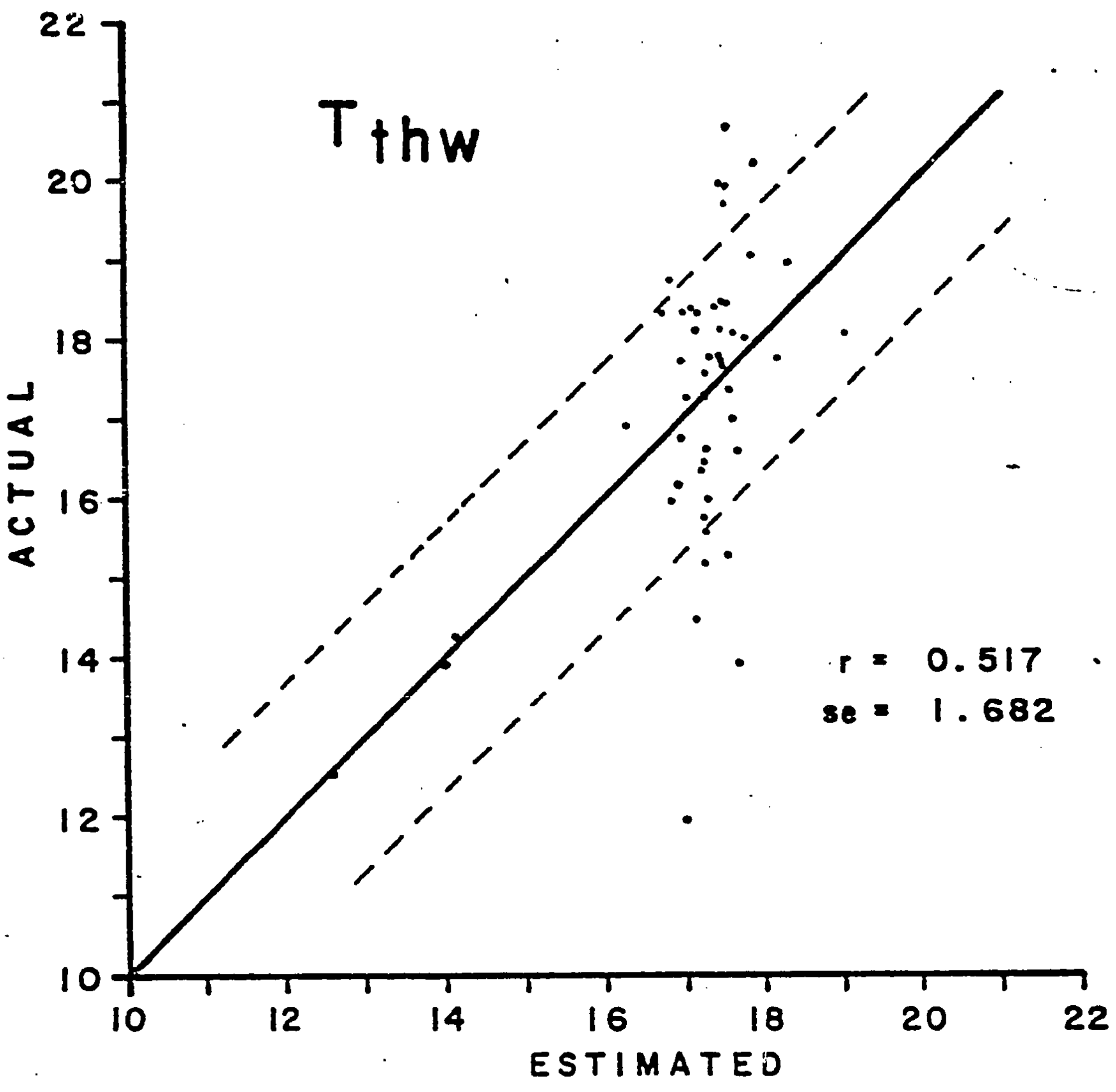

Dms
ACTUAL
ESTIMATED
0
20
40
60
80
r = 0.511
se = 13.231

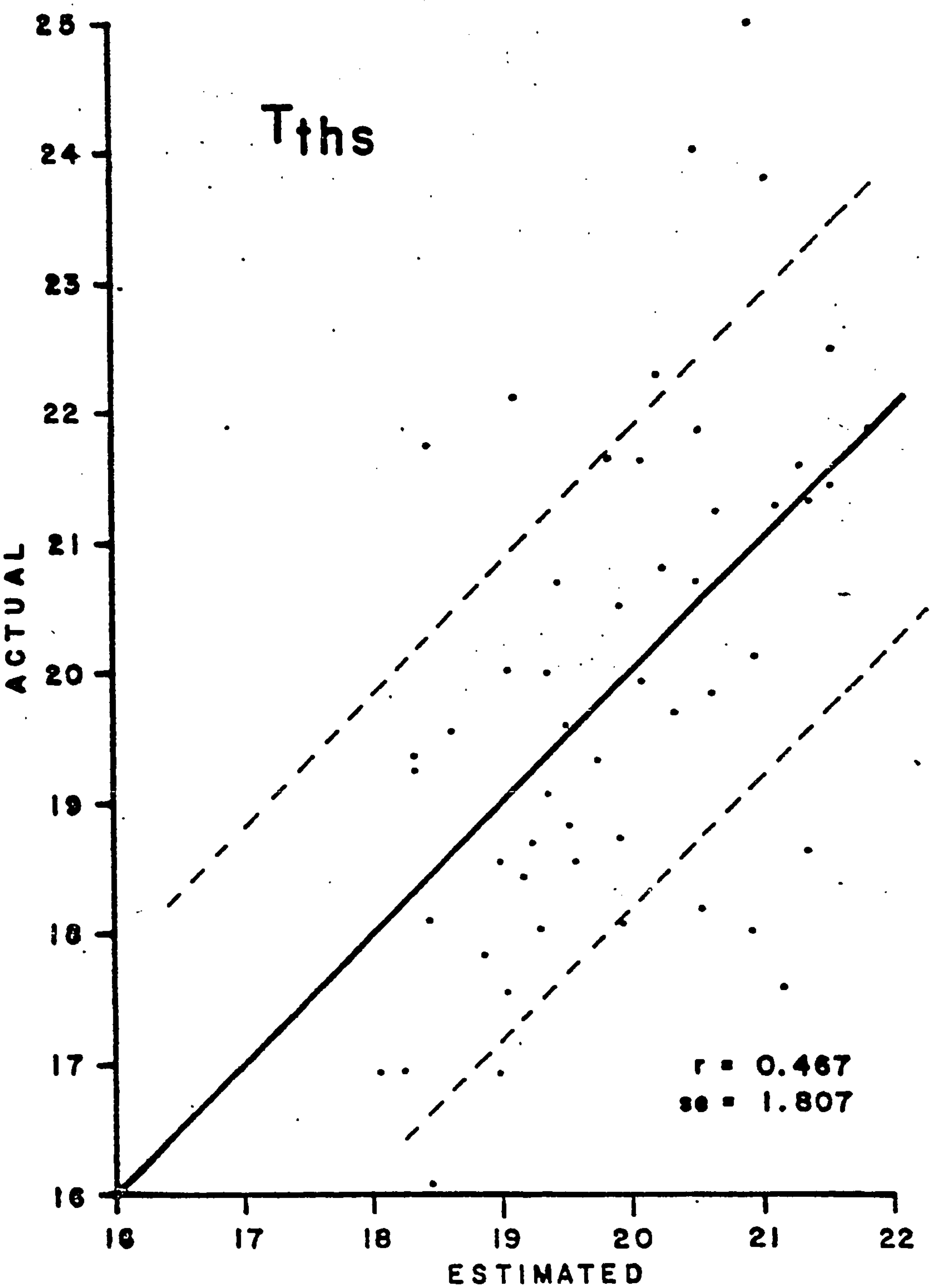


D thw
ACTUAL
ESTIMATED
r = 0.787
se = 19.185
0
50
100
150
200

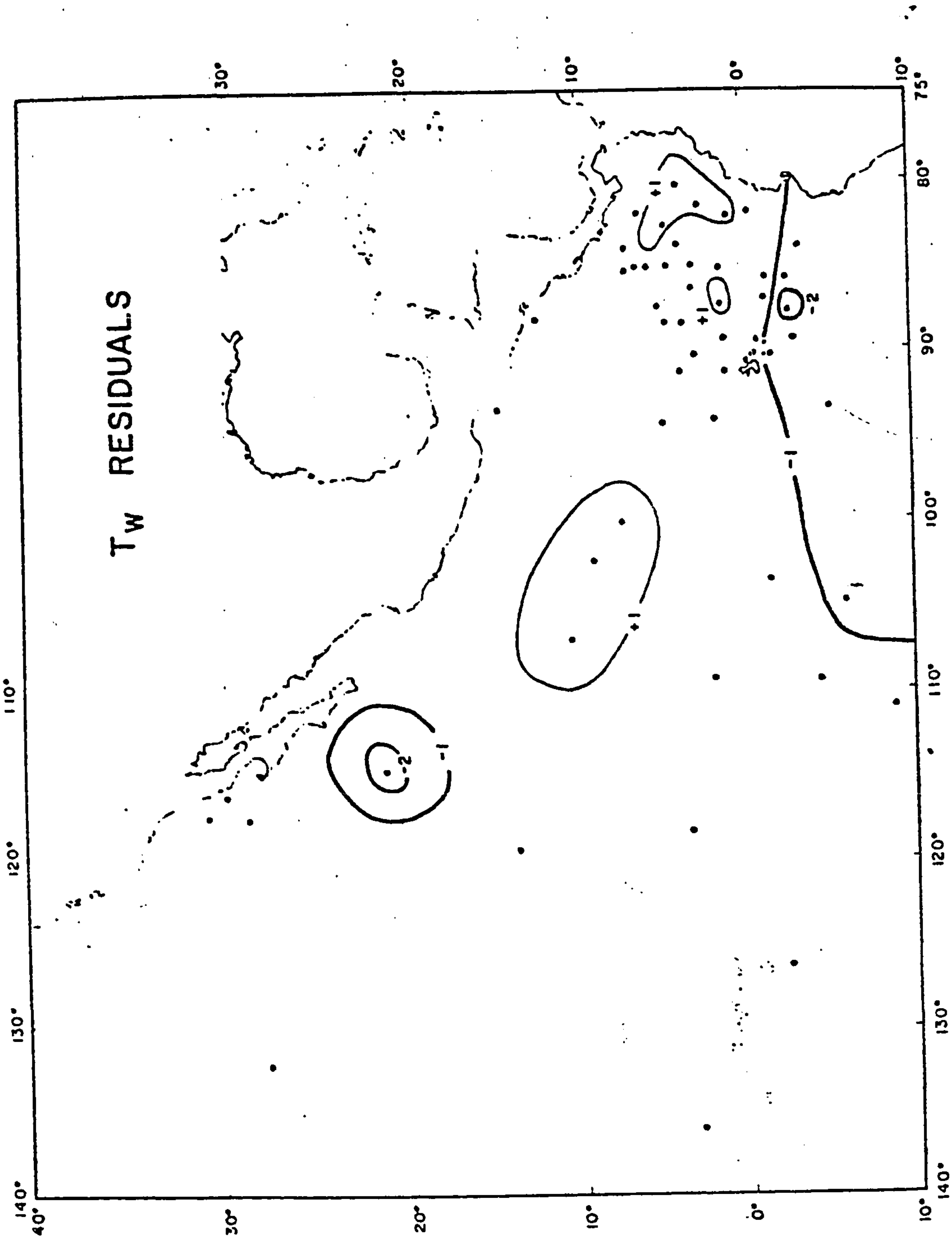


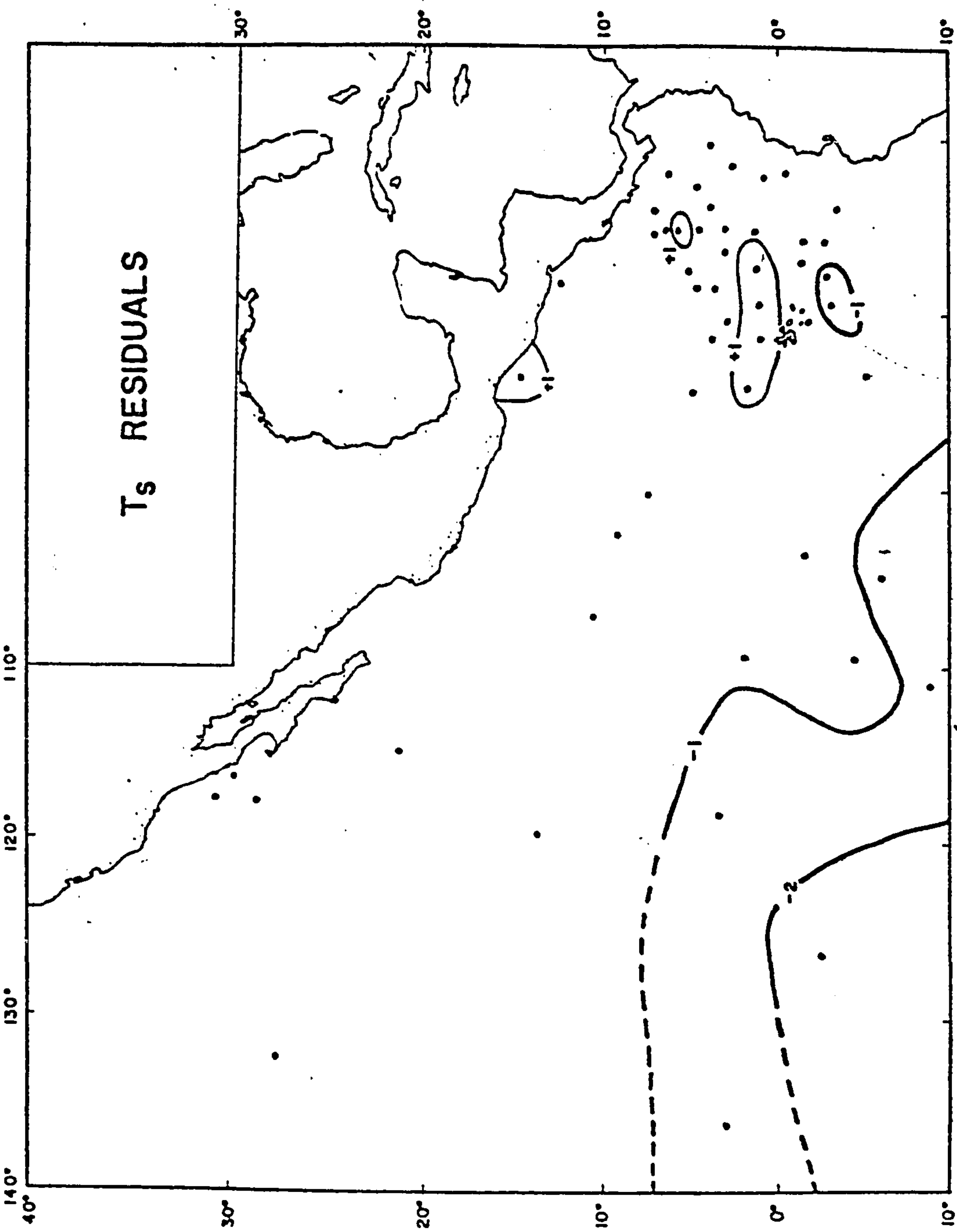
Dths
r = 0.579
se = 20.912
ACTUAL
ESTIMATED
0
50
100
150
200

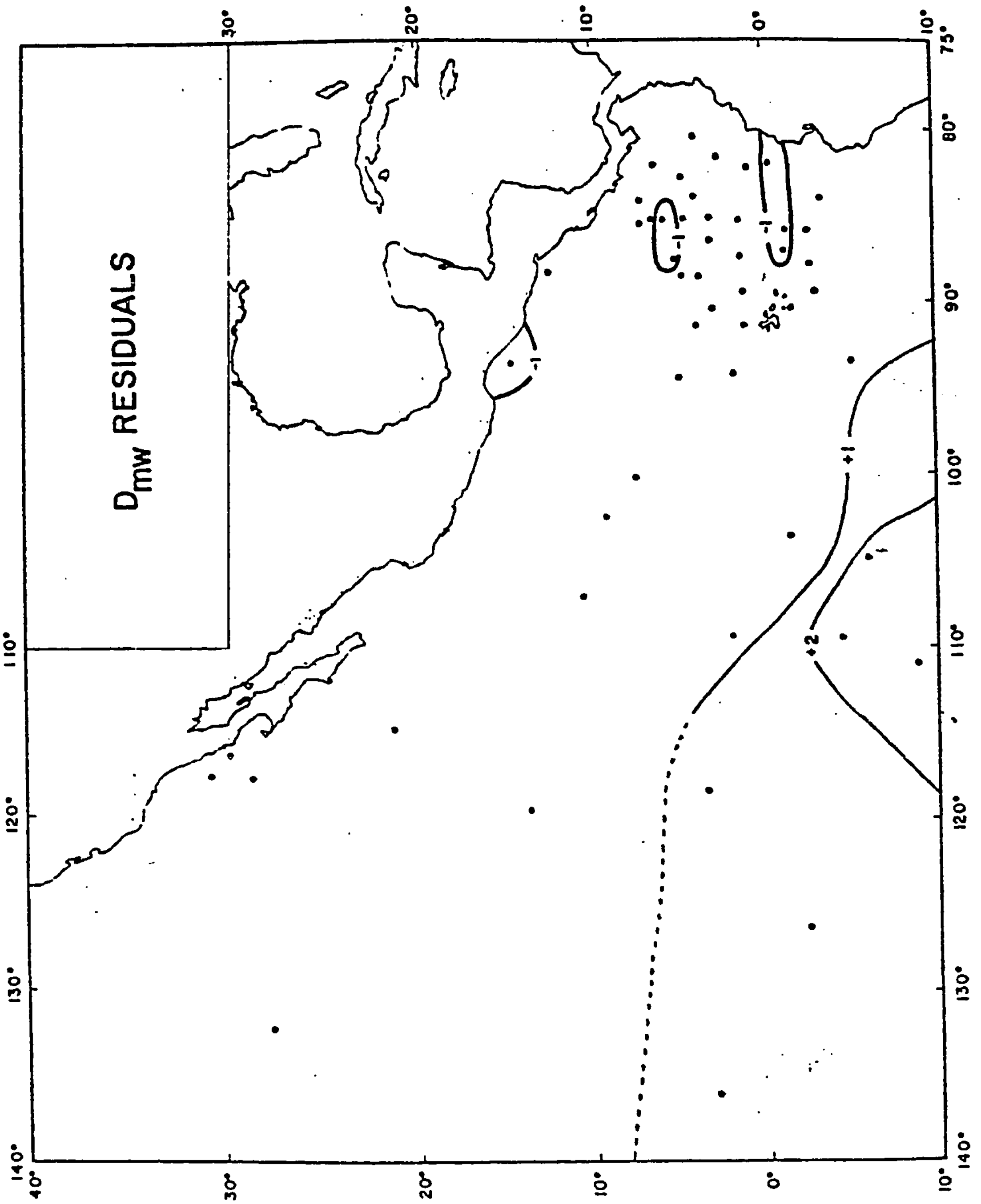

Tthw
ACTUAL
ESTIMATED
22
20
18
16
14
12
10
10
12
14
16
18
20
22
r = 0.517
se = 1.682

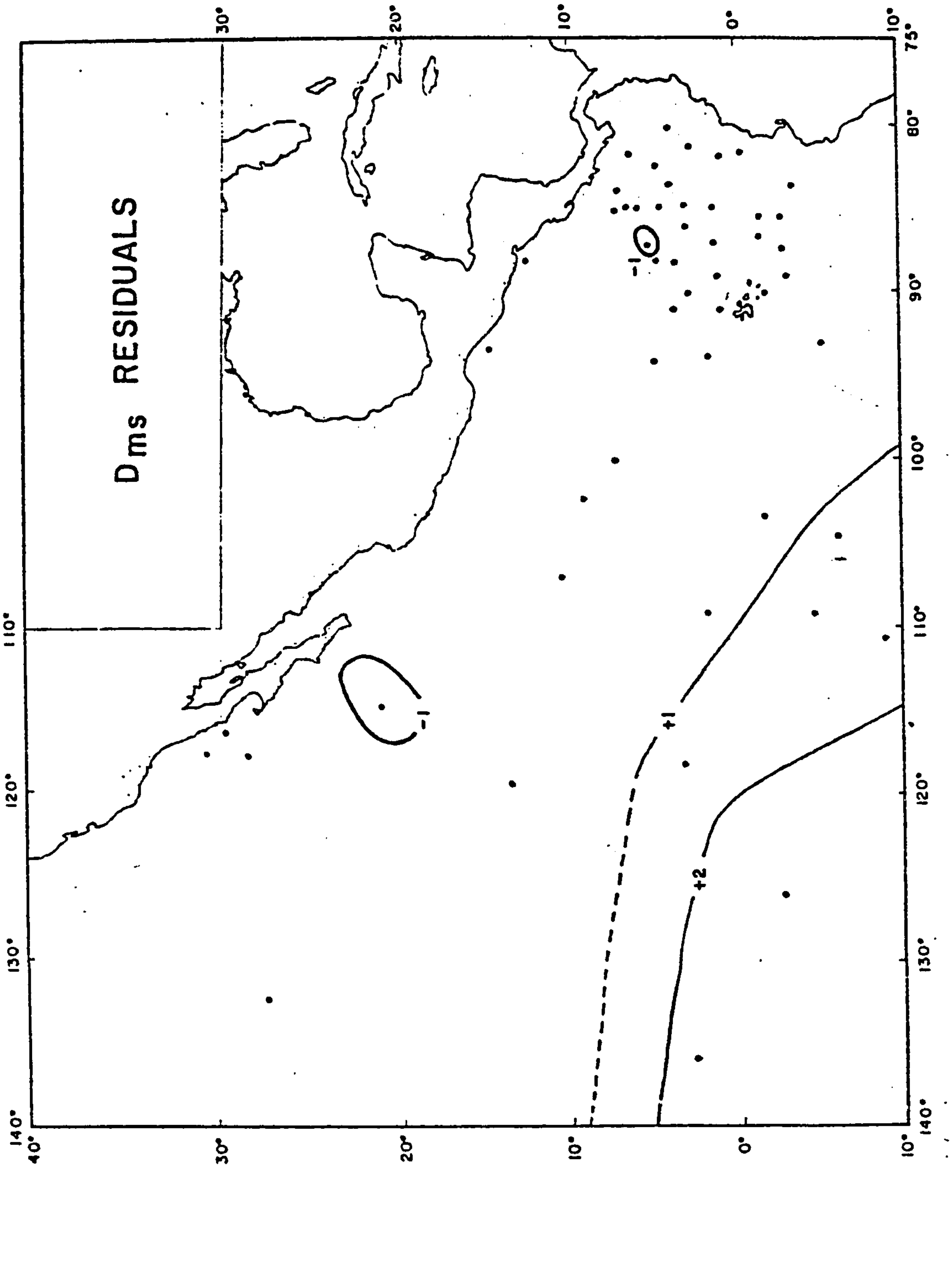


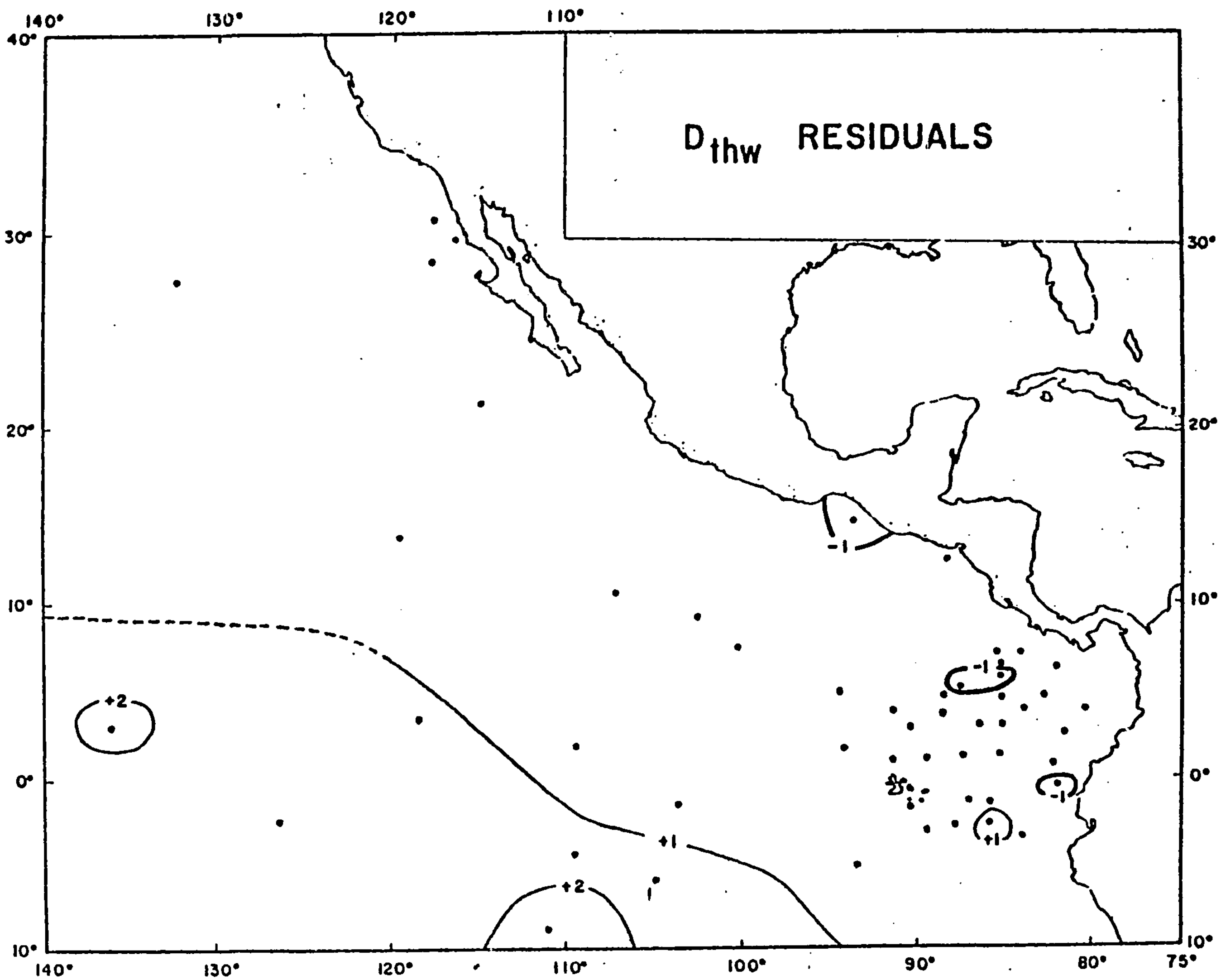
Tths
ACTUAL
ESTIMATED
r = 0.467
se = 1.807


T_W RESIDUALS
+1
-1
-2
30°
20°
10°
0°
10°
75°
80°
90°
100°
110°
120°
130°
140°
40°

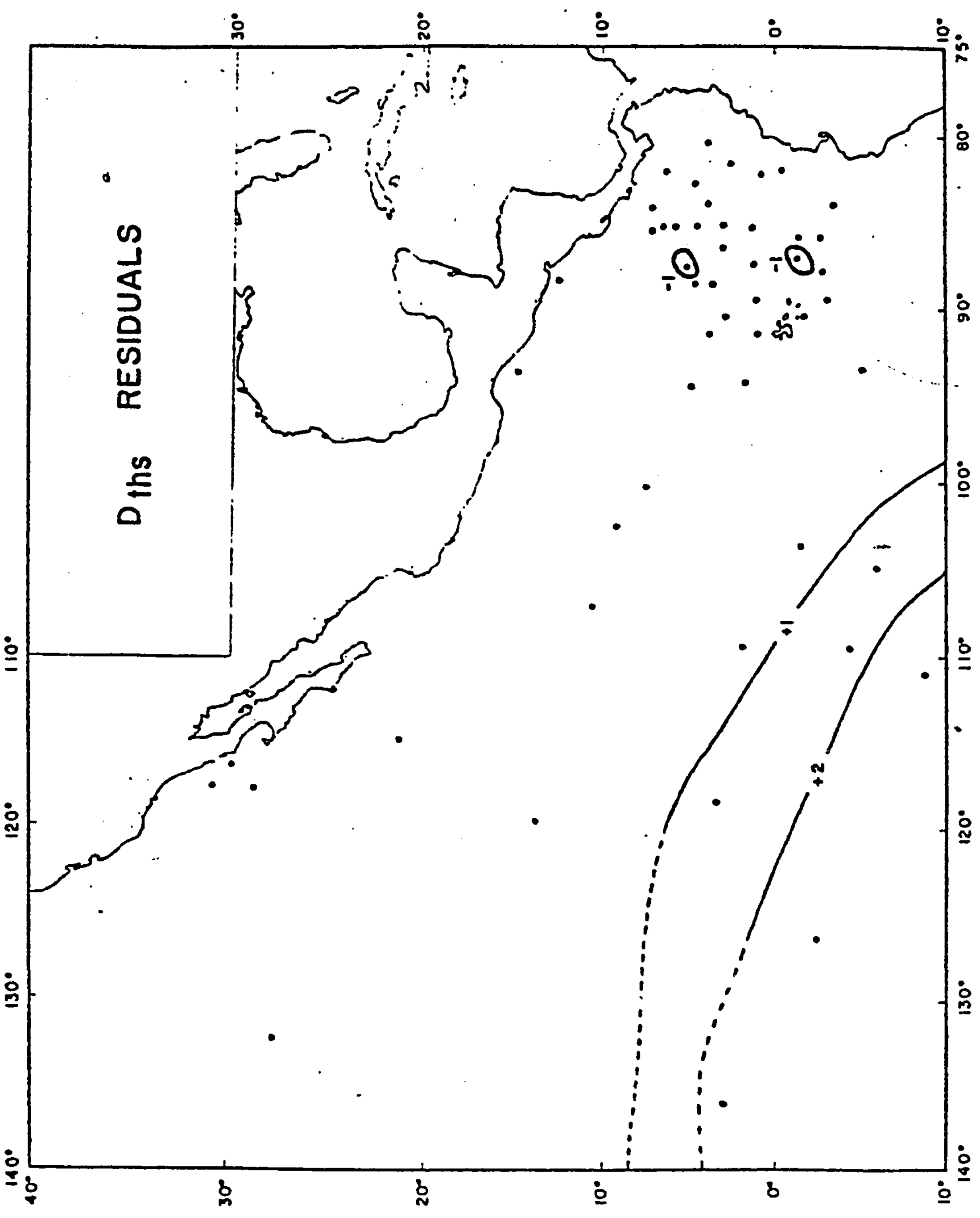

Ts RESIDUALS
30°
20°
10°
0°
10°
75°
80°
90°
100°
110°
120°
130°
140°
40°
+1
-1
-2

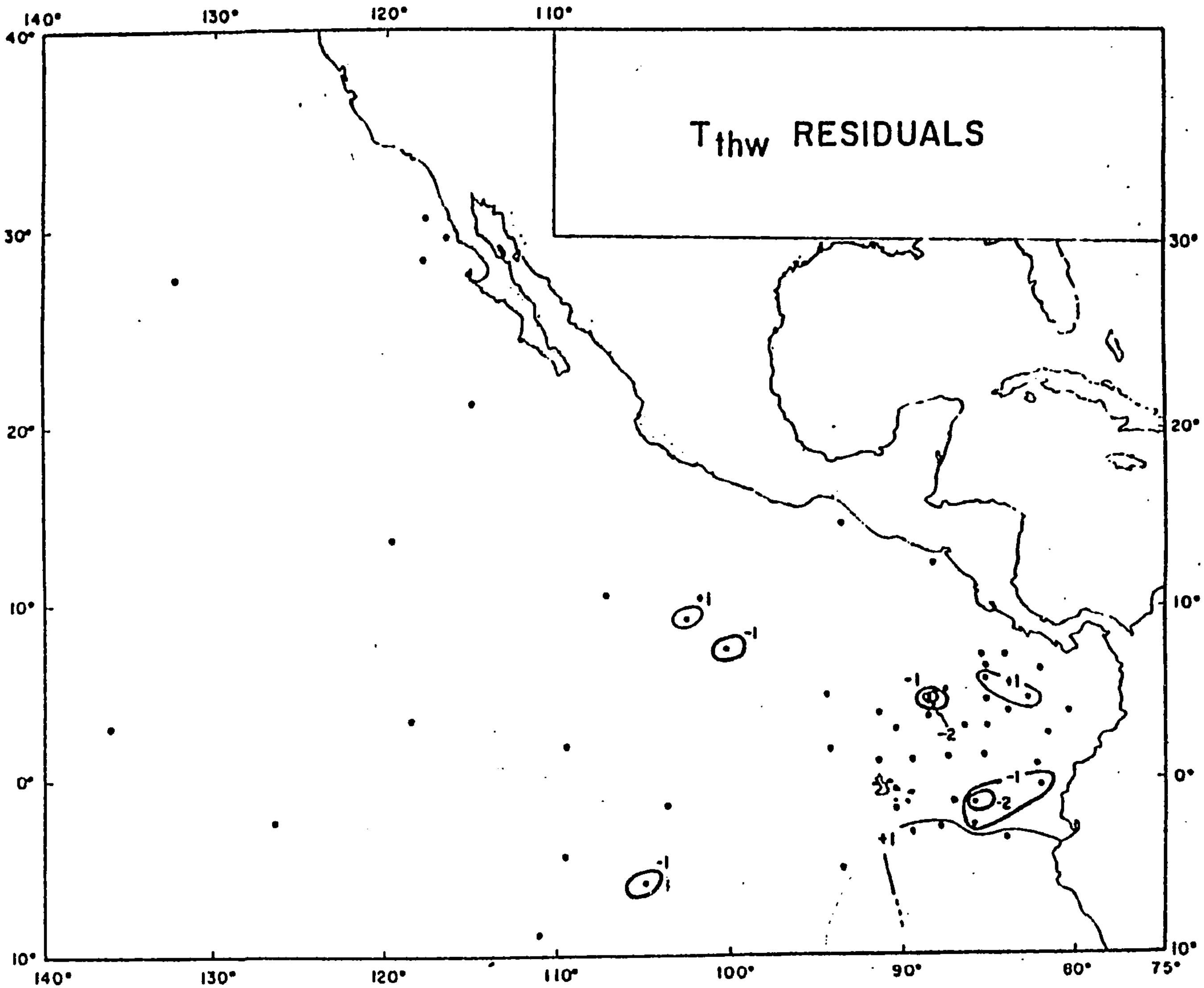

D$_{mw}$ RESIDUALS
75°
80°
90°
100°
110°
120°
130°
140°
40°
30°
20°
10°
0°
10°
-1
+1
+2


Dms RESIDUALS
-1
-1
+1
+2
30°
20°
10°
0°
10°
75°
80°
90°
100°
110°
120°
130°
140°
40°

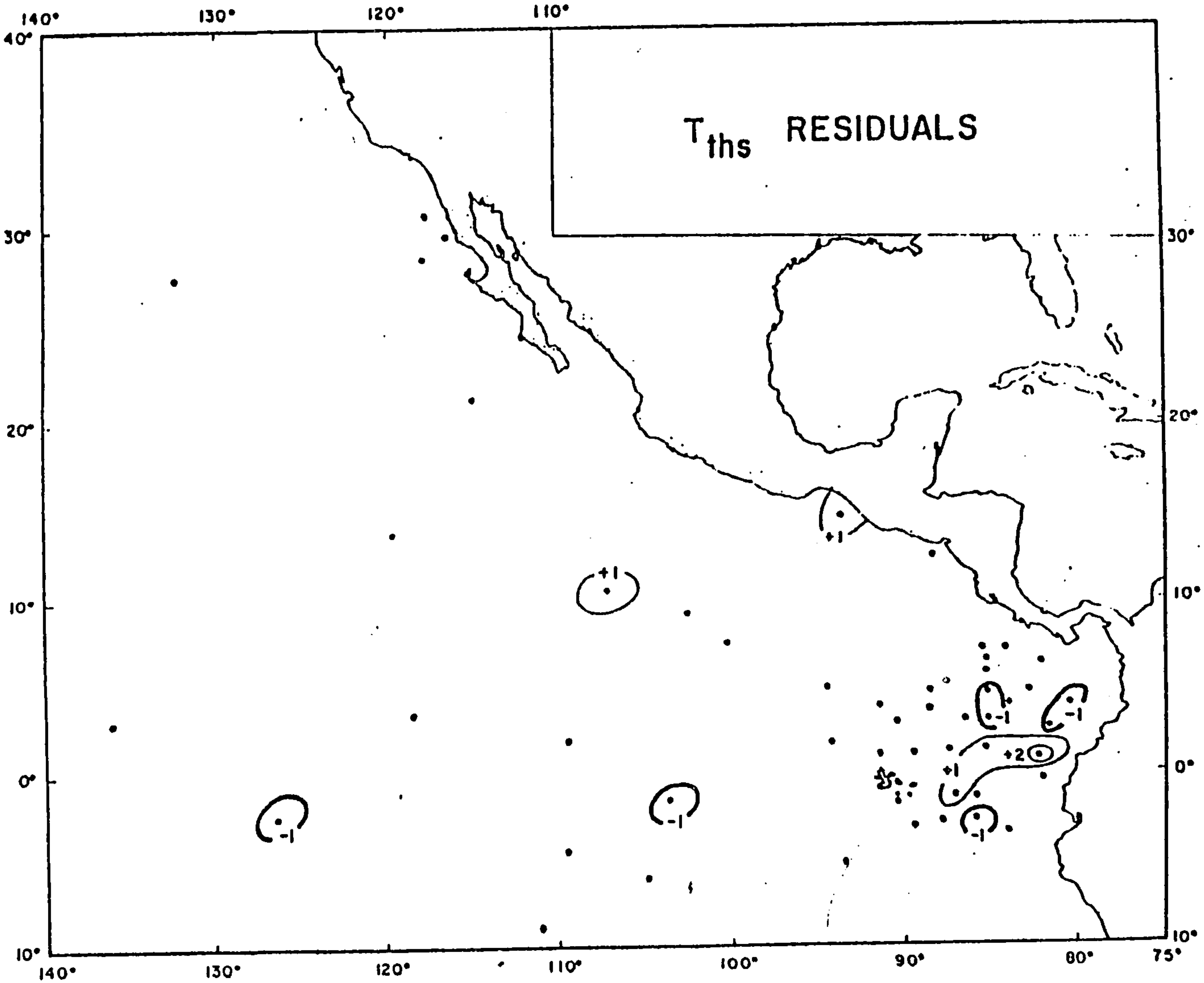


D_{thw} RESIDUALS
140°
130°
120°
110°
100°
90°
80°
75°
40°
30°
20°
10°
0°
10°
+2
+1
-1
-1.5


D ths RESIDUALS
+1
+2
-1
40°
30°
20°
10°
0°
10°
75°
80°
90°
100°
110°
120°
130°
140°



T thw RESIDUALS
140°
130°
120°
110°
100°
90°
80°
75°
40°
30°
20°
10°
0°
10°



T_{ths} RESIDUALS
140°
130°
120°
110°
100°
90°
80°
75°
40°
30°
20°
10°
0°
10°
+1
+2
-1

RAW FORAMINIFERAL COUNTS FOR CORE V19-29

SAMPLE NAME	UNIVERSA	CONGLOBT	RUBER	TENELLUS	SACC	DEHISCEN
V 19 29 1	1.0000	0.0000	1.0000	0.0000	0.0000	0.0000
V 19 29 1	0.0000	0.0000	1.0000	0.0000	1.0000	0.0000
V 19 29 11	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
V 19 29 19	0.0000	0.0000	0.0000	0.0000	2.0000	0.0000
V 19 29 29	2.0000	0.0000	5.0000	0.0000	4.0000	0.0000
V 19 29 39	1.0000	1.0000	2.0000	1.0000	0.0000	0.0000
V 19 29 49	0.0000	0.0000	1.0000	0.0000	1.0000	0.0000
V 19 29 60	2.0000	0.0000	5.0000	1.0000	2.0000	0.0000
V 19 29 80	0.0000	1.0000	2.0000	0.0000	1.0000	0.0000
V 19 29 100	0.0000	0.0000	1.0000	1.0000	8.0000	0.0000
V 19 29 120	7.0000	0.0000	2.0000	0.0000	3.0000	0.0000
V 19 29 140	3.0000	0.0000	6.0000	0.0000	1.0000	0.0000
V 19 29 160	14.0000	0.0000	0.0000	0.0000	1.0000	0.0000
V 19 29 180	50.0000	0.0000	5.0000	0.0000	0.0000	0.0000
V 19 29 200	37.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 19 29 220	49.0000	0.0000	3.0000	1.0000	0.0000	0.0000
V 19 29 240	19.0000	0.0000	1.0000	0.0000	0.0000	0.0000
V 19 29 260	10.0000	0.0000	3.0000	0.0000	0.0000	0.0000
V 19 29 280	11.0000	0.0000	2.0000	1.0000	0.0000	0.0000
V 19 29 300	59.0000	0.0000	9.0000	0.0000	1.0000	0.0000
V 19 29 320	7.0000	0.0000	1.0000	0.0000	1.0000	0.0000
V 19 29 340	62.0000	1.0000	2.0000	0.0000	0.0000	0.0000
V 19 29 360	6.0000	0.0000	1.0000	0.0000	0.0000	0.0000
V 19 29 380	10.0000	0.0000	1.0000	0.0000	0.0000	0.0000
V 19 29 400	7.0000	0.0000	1.0000	0.0000	0.0000	0.0000
V 19 29 420	7.0000	0.0000	1.0000	0.0000	0.0000	0.0000
V 19 29 440	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 19 29 460	4.0000	0.0000	2.0000	0.0000	0.0000	0.0000
V 19 29 480	4.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 19 29 500	5.0000	3.0000	3.0000	0.0000	0.0000	0.0000
V 19 29 520	2.0000	0.0000	0.0000	1.0000	1.0000	0.0000
V 19 29 540	4.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 19 29 560	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 19 29 580	5.0000	0.0000	3.0000	0.0000	0.0000	0.0000
V 19 29 600	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 19 29 620	5.0000	0.0000	0.0000	0.0000	1.0000	0.0000
V 19 29 640	11.0000	1.0000	2.0000	0.0000	2.0000	0.0000
V 19 29 660	5.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 19 29 680	5.0000	0.0000	0.0000	0.0000	1.0000	0.0000
V 19 29 700	3.0000	0.0000	2.0000	0.0000	0.0000	0.0000
V 19 29 720	0.0000	0.0000	1.0000	0.0000	2.0000	0.0000
V 19 29 740	6.0000	0.0000	1.0000	0.0000	2.0000	0.0000
V 19 29 760	8.0000	0.0000	1.0000	0.0000	1.0000	0.0000
V 19 29 780	1.0000	0.0000	2.0000	0.0000	1.0000	0.0000

V	19 29 800	3.0000	0.0000	2.0000	0.0000	1.0000	0.0000
V	19 29 820	3.0000	2.0000	13.0000	0.0000	1.0000	0.0000
V	19 29 840	1.0000	0.0000	6.0000	0.0000	1.0000	0.0000
V	19 29 860	3.0000	0.0000	9.0000	0.0000	1.0000	0.0000
V	19 29 880	3.0000	0.0000	11.0000	0.0000	2.0000	0.0000
V	19 29 900	7.0000	0.0000	5.0000	0.0000	1.0000	0.0000
V	19 29 920	5.0000	0.0000	3.0000	0.0000	2.0000	0.0000
V	19 29 940	4.0000	0.0000	2.0000	0.0000	0.0000	0.0000
V	19 29 960	2.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V	19 29 980	3.0000	0.0000	1.0000	1.0000	0.0000	0.0000
V	19 291000	7.0000	0.0000	2.0000	0.0000	1.0000	0.0000
V	19 291020	16.0000	0.0000	3.0000	0.0000	0.0000	0.0000
V	19 291040	6.0000	1.0000	4.0000	0.0000	0.0000	0.0000
V	19 291060	2.0000	0.0000	1.0000	0.0000	2.0000	0.0000
V	19 291080	5.0000	0.0000	1.0000	0.0000	1.0000	0.0000
V	19 291100	7.0000	0.0000	0.0000	0.0000	1.0000	0.0000
V	19 291120	17.0000	0.0000	2.0000	0.0000	2.0000	0.0000
V	19 291140	28.0000	0.0000	2.0000	0.0000	0.0000	0.0000
V	19 291160	14.0000	0.0000	3.0000	0.0000	0.0000	0.0000
V	19 291180	3.0000	0.0000	2.0000	0.0000	1.0000	0.0000
V	19 291200	7.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V	19 291220	3.0000	0.0000	5.0000	0.0000	2.0000	0.0000
V	19 291240	2.0000	0.0000	7.0000	0.0000	1.0000	0.0000
V	19 291260	8.0000	0.0000	5.0000	0.0000	5.0000	0.0000
V	19 291280	1.0000	0.0000	3.0000	0.0000	2.0000	0.0000
V	19 291300	3.0000	0.0000	3.0000	0.0000	1.0000	0.0000
V	19 291320	3.0000	0.0000	2.0000	0.0000	0.0000	0.0000
V	19 291340	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V	19 291360	7.0000	0.0000	4.0000	0.0000	6.0000	0.0000
V	19 291380	6.0000	0.0000	6.0000	0.0000	1.0000	0.0000
V	19 291400	4.0000	0.0000	1.0000	0.0000	0.0000	0.0000
V	19 291420	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V	19 291440	0.0000	0.0000	2.0000	0.0000	1.0000	0.0000
V	19 291460	6.0000	0.0000	2.0000	0.0000	0.0000	0.0000
V	19 291480	3.0000	0.0000	2.0000	0.0000	0.0000	0.0000
V	19 291500	22.0000	0.0000	2.0000	0.0000	0.0000	0.0000
V	19 291520	6.0000	0.0000	5.0000	0.0000	0.0000	0.0000
V	19 291540	7.0000	0.0000	3.0000	0.0000	4.0000	0.0000
V	19 291560	21.0000	0.0000	1.0000	0.0000	0.0000	0.0000
V	19 291580	16.0000	0.0000	3.0000	0.0000	0.0000	0.0000
V	19 291600	8.0000	0.0000	2.0000	0.0000	0.0000	0.0000
V	19 291620	4.0000	0.0000	3.0000	0.0000	0.0000	0.0000
V	19 291640	3.0000	0.0000	5.0000	0.0000	1.0000	0.0000
V	19 291660	7.0000	1.0000	1.0000	0.0000	0.0000	0.0000
V	19 291680	9.0000	0.0000	1.0000	0.0000	0.0000	0.0000

SAMPLE NAME	AEQUILAT	CALIDA	BULLOIDS	FALCON	DIGITATA	RUBESCNS
V 19 29 1	3.0000	2.0000	10.0000	0.0000	0.0000	0.0000
V 19 29 1	1.0000	0.0000	10.0000	0.0000	1.0000	1.0000
V 19 29 11	1.0000	0.0000	11.0000	0.0000	0.0000	0.0000
V 19 29 19	2.0000	0.0000	17.0000	0.0000	0.0000	0.0000
V 19 29 29	2.0000	2.0000	24.0000	1.0000	0.0000	0.0000
V 19 29 39	0.0000	5.0000	51.0000	1.0000	0.0000	0.0000
V 19 29 49	4.0000	1.0000	92.0000	1.0000	0.0000	0.0000
V 19 29 60	1.0000	0.0000	79.0000	0.0000	0.0000	1.0000
V 19 29 80	2.0000	1.0000	137.0000	2.0000	0.0000	0.0000
V 19 29 100	4.0000	0.0000	179.0000	0.0000	0.0000	0.0000
V 19 29 120	9.0000	9.0000	286.0000	0.0000	1.0000	1.0000
V 19 29 140	3.0000	10.0000	455.0000	0.0000	1.0000	0.0000
V 19 29 160	0.0000	6.0000	102.0000	0.0000	0.0000	0.0000
V 19 29 180	1.0000	1.0000	211.0000	0.0000	1.0000	0.0000
V 19 29 200	3.0000	3.0000	142.0000	0.0000	0.0000	0.0000
V 19 29 220	3.0000	9.0000	249.0000	0.0000	3.0000	0.0000
V 19 29 240	1.0000	3.0000	65.0000	0.0000	2.0000	0.0000
V 19 29 260	0.0000	4.0000	157.0000	1.0000	0.0000	0.0000
V 19 29 280	0.0000	9.0000	121.0000	0.0000	1.0000	1.0000
V 19 29 300	9.0000	25.0000	351.0000	1.0000	1.0000	1.0000
V 19 29 320	1.0000	8.0000	85.0000	1.0000	0.0000	0.0000
V 19 29 340	7.0000	6.0000	226.0000	0.0000	2.0000	0.0000
V 19 29 360	3.0000	8.0000	93.0000	1.0000	1.0000	0.0000
V 19 29 380	0.0000	2.0000	37.0000	0.0000	0.0000	0.0000
V 19 29 400	4.0000	2.0000	141.0000	0.0000	1.0000	0.0000
V 19 29 420	2.0000	2.0000	119.0000	0.0000	3.0000	0.0000
V 19 29 440	2.0000	25.0000	250.0000	1.0000	0.0000	0.0000
V 19 29 460	4.0000	20.0000	224.0000	1.0000	1.0000	0.0000
V 19 29 480	7.0000	5.0000	194.0000	0.0000	1.0000	0.0000
V 19 29 500	2.0000	4.0000	172.0000	0.0000	1.0000	0.0000
V 19 29 520	0.0000	12.0000	155.0000	1.0000	2.0000	0.0000
V 19 29 540	0.0000	11.0000	80.0000	0.0000	0.0000	0.0000
V 19 29 560	1.0000	11.0000	233.0000	1.0000	0.0000	0.0000
V 19 29 580	4.0000	8.0000	161.0000	0.0000	1.0000	0.0000
V 19 29 600	1.0000	0.0000	8.0000	0.0000	0.0000	0.0000
V 19 29 620	0.0000	1.0000	96.0000	0.0000	1.0000	0.0000
V 19 29 640	1.0000	1.0000	143.0000	0.0000	3.0000	1.0000
V 19 29 660	2.0000	0.0000	76.0000	0.0000	0.0000	0.0000
V 19 29 680	1.0000	4.0000	101.0000	1.0000	0.0000	0.0000
V 19 29 700	0.0000	2.0000	130.0000	0.0000	0.0000	0.0000
V 19 29 720	0.0000	0.0000	14.0000	0.0000	0.0000	0.0000
V 19 29 740	0.0000	0.0000	82.0000	0.0000	0.0000	0.0000
V 19 29 760	2.0000	2.0000	129.0000	0.0000	0.0000	0.0000
V 19 29 780	0.0000	1.0000	109.0000	0.0000	0.0000	0.0000

V 19 29 800	0.0000	2.0000	146.0000	0.0000	0.0000	0.0000
V 19 29 820	12.0000	1.0000	71.0000	0.0000	0.0000	0.0000
V 19 29 840	2.0000	1.0000	96.0000	0.0000	0.0000	0.0000
V 19 29 860	3.0000	19.0000	284.0000	0.0000	5.0000	0.0000
V 19 29 880	6.0000	11.0000	197.0000	1.0000	3.0000	1.0000
V 19 29 900	0.0000	11.0000	109.0000	0.0000	0.0000	0.0000
V 19 29 920	3.0000	3.0000	129.0000	0.0000	1.0000	1.0000
V 19 29 940	0.0000	9.0000	197.0000	0.0000	1.0000	1.0000
V 19 29 960	5.0000	17.0000	259.0000	0.0000	0.0000	1.0000
V 19 29 980	0.0000	17.0000	176.0000	0.0000	0.0000	0.0000
V 19 291000	1.0000	15.0000	245.0000	1.0000	0.0000	1.0000
V 19 291020	2.0000	7.0000	227.0000	3.0000	0.0000	0.0000
V 19 291040	1.0000	12.0000	256.0000	2.0000	3.0000	0.0000
V 19 291060	0.0000	15.0000	171.0000	0.0000	0.0000	0.0000
V 19 291080	3.0000	33.0000	313.0000	0.0000	1.0000	0.0000
V 19 291100	3.0000	7.0000	142.0000	1.0000	1.0000	1.0000
V 19 291120	4.0000	6.0000	265.0000	2.0000	2.0000	0.0000
V 19 291140	2.0000	19.0000	248.0000	0.0000	0.0000	0.0000
V 19 291160	5.0000	4.0000	91.0000	0.0000	1.0000	0.0000
V 19 291180	5.0000	6.0000	107.0000	0.0000	0.0000	0.0000
V 19 291200	1.0000	11.0000	203.0000	1.0000	2.0000	0.0000
V 19 291220	2.0000	2.0000	55.0000	0.0000	0.0000	0.0000
V 19 291240	5.0000	1.0000	41.0000	0.0000	0.0000	1.0000
V 19 291260	2.0000	1.0000	17.0000	0.0000	0.0000	0.0000
V 19 291280	0.0000	0.0000	8.0000	1.0000	0.0000	0.0000
V 19 291300	2.0000	0.0000	33.0000	0.0000	2.0000	0.0000
V 19 291320	1.0000	0.0000	10.0000	0.0000	0.0000	0.0000
V 19 291340	0.0000	1.0000	36.0000	0.0000	1.0000	0.0000
V 19 291360	6.0000	2.0000	32.0000	0.0000	0.0000	0.0000
V 19 291380	4.0000	6.0000	110.0000	0.0000	2.0000	4.0000
V 19 291400	2.0000	5.0000	80.0000	0.0000	0.0000	0.0000
V 19 291420	7.0000	6.0000	235.0000	0.0000	0.0000	0.0000
V 19 291440	2.0000	5.0000	164.0000	0.0000	0.0000	0.0000
V 19 291460	6.0000	11.0000	171.0000	0.0000	2.0000	0.0000
V 19 291480	0.0000	4.0000	83.0000	0.0000	1.0000	0.0000
V 19 291500	0.0000	1.0000	81.0000	0.0000	2.0000	0.0000
V 19 291520	0.0000	7.0000	103.0000	0.0000	0.0000	1.0000
V 19 291540	2.0000	1.0000	100.0000	0.0000	1.0000	1.0000
V 19 291560	2.0000	3.0000	79.0000	0.0000	0.0000	0.0000
V 19 291580	6.0000	3.0000	72.0000	0.0000	1.0000	0.0000
V 19 291600	1.0000	3.0000	77.0000	0.0000	0.0000	0.0000
V 19 291620	1.0000	2.0000	90.0000	0.0000	0.0000	0.0000
V 19 291640	3.0000	1.0000	20.0000	0.0000	0.0000	0.0000
V 19 291660	1.0000	1.0000	41.0000	0.0000	1.0000	0.0000
V 19 291680	1.0000	3.0000	83.0000	0.0000	0.0000	0.0000

SAMPLE NAME	HUMILIS	QUINQLBA	PACHY L	PACHY R	CONGLOMR	HEXAGONA
V 19 29 1	0.0000	1.0000	0.0000	4.0000	0.0000	2.0000
V 19 29 1	0.0000	0.0000	0.0000	2.0000	0.0000	0.0000
V 19 29 11	0.0000	0.0000	0.0000	6.0000	2.0000	1.0000
V 19 29 19	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000
V 19 29 29	0.0000	0.0000	0.0000	6.0000	0.0000	3.0000
V 19 29 39	0.0000	1.0000	1.0000	21.0000	0.0000	3.0000
V 19 29 49	0.0000	0.0000	1.0000	42.0000	0.0000	0.0000
V 19 29 60	0.0000	2.0000	3.0000	18.0000	0.0000	0.0000
V 19 29 80	0.0000	0.0000	2.0000	39.0000	0.0000	2.0000
V 19 29 100	0.0000	4.0000	6.0000	108.0000	0.0000	0.0000
V 19 29 120	0.0000	38.0000	30.0000	111.0000	0.0000	0.0000
V 19 29 140	0.0000	37.0000	11.0000	142.0000	0.0000	0.0000
V 19 29 160	0.0000	4.0000	4.0000	89.0000	0.0000	0.0000
V 19 29 180	0.0000	4.0000	14.0000	126.0000	0.0000	0.0000
V 19 29 200	0.0000	6.0000	2.0000	20.0000	0.0000	0.0000
V 19 29 220	0.0000	5.0000	9.0000	13.0000	0.0000	0.0000
V 19 29 240	0.0000	2.0000	0.0000	5.0000	0.0000	0.0000
V 19 29 260	0.0000	1.0000	6.0000	17.0000	0.0000	1.0000
V 19 29 280	0.0000	4.0000	2.0000	9.0000	0.0000	1.0000
V 19 29 300	0.0000	0.0000	3.0000	35.0000	0.0000	7.0000
V 19 29 320	0.0000	0.0000	0.0000	7.0000	0.0000	0.0000
V 19 29 340	0.0000	6.0000	0.0000	22.0000	0.0000	3.0000
V 19 29 360	0.0000	5.0000	0.0000	6.0000	0.0000	1.0000
V 19 29 380	0.0000	1.0000	2.0000	0.0000	0.0000	0.0000
V 19 29 400	0.0000	4.0000	1.0000	6.0000	0.0000	5.0000
V 19 29 420	0.0000	6.0000	28.0000	0.0000	0.0000	0.0000
V 19 29 440	0.0000	3.0000	0.0000	15.0000	0.0000	2.0000
V 19 29 460	0.0000	18.0000	1.0000	12.0000	0.0000	2.0000
V 19 29 480	0.0000	6.0000	12.0000	0.0000	0.0000	1.0000
V 19 29 500	0.0000	2.0000	0.0000	32.0000	0.0000	2.0000
V 19 29 520	0.0000	2.0000	0.0000	12.0000	0.0000	0.0000
V 19 29 540	2.0000	2.0000	12.0000	0.0000	0.0000	0.0000
V 19 29 560	0.0000	3.0000	4.0000	14.0000	0.0000	0.0000
V 19 29 580	0.0000	5.0000	0.0000	16.0000	0.0000	2.0000
V 19 29 600	0.0000	1.0000	0.0000	3.0000	0.0000	1.0000
V 19 29 620	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000
V 19 29 640	0.0000	1.0000	0.0000	3.0000	0.0000	3.0000
V 19 29 660	0.0000	0.0000	0.0000	2.0000	0.0000	1.0000
V 19 29 680	0.0000	0.0000	1.0000	6.0000	0.0000	1.0000
V 19 29 700	0.0000	1.0000	0.0000	5.0000	1.0000	0.0000
V 19 29 720	0.0000	0.0000	0.0000	2.0000	0.0000	0.0000
V 19 29 740	0.0000	0.0000	0.0000	3.0000	0.0000	0.0000
V 19 29 760	0.0000	0.0000	1.0000	2.0000	0.0000	0.0000
V 19 29 780	0.0000	0.0000	0.0000	10.0000	0.0000	0.0000

V 19 29 800	0.0000	0.0000	0.0000	22.0000	0.0000	0.0000
V 19 29 820	0.0000	0.0000	0.0000	14.0000	0.0000	2.0000
V 19 29 840	0.0000	1.0000	0.0000	2.0000	1.0000	1.0000
V 19 29 860	0.0000	9.0000	1.0000	15.0000	3.0000	0.0000
V 19 29 880	0.0000	6.0000	1.0000	8.0000	0.0000	1.0000
V 19 29 900	0.0000	0.0000	0.0000	13.0000	0.0000	0.0000
V 19 29 920	0.0000	0.0000	2.0000	27.0000	0.0000	2.0000
V 19 29 940	0.0000	1.0000	1.0000	10.0000	0.0000	0.0000
V 19 29 960	0.0000	2.0000	1.0000	24.0000	0.0000	0.0000
V 19 29 980	0.0000	1.0000	2.0000	21.0000	0.0000	1.0000
V 19 291000	0.0000	5.0000	1.0000	22.0000	0.0000	1.0000
V 19 291020	0.0000	1.0000	0.0000	8.0000	0.0000	0.0000
V 19 291040	0.0000	0.0000	1.0000	20.0000	1.0000	5.0000
V 19 291060	0.0000	9.0000	3.0000	33.6900	4.0000	0.0000
V 19 291080	0.0000	4.0000	4.0000	31.0630	0.0000	1.0000
V 19 291100	0.0000	2.0000	1.0000	34.0000	0.0000	0.0000
V 19 291120	0.0000	4.0000	3.0000	58.0000	1.0000	0.0000
V 19 291140	0.0000	14.0000	0.0000	22.0000	0.0000	0.0000
V 19 291160	0.0000	0.0000	3.0000	23.0000	0.0000	0.0000
V 19 291180	0.0000	3.0000	2.0000	21.0000	0.0000	0.0000
V 19 291200	0.0000	10.0000	4.0000	30.0000	0.0000	2.0000
V 19 291220	0.0000	0.0000	0.0000	5.0000	0.0000	1.0000
V 19 291240	0.0000	1.0000	0.0000	4.0000	0.0000	0.0000
V 19 291260	0.0000	0.0000	0.0000	3.0000	1.0000	0.0000
V 19 291280	0.0000	0.0000	0.0000	11.0000	0.0000	2.0000
V 19 291300	0.0000	0.0000	1.0000	3.0000	0.0000	0.0000
V 19 291320	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 19 291340	0.0000	0.0000	0.0000	3.0000	0.0000	2.0000
V 19 291360	0.0000	2.0000	16.0000	0.0000	0.0000	1.0000
V 19 291380	0.0000	1.0000	3.0000	23.0000	0.0000	1.0000
V 19 291400	0.0000	1.0000	1.0000	43.0000	0.0000	0.0000
V 19 291420	0.0000	5.0000	0.0000	48.0000	0.0000	0.0000
V 19 291440	0.0000	2.0000	0.0000	30.0000	0.0000	0.0000
V 19 291460	0.0000	5.0000	0.0000	20.0000	0.0000	1.0000
V 19 291480	0.0000	2.0000	0.0000	4.0000	0.0000	0.0000
V 19 291500	0.0000	1.0000	0.0000	8.0000	0.0000	0.0000
V 19 291520	0.0000	1.0000	0.0000	6.0000	0.0000	0.0000
V 19 291540	0.0000	2.0000	0.0000	14.0000	0.0000	1.0000
V 19 291560	0.0000	0.0000	0.0000	7.0000	1.0000	3.0000
V 19 291580	0.0000	0.0000	0.0000	10.0000	0.0000	2.0000
V 19 291600	0.0000	0.0000	0.0000	15.0000	0.0000	0.0000
V 19 291620	0.0000	0.0000	0.0000	9.0000	0.0000	0.0000
V 19 291640	0.0000	0.0000	0.0000	23.0000	0.0000	2.0000
V 19 291660	0.0000	2.0000	0.0000	11.0000	0.0000	1.0000
V 19 291680	0.0000	2.0000	1.0000	28.0000	0.0000	1.0000

SAMPLE NAME	OBLIQUIL	INFLATA	TRUNC L	TRUNC R	CRASSAFM	MENTUM
V 19 29 1	0.0000	0.0000	0.0000	0.0000	0.0000	8.0000
V 19 29 1	1.0000	0.0000	0.0000	0.0000	0.0000	3.0000
V 19 29 11	0.0000	0.0000	0.0000	0.0000	0.0000	6.0000
V 19 29 19	2.0000	0.0000	0.0000	0.0000	0.0000	7.0000
V 19 29 29	0.0000	0.0000	0.0000	0.0000	0.0000	9.0000
V 19 29 39	0.0000	0.0000	0.0000	0.0000	1.0000	7.0000
V 19 29 49	1.0000	0.0000	0.0000	0.0000	0.0000	4.0000
V 19 29 60	0.0000	0.0000	0.0000	0.0000	1.0000	3.0000
V 19 29 80	1.0000	2.0000	0.0000	0.0000	0.0000	9.0000
V 19 29 100	1.0000	0.0000	0.0000	0.0000	2.0000	8.0000
V 19 29 120	1.0000	217.0000	0.0000	0.0000	5.0000	11.0000
V 19 29 140	0.0000	138.0000	0.0000	0.0000	0.0000	9.0000
V 19 29 160	0.0000	36.0000	0.0000	0.0000	0.0000	7.0000
V 19 29 180	0.0000	14.0000	1.0000	0.0000	0.0000	6.0000
V 19 29 200	0.0000	77.0000	0.0000	0.0000	0.0000	2.0000
V 19 29 220	1.0000	137.0000	3.0000	0.0000	0.0000	6.0000
V 19 29 240	0.0000	111.0000	0.0000	0.0000	0.0000	2.0000
V 19 29 260	0.0000	157.0000	0.0000	0.0000	0.0000	12.0000
V 19 29 280	1.0000	195.0000	0.0000	0.0000	0.0000	12.0000
V 19 29 300	0.0000	43.0000	0.0000	0.0000	0.0000	32.0000
V 19 29 320	0.0000	0.0000	0.0000	0.0000	0.0000	9.0000
V 19 29 340	1.0000	3.0000	0.0000	0.0000	0.0000	14.0000
V 19 29 360	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
V 19 29 380	0.0000	2.0000	0.0000	0.0000	0.0000	4.0000
V 19 29 400	0.0000	0.0000	0.0000	0.0000	0.0000	6.0000
V 19 29 420	0.0000	1.0000	0.0000	0.0000	0.0000	4.0000
V 19 29 440	0.0000	0.0000	0.0000	0.0000	0.0000	5.0000
V 19 29 460	0.0000	0.0000	0.0000	0.0000	0.0000	2.0000
V 19 29 480	0.0000	1.0000	0.0000	0.0000	0.0000	7.0000
V 19 29 500	0.0000	20.0000	0.0000	0.0000	1.0000	13.0000
V 19 29 520	0.0000	7.0000	0.0000	0.0000	32.0000	8.0000
V 19 29 540	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
V 19 29 560	0.0000	2.0000	0.0000	0.0000	0.0000	10.0000
V 19 29 580	0.0000	1.0000	0.0000	0.0000	0.0000	5.0000
V 19 29 600	0.0000	1.0000	0.0000	0.0000	0.0000	5.0000
V 19 29 620	0.0000	0.0000	0.0000	0.0000	2.0000	9.0000
V 19 29 640	0.0000	1.0000	0.0000	0.0000	0.0000	9.0000
V 19 29 660	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
V 19 29 680	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
V 19 29 700	0.0000	2.0000	0.0000	0.0000	0.0000	4.0000
V 19 29 720	0.0000	2.0000	0.0000	0.0000	0.0000	2.0000
V 19 29 740	0.0000	1.0000	0.0000	0.0000	0.0000	7.0000
V 19 29 760	0.0000	0.0000	0.0000	0.0000	1.0000	5.0000
V 19 29 780	0.0000	0.0000	0.0000	0.0000	1.0000	4.0000

V 19 29 800	1.0000	7.0000	0.0000	0.0000	0.0000	19.0000
V 19 29 820	4.0000	0.0000	0.0000	0.0000	1.0000	13.0000
V 19 29 840	3.0000	0.0000	0.0000	0.0000	0.0000	7.0000
V 19 29 860	5.0000	0.0000	0.0000	0.0000	0.0000	12.0000
V 19 29 880	1.0000	0.0000	0.0000	0.0000	1.0000	15.0000
V 19 29 900	1.0000	0.0000	0.0000	0.0000	0.0000	1.0000
V 19 29 920	1.0000	0.0000	0.0000	0.0000	0.0000	2.0000
V 19 29 940	0.0000	1.0000	0.0000	0.0000	0.0000	3.0000
V 19 29 960	0.0000	1.0000	0.0000	0.0000	0.0000	3.0000
V 19 29 980	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
V 19 291000	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
V 19 291020	0.0000	0.0000	0.0000	0.0000	0.0000	2.0000
V 19 291040	0.0000	0.0000	0.0000	0.0000	1.0000	2.0000
V 19 291060	0.0000	2.0000	0.0000	0.0000	0.0000	3.0000
V 19 291080	0.0000	0.0000	0.0000	0.0000	0.0000	2.0000
V 19 291100	0.0000	0.0000	0.0000	0.0000	2.0000	3.0000
V 19 291120	0.0000	0.0000	0.0000	0.0000	1.0000	3.0000
V 19 291140	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000
V 19 291160	0.0000	0.0000	0.0000	0.0000	1.0000	3.0000
V 19 291180	1.0000	4.0000	0.0000	0.0000	0.0000	9.0000
V 19 291200	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000
V 19 291220	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
V 19 291240	0.0000	0.0000	0.0000	0.0000	0.0000	17.0000
V 19 291260	0.0000	0.0000	0.0000	0.0000	0.0000	22.0000
V 19 291280	0.0000	0.0000	0.0000	0.0000	0.0000	18.0000
V 19 291300	0.0000	0.0000	0.0000	0.0000	0.0000	8.0000
V 19 291320	0.0000	0.0000	0.0000	0.0000	0.0000	25.0000
V 19 291340	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000
V 19 291360	2.0000	0.0000	1.0000	0.0000	1.0000	31.0000
V 19 291380	2.0000	0.0000	0.0000	0.0000	0.0000	14.0000
V 19 291400	0.0000	0.0000	0.0000	0.0000	0.0000	6.0000
V 19 291420	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000
V 19 291440	0.0000	0.0000	0.0000	0.0000	8.0000	5.0000
V 19 291460	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
V 19 291480	0.0000	0.0000	0.0000	0.0000	0.0000	3.0000
V 19 291500	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
V 19 291520	0.0000	0.0000	0.0000	0.0000	0.0000	4.0000
V 19 291540	0.0000	0.0000	0.0000	0.0000	2.0000	4.0000
V 19 291560	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 19 291580	0.0000	0.0000	0.0000	0.0000	0.0000	2.0000
V 19 291600	1.0000	0.0000	0.0000	0.0000	0.0000	3.0000
V 19 291620	0.0000	0.0000	0.0000	0.0000	1.0000	5.0000
V 19 291640	0.0000	0.0000	0.0000	0.0000	2.0000	17.0000
V 19 291660	0.0000	0.0000	1.0000	1.0000	1.0000	1.0000
V 19 291680	1.0000	0.0000	0.0000	0.0000	0.0000	5.0000

SAMPLE NAME	GLUTINAT	OUTER 5	OUTER 4	THEYERI
V 19 29 1	5.0000	295.0000	64.0000	0.0000
V 19 29 1	6.0000	173.0000	30.0000	0.0000
V 19 29 11	3.0000	234.0000	66.0000	0.0000
V 19 29 19	9.0000	215.0000	42.0000	1.0000
V 19 29 29	15.0000	341.0000	73.0000	0.0000
V 19 29 39	2.0000	309.0000	58.0000	0.0000
V 19 29 49	8.0000	239.0000	34.0000	0.0000
V 19 29 60	10.0000	209.0000	36.0000	3.0000
V 19 29 80	3.0000	285.0000	43.0000	1.0000
V 19 29 100	12.0000	302.0000	69.0000	0.0000
V 19 29 120	22.0000	391.0000	50.0000	0.0000
V 19 29 140	28.0000	356.0000	61.0000	0.0000
V 19 29 160	6.0000	436.0000	54.0000	1.0000
V 19 29 180	27.0000	177.0000	41.0000	1.0000
V 19 29 200	6.0000	89.0000	17.0000	0.0000
V 19 29 220	9.0000	208.0000	39.0000	1.0000
V 19 29 240	7.0000	158.0000	15.0000	1.0000
V 19 29 260	15.0000	212.0000	12.0000	1.0000
V 19 29 280	6.0000	204.0000	27.0000	1.0000
V 19 29 300	10.0000	537.0000	36.0000	0.0000
V 19 29 320	3.0000	125.0000	15.0000	1.0000
V 19 29 340	11.0000	407.0000	42.0000	0.0000
V 19 29 360	6.0000	186.0000	29.0000	0.0000
V 19 29 380	9.0000	149.0000	16.0000	0.0000
V 19 29 400	16.0000	300.0000	26.0000	1.0000
V 19 29 420	6.0000	276.0000	29.0000	0.0000
V 19 29 440	14.0000	287.0000	23.0000	0.0000
V 19 29 460	0.0000	328.0000	36.0000	0.0000
V 19 29 480	5.0000	269.0000	54.0000	0.0000
V 19 29 500	9.0000	301.0000	65.0000	0.0000
V 19 29 520	6.0000	185.0000	26.0000	0.0000
V 19 29 540	3.0000	151.0000	21.0000	1.0000
V 19 29 560	3.0000	261.0000	36.0000	0.0000
V 19 29 580	5.0000	241.0000	36.0000	0.0000
V 19 29 600	2.0000	172.0000	22.0000	0.0000
V 19 29 620	5.0000	396.0000	53.0000	2.0000
V 19 29 640	9.0000	440.0000	62.0000	0.0000
V 19 29 660	1.0000	168.0000	29.0000	0.0000
V 19 29 680	3.0000	347.0000	28.0000	0.0000
V 19 29 700	4.0000	227.0000	32.0000	1.0000
V 19 29 720	1.0000	238.0000	29.0000	0.0000
V 19 29 740	3.0000	223.0000	35.0000	0.0000
V 19 29 760	0.0000	143.0000	18.0000	0.0000
V 19 29 780	2.0000	236.0000	34.0000	0.0000

V	19	29 800	2.0000	372.0000	104.0000	0.0000
V	19	29 820	18.0000	370.0000	104.0000	1.0000
V	19	29 840	7.0000	119.0000	27.0000	0.0000
V	19	29 860	18.0000	672.0000	101.0000	2.0000
V	19	29 880	13.0000	256.0000	46.0000	4.0000
V	19	29 900	5.0000	112.0000	36.0000	2.0000
V	19	29 920	2.0000	263.0000	68.0000	3.0000
V	19	29 940	3.0000	254.0000	110.0000	0.0000
V	19	29 960	4.0000	393.0000	117.0000	3.0000
V	19	29 980	3.0000	277.0000	38.0000	0.0000
V	19	291000	6.0000	232.0000	54.0000	1.0000
V	19	291020	0.0000	245.0000	55.0000	1.0000
V	19	291040	0.0000	352.0000	67.0000	2.0000
V	19	291060	5.0000	264.0000	53.0000	0.0000
V	19	291080	6.0000	195.0000	27.0000	1.0000
V	19	291100	0.0000	178.0000	22.0000	0.0000
V	19	291120	4.0000	361.0000	54.0000	0.0000
V	19	291140	4.0000	165.0000	28.0000	0.0000
V	19	291160	3.0000	260.0000	50.0000	0.0000
V	19	291180	2.0000	238.0000	41.0000	0.0000
V	19	291200	5.0000	224.0000	73.0000	1.0000
V	19	291220	2.0000	186.0000	51.0000	0.0000
V	19	291240	4.0000	194.0000	64.0000	0.0000
V	19	291260	4.0000	171.0000	50.0000	0.0000
V	19	291280	5.0000	169.0000	36.0000	1.0000
V	19	291300	4.0000	173.0000	47.0000	2.0000
V	19	291320	3.0000	107.0000	37.0000	1.0000
V	19	291340	1.0000	155.0000	27.0000	0.0000
V	19	291360	11.0000	283.0000	79.0000	3.0000
V	19	291380	3.0000	441.0000	89.0000	2.0000
V	19	291400	2.0000	389.0000	63.0000	2.0000
V	19	291420	3.0000	357.0000	62.0000	3.0000
V	19	291440	3.0000	446.0000	92.0000	3.0000
V	19	291460	3.0000	347.0000	76.0000	0.0000
V	19	291480	8.0000	208.0000	36.0000	1.0000
V	19	291500	8.0000	206.0000	36.0000	0.0000
V	19	291520	1.0000	168.0000	41.0000	0.0000
V	19	291540	6.0000	427.0000	60.0000	0.0000
V	19	291560	3.0000	338.0000	35.0000	2.0000
V	19	291580	2.0000	298.0000	39.0000	1.0000
V	19	291600	3.0000	240.0000	19.0000	0.0000
V	19	291620	5.0000	251.0000	24.0000	0.0000
V	19	291640	3.0000	346.0000	44.0000	0.0000
V	19	291660	2.0000	200.0000	26.0000	0.0000
V	19	291680	3.0000	265.0000	47.0000	2.0000

SPECIES DATA FOR V19-29 EXPRESSED AS PERCENT RESISTANT FAUNA

SAMPLE NAME	PACHY L	PACHY R	CONGLOMR	OBLIQUIL	INFLATA	TRUNC L
V 19 29 0	0.0000	1.0782	0.0000	0.0000	0.0000	0.0000
V 19 29 1	0.0000	0.9569	0.0000	0.4785	0.0000	0.0000
V 19 29 11	0.0000	1.9108	0.6369	0.0000	0.0000	0.0000
V 19 29 19	0.0000	0.0000	0.0000	0.7519	0.0000	0.0000
V 19 29 29	0.0000	1.3986	0.0000	0.0000	0.0000	0.0000
V 19 29 39	0.2519	5.2897	0.0000	0.0000	0.0000	0.0000
V 19 29 49	0.3115	13.0841	0.0000	0.3115	0.0000	0.0000
V 19 29 60	1.1111	6.6667	0.0000	0.0000	0.0000	0.0000
V 19 29 80	0.5249	10.2362	0.0000	0.2625	0.5249	0.0000
V 19 29 100	1.2097	21.7742	0.0000	0.2016	0.0000	0.0000
V 19 29 120	3.6765	13.6029	0.0000	0.1225	26.5931	0.0000
V 19 29 140	1.5342	19.8047	0.0000	0.0000	19.2469	0.0000
V 19 29 160	0.6390	14.2173	0.0000	0.0000	5.7508	0.0000
V 19 29 180	3.6939	33.2454	0.0000	0.0000	3.6939	0.2639
V 19 29 200	0.9662	9.6618	0.0000	0.0000	37.1981	0.0000
V 19 29 220	2.1635	3.1250	0.0000	0.2404	32.9327	0.7212
V 19 29 240	0.0000	1.7182	0.0000	0.0000	38.1443	0.0000
V 19 29 260	1.4423	4.0865	0.0000	0.0000	37.7404	0.0000
V 19 29 280	0.4444	2.0000	0.0000	0.2222	43.3333	0.0000
V 19 29 300	0.4373	5.1020	0.0000	0.0000	6.2682	0.0000
V 19 29 320	0.0000	4.4872	0.0000	0.0000	0.0000	0.0000
V 19 29 340	0.0000	4.4990	0.0000	0.2045	0.6135	0.0000
V 19 29 360	0.0000	2.6667	0.0000	0.0000	0.0000	0.0000
V 19 29 380	1.1561	0.0000	0.0000	0.0000	1.1561	0.0000
V 19 29 400	0.2950	1.7699	0.0000	0.0000	0.0000	0.0000
V 19 29 420	8.2840	0.0000	0.0000	0.0000	0.2959	0.0000
V 19 29 440	0.0000	4.5455	0.0000	0.0000	0.0000	0.0000
V 19 29 460	0.2639	3.1662	0.0000	0.0000	0.0000	0.0000
V 19 29 480	3.4985	0.0000	0.0000	0.0000	0.2915	0.0000
V 19 29 500	0.0000	7.4074	0.0000	0.0000	4.6296	0.0000
V 19 29 520	0.0000	4.4444	0.0000	0.0000	2.5926	0.0000
V 19 29 540	6.3830	0.0000	0.0000	0.0000	0.0000	0.0000
V 19 29 560	1.2232	4.2813	0.0000	0.0000	0.6116	0.0000
V 19 29 580	0.0000	5.3512	0.0000	0.0000	0.3344	0.0000
V 19 29 600	0.0000	1.4778	0.0000	0.0000	0.4926	0.0000
V 19 29 620	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 19 29 640	0.0000	0.5825	0.0000	0.0000	0.1942	0.0000
V 19 29 660	0.0000	0.9852	0.0000	0.0000	0.0000	0.0000
V 19 29 680	0.2591	1.5544	0.0000	0.0000	0.0000	0.0000
V 19 29 700	0.0000	1.8450	3.3690	0.0000	0.7380	0.0000
V 19 29 720	0.0000	0.7326	0.0000	0.0000	0.7326	0.0000
V 19 29 740	0.0000	1.1152	0.0000	0.0000	0.3717	0.0000
V 19 29 760	0.5882	1.1765	0.0000	0.0000	0.0000	0.0000
V 19 29 780	0.0000	3.5088	0.0000	0.0000	0.0000	0.0000

V 19 29 800	0.0000	4.1905	0.0000	0.1905	1.3333	0.0000
V 19 29 820	0.0000	2.7668	0.0000	0.7905	0.0000	0.0000
V 19 29 840	0.0000	1.2579	0.6289	1.8868	0.0000	0.0000
V 19 29 860	0.1236	1.8541	0.3708	0.6180	0.0000	0.0000
V 19 29 880	0.3049	2.4390	0.0000	0.3049	0.0000	0.0000
V 19 29 900	0.0000	7.9755	0.0000	0.6135	0.0000	0.0000
V 19 29 920	0.5510	7.4390	0.0000	0.2755	0.0000	0.0000
V 19 29 940	0.2639	2.6385	0.0000	0.0000	0.2639	0.0000
V 19 29 960	0.1855	4.4527	0.0000	0.0000	0.1855	0.0000
V 19 29 980	0.5848	6.1404	0.0000	0.0000	0.0000	0.0000
V 19 291000	0.3195	7.0288	0.0000	0.0000	0.0000	0.0000
V 19 291020	0.0000	2.5806	0.0000	0.0000	0.0000	0.0000
V 19 291040	0.2252	4.5045	0.2252	0.0000	0.0000	0.0000
V 19 291060	0.8287	9.1160	1.1050	0.0000	0.5525	0.0000
V 19 291080	1.5444	11.9691	0.0000	0.0000	0.0000	0.0000
V 19 291100	0.4167	14.1667	0.0000	0.0000	0.0000	0.0000
V 19 291120	0.6237	12.0582	0.2079	0.0000	0.0000	0.0000
V 19 291140	0.0000	10.0917	0.0000	0.0000	0.0000	0.0000
V 19 291160	0.8824	6.7647	0.0000	0.0000	0.0000	0.0000
V 19 291180	0.6329	6.6456	0.0000	0.3165	1.2658	0.0000
V 19 291200	1.1976	8.9820	0.0000	0.0000	0.0000	0.0000
V 19 291220	0.0000	2.0325	0.0000	0.0000	0.0000	0.0000
V 19 291240	0.0000	1.4337	0.0000	0.0000	0.0000	0.0000
V 19 291260	0.0000	1.2146	0.4049	0.0000	0.0000	0.0000
V 19 291280	0.0000	4.7009	0.0000	0.0000	0.0000	0.0000
V 19 291300	0.4310	1.2931	0.0000	0.0000	0.0000	0.0000
V 19 291320	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 19 291340	0.0000	1.5957	0.0000	0.0000	0.0000	0.0000
V 19 291360	3.8741	0.0000	0.0000	0.4843	0.0000	0.2421
V 19 291380	0.5245	4.0210	0.0000	0.3497	0.0000	0.0000
V 19 291400	0.1992	8.5657	0.0000	0.0000	0.0000	0.0000
V 19 291420	0.0000	10.2128	0.0000	0.0000	0.0000	0.0000
V 19 291440	0.0000	5.1635	0.0000	0.0000	0.0000	0.0000
V 19 291460	0.0000	4.4743	0.0000	0.0000	0.0000	0.0000
V 19 291480	0.0000	1.5936	0.0000	0.0000	0.0000	0.0000
V 19 291500	0.0000	3.1496	0.0000	0.0000	0.0000	0.0000
V 19 291520	0.0000	2.7397	0.0000	0.0000	0.0000	0.0000
V 19 291540	0.0000	2.7613	0.0000	0.0000	0.0000	0.0000
V 19 291560	0.0000	1.8373	0.2625	0.0000	0.0000	0.0000
V 19 291580	0.0000	2.8653	0.0000	0.0000	0.0000	0.0000
V 19 291600	0.0000	5.3957	0.0000	0.3597	0.0000	0.0000
V 19 291620	0.0000	3.1034	0.0000	0.0000	0.0000	0.0000
V 19 291640	0.0000	5.3241	0.0000	0.0000	0.0000	0.0000
V 19 291660	0.0000	4.5643	0.0000	0.0000	0.0000	0.4149
V 19 291680	0.2882	8.0692	0.0000	0.2882	0.0000	0.0000
V 19 291690	0.0000	5.6106	0.0000	0.0000	0.0000	0.0000

SAMPLE NAME	TRUNC R	CRASSAFM	MENTUM	OUTER 5	OUTER 4
V 19 29 0	0.0000	0.0000	2.1563	79.5148	17.2507
V 19 29 1	0.0000	0.0000	1.4354	82.7751	14.3541
V 19 29 11	0.0000	0.0000	1.9108	74.5223	21.0191
V 19 29 19	0.0000	0.0000	2.6316	80.8271	15.7895
V 19 29 29	0.0000	0.0000	2.0979	79.4872	17.0163
V 19 29 39	0.0000	0.2519	1.7632	77.8337	14.6096
V 19 29 49	0.0000	0.0000	1.2461	74.4548	10.5919
V 19 29 60	0.0000	0.3704	1.1111	77.4074	13.3333
V 19 29 80	0.0000	0.0000	2.3622	74.8031	11.2861
V 19 29 100	0.0000	0.4032	1.6129	60.8871	13.9113
V 19 29 120	0.0000	0.6127	1.3480	47.9167	6.1274
V 19 29 140	0.0000	0.0000	1.2552	49.6513	8.5077
V 19 29 160	0.0000	0.0000	1.1182	69.6485	8.6262
V 19 29 180	0.0000	0.0000	1.5831	46.7018	10.8179
V 19 29 200	0.0000	0.0000	0.9662	42.9952	8.2126
V 19 29 220	0.0000	0.0000	1.4423	50.0000	9.3750
V 19 29 240	0.0000	0.0000	0.6873	54.2955	5.1546
V 19 29 260	0.0000	0.0000	2.8846	50.9615	2.8846
V 19 29 280	0.0000	0.0000	2.6667	45.3333	6.0000
V 19 29 300	0.0000	0.0000	4.6647	78.2799	5.2478
V 19 29 320	0.0000	0.0000	5.7692	80.1282	9.6154
V 19 29 340	0.0000	0.0000	2.8630	83.2311	8.5890
V 19 29 360	0.0000	0.0000	1.7778	82.6667	12.8889
V 19 29 380	0.0000	0.0000	2.3121	86.1272	9.2486
V 19 29 400	0.0000	0.0000	1.7699	88.4956	7.6696
V 19 29 420	0.0000	0.0000	1.1834	81.6568	8.5799
V 19 29 440	0.0000	0.0000	1.5152	86.9697	6.9697
V 19 29 460	0.0000	0.0000	0.5277	86.5435	9.4987
V 19 29 480	0.0000	0.0000	2.0408	78.4256	15.7434
V 19 29 500	0.0000	0.2315	3.0093	69.6759	15.0463
V 19 29 520	0.0000	11.8518	2.9630	68.5185	9.6296
V 19 29 540	0.0000	0.0000	2.1277	80.3191	11.1702
V 19 29 560	0.0000	0.0000	3.0581	79.8165	11.0092
V 19 29 580	0.0000	0.0000	1.6722	80.6020	12.0401
V 19 29 600	0.0000	0.0000	2.4631	84.7290	10.8374
V 19 29 620	0.0000	0.4348	1.9565	86.0869	11.5217
V 19 29 640	0.0000	0.0000	1.7476	85.4369	12.0388
V 19 29 660	0.0000	0.0000	1.9704	82.7586	14.2857
V 19 29 680	0.0000	0.0000	1.0363	89.8964	7.2539
V 19 29 700	0.0000	0.0000	1.4760	83.7638	11.8081
V 19 29 720	0.0000	0.0000	0.7326	87.1795	10.6227
V 19 29 740	0.0000	0.0000	2.6022	82.8996	13.0112
V 19 29 760	0.0000	0.5882	2.9412	84.1176	10.5882
V 19 29 780	0.0000	0.3509	1.4035	82.8070	11.9298

V	19 29 800	0.0000	0.0000	3.6190	70.8571	19.8095
V	19 29 820	0.0000	0.1976	2.5692	73.1225	20.5533
V	19 29 840	0.0000	0.0000	4.4025	74.8428	16.9811
V	19 29 860	0.0000	0.0000	1.4833	83.0655	12.4845
V	19 29 880	0.0000	0.3049	4.5732	78.0488	14.0244
V	19 29 900	0.0000	0.0000	0.6135	68.7117	22.0859
V	19 29 920	0.0000	0.0000	0.5510	72.4518	18.7328
V	19 29 940	0.0000	0.0000	0.7916	67.0185	29.0237
V	19 29 960	0.0000	0.0000	0.5566	72.9128	21.7068
V	19 29 980	0.0000	0.0000	1.1696	80.9941	11.1111
V	19 291000	0.0000	0.0000	1.2780	74.1214	17.2524
V	19 291020	0.0000	0.0000	0.6452	79.0322	17.7419
V	19 291040	0.0000	0.2252	0.4505	79.2793	15.0901
V	19 291060	0.0000	0.0000	0.8287	72.9282	14.6409
V	19 291080	0.0000	0.0000	0.7722	75.2896	10.4247
V	19 291100	0.0000	0.8333	1.2500	74.1667	9.1667
V	19 291120	0.0000	0.2079	0.6237	75.0520	11.2266
V	19 291140	0.0000	0.0000	1.3761	75.6881	12.8440
V	19 291160	0.0000	0.2941	0.8824	76.4706	14.7059
V	19 291180	0.0000	0.0000	2.8481	75.3165	12.9747
V	19 291200	0.0000	0.0000	0.8982	67.0659	21.8563
V	19 291220	0.0000	0.0000	1.6260	75.6097	20.7317
V	19 291240	0.0000	0.0000	6.0932	69.5340	22.9391
V	19 291260	0.0000	0.0000	8.9069	69.2308	20.2429
V	19 291280	0.0000	0.0000	7.6923	72.2222	15.3846
V	19 291300	0.0000	0.0000	3.4483	74.5690	20.2586
V	19 291320	0.0000	0.0000	14.7929	63.3136	21.8935
V	19 291340	0.0000	0.0000	1.5957	82.4468	14.3617
V	19 291360	0.0000	0.2421	7.5060	68.5230	19.1283
V	19 291380	0.0000	0.0000	2.4476	77.0979	15.5594
V	19 291400	0.0000	0.0000	1.1952	77.4900	12.5498
V	19 291420	0.0000	0.0000	0.6383	75.9574	13.1915
V	19 291440	0.0000	1.3769	0.8606	76.7642	15.8348
V	19 291460	0.0000	0.0000	0.8949	77.6286	17.0022
V	19 291480	0.0000	0.0000	1.1952	82.8685	14.3426
V	19 291500	0.0000	0.0000	1.5748	81.1024	14.1732
V	19 291520	0.0000	0.0000	1.8265	76.7123	18.7215
V	19 291540	0.0000	0.3945	0.7890	84.2209	11.8343
V	19 291560	0.0000	0.0000	0.0000	88.7139	9.1864
V	19 291580	0.0000	0.0000	0.5731	85.3868	11.1748
V	19 291600	0.0000	0.0000	1.0791	86.3309	6.8345
V	19 291620	0.0000	0.3448	1.7241	86.5517	8.2759
V	19 291640	0.0000	0.4630	3.9352	80.0926	10.1852
V	19 291660	0.4149	0.4149	0.4149	82.9875	10.7884
V	19 291680	0.0000	0.0000	1.4409	76.3689	13.5447
V	19 291690	0.0000	0.0000	1.9802	80.1980	12.2112

RAW FORAMINIFERAL COUNTS FOR CORE V21-29

SAMPLE NAME	UNIVERSA	CONGLOBT	RUBER	TENELLUS	SACC	DEHSCENS
V 21 29 1	1.0000	0.0000	79.0000	4.0000	24.0000	0.0000
V 21 29 25	2.0000	0.0000	31.0000	0.0000	9.0000	0.0000
V 21 29 45	1.0000	0.0000	26.0000	0.0000	9.0000	0.0000
V 21 29 65	1.0000	0.0000	23.0000	0.0000	8.0000	0.0000
V 21 29 85	3.0000	0.0000	31.0000	0.0000	6.0000	0.0000
V 21 29 105	3.0000	0.0000	16.0000	0.0000	5.0000	0.0000
V 21 29 125	0.0000	0.0000	13.0000	0.0000	2.0000	0.0000
V 21 29 145	0.0000	1.0000	23.0000	0.0000	5.0000	0.0000
V 21 29 165	4.0000	0.0000	4.0000	0.0000	5.0000	0.0000
V 21 29 185	4.0000	1.0000	25.0000	0.0000	3.0000	0.0000

SAMPLE NAME	AEQUILAT	CALIDA	BULLOIDS	FALCON	DIGITATA	RUBESCEN
V 21 29 1	30.0000	5.0000	283.0000	3.0000	0.0000	14.0000
V 21 29 25	3.0000	6.0000	140.0000	4.0000	0.0000	4.0000
V 21 29 45	30.0000	11.0000	240.0000	4.0000	2.0000	5.0000
V 21 29 65	6.0000	3.0000	168.0000	5.0000	0.0000	6.0000
V 21 29 85	8.0000	6.0000	194.0000	3.0000	0.0000	1.0000
V 21 29 105	3.0000	0.0000	198.0000	0.0000	0.0000	0.0000
V 21 29 125	7.0000	1.0000	142.0000	0.0000	0.0000	5.0000
V 21 29 145	18.0000	0.0000	243.0000	1.0000	0.0000	6.0000
V 21 29 165	2.0000	5.0000	196.0000	5.0000	0.0000	6.0000
V 21 29 185	3.0000	0.0000	326.0000	2.0000	0.0000	4.0000

SAMPLE NAME	HUMILIS	QUINQLBA	PACHY L	PACHY R	CONGLOMR	HEXAGONA
V 21 29 1	11.0000	2.0000	28.0000	521.0000	17.0000	1.0000
V 21 29 25	1.0000	0.0000	17.0000	229.0000	7.0000	0.0000
V 21 29 45	1.0000	0.0000	16.0000	279.0000	0.0000	0.0000
V 21 29 65	1.0000	0.0000	2.0000	221.0000	1.0000	0.0000
V 21 29 85	3.0000	1.0000	16.0000	252.0000	0.0000	0.0000
V 21 29 105	0.0000	0.0000	20.0000	211.0000	0.0000	0.0000
V 21 29 125	13.0000	1.0000	11.0000	136.0000	0.0000	0.0000
V 21 29 145	15.0000	0.0000	21.0000	250.0000	0.0000	2.0000
V 21 29 165	5.0000	0.0000	0.0000	220.0000	1.0000	0.0000
V 21 29 185	10.0000	3.0000	29.0000	321.0000	0.0000	0.0000

SAMPLE NAME	OBLIQUIL	INFLATA	TRUNC L	TRUNC R	CRASSAFM	MENTUM
V 21 29 1	1.0000	4.0000	0.0000	0.0000	5.0000	43.0000
V 21 29 25	0.0000	4.0000	0.0000	0.0000	0.0000	18.0000
V 21 29 45	0.0000	14.0000	0.0000	0.0000	0.0000	23.0000
V 21 29 65	0.0000	9.0000	0.0000	0.0000	0.0000	4.0000
V 21 29 85	0.0000	13.0000	0.0000	0.0000	3.0000	14.0000
V 21 29 105	0.0000	10.0000	0.0000	0.0000	13.0000	4.0000
V 21 29 125	0.0000	15.0000	0.0000	0.0000	5.0000	5.0000
V 21 29 145	2.0000	22.0000	0.0000	0.0000	17.0000	9.0000
V 21 29 165	0.0000	19.0000	1.0000	0.0000	10.0000	5.0000
V 21 29 185	0.0000	36.0000	0.0000	0.0000	22.0000	7.0000

SAMPLE NAME	GLUTINAT	DUTER 5	DUTER 4	THEYERI
V 21 29 1	95.0000	451.0000	70.0000	27.0000
V 21 29 25	35.0000	94.0000	135.0000	5.0000
V 21 29 45	54.0000	215.0000	64.0000	11.0000
V 21 29 65	57.0000	148.0000	73.0000	12.0000
V 21 29 85	39.0000	179.0000	73.0000	8.0000
V 21 29 105	30.0000	122.0000	89.0000	4.0000
V 21 29 125	24.0000	85.0000	51.0000	2.0000
V 21 29 145	44.0000	173.0000	77.0000	6.0000
V 21 29 165	30.0000	146.0000	74.0000	4.0000
V 21 29 185	62.0000	202.0000	119.0000	3.0000

SPECIES DATA FOR V21-29 EXPRESSED AS PERCENT RESISTANT FAUNA

SAMPLE NAME	PACHY L	PACHY R	CONGLOMR	OBLIQUIL	INFLATA	TRUNC L
V 21 29 1	0.3311	4.6358	0.0000	0.1656	0.6623	0.0000
V 21 29 25	0.0000	6.3433	0.0000	0.0000	1.4925	0.0000
V 21 29 45	0.0000	4.8193	0.0000	0.0000	4.2169	0.0000
V 21 29 65	0.0000	0.8439	0.4219	0.0000	3.7975	0.0000
V 21 29 85	0.3344	5.3512	0.0000	0.0000	4.3478	0.0000
V 21 29 105	0.0000	7.7519	0.0000	0.0000	3.8760	0.0000
V 21 29 125	0.5780	6.3584	0.0000	0.0000	8.6705	0.0000
V 21 29 145	0.0000	6.5421	0.0000	0.6231	6.8536	0.0000
V 21 29 165	0.0000	0.0000	0.0000	0.0000	7.4510	0.3922
V 21 29 185	0.7177	6.9378	0.0000	0.0000	8.6124	0.0000

SAMPLE NAME	TRUNC R	CRASSAFM	MENTUM	DUTER 5	DUTER 4
V 21 29 1	0.0000	0.8278	7.1192	74.6689	11.5894
V 21 29 25	0.0000	0.0000	6.7164	35.0746	50.3731
V 21 29 45	0.0000	0.0000	6.9277	64.7590	19.2771
V 21 29 65	0.0000	0.0000	1.6878	62.4473	30.8017
V 21 29 85	0.0000	1.0033	4.6823	59.8662	24.4147
V 21 29 105	0.0000	5.0388	1.5504	47.2868	34.4961
V 21 29 125	0.0000	2.8902	2.8902	49.1329	29.4798
V 21 29 145	0.0000	5.2959	2.8037	53.8941	23.9875
V 21 29 165	0.0000	3.9216	1.9608	57.2549	29.0196
V 21 29 185	0.0000	5.2632	1.6746	48.3253	28.4689

RAW FORAMINIFERAL COUNTS FOR CORE V21-212

SAMPLE NAME	UNIVERSA	CONGLOBT	RUBER	TENELLUS	SACC	DEHSCEN
V 21212 1	1.0000	2.0000	41.0000	0.0000	32.0000	0.0000
V 21212 19	0.0000	0.0000	18.0000	0.0000	13.0000	1.0000
V 21212 38	4.0000	0.0000	44.0000	0.0000	2.0000	0.0000
V 21212 59	4.0000	0.0000	28.0000	4.0000	1.0000	0.0000
V 21212 80	11.0000	2.0000	53.0000	0.0000	7.0000	0.0000
V 21212 101	2.0000	1.0000	38.0000	0.0000	7.0000	0.0000
V 21212 121	7.0000	2.0000	23.0000	0.0000	1.0000	0.0000
V 21212 139	0.0000	1.0000	11.0000	0.0000	4.0000	0.0000
V 21212 161	0.0000	7.0000	36.0000	2.0000	12.0000	0.0000
V 21212 180	5.0000	0.0000	30.0000	0.0000	5.0000	0.0000
V 21212 201	3.0000	0.0000	18.0000	0.0000	5.0000	0.0000

SAMPLE NAME	AEQUILAT	CALIDA	BULLOIDS	FALCON	DIGITATA	RUBESCNS
V 21212 1	7.0000	0.0000	18.0000	0.0000	0.0000	0.0000
V 21212 19	2.0000	0.0006	4.0000	0.0000	1.0000	4.0000
V 21212 38	3.0000	2.0000	20.0000	0.0000	0.0000	1.0000
V 21212 59	0.0000	1.0000	25.0000	0.0000	2.0000	1.0000
V 21212 80	8.0000	4.0000	47.0000	0.0000	0.0000	4.0000
V 21212 101	2.0000	0.0000	35.0000	0.0000	0.0000	2.0000
V 21212 121	1.0000	3.0000	16.0000	0.0000	0.0000	2.0000
V 21212 139	2.0000	1.0000	9.0000	0.0000	0.0000	0.0000
V 21212 161	11.0000	3.0000	35.0000	0.0000	0.0000	2.0000
V 21212 180	5.0000	3.0000	29.0000	0.0000	0.0000	0.0000
V 21212 201	3.0000	3.0000	28.0000	0.0000	0.0000	1.0000

SAMPLE NAME	HUMILIS	QUINQLBA	PACHY L	PACHY R	CONGLOMR	HEXAGONA
V 21212 1	0.0000	0.0000	0.0000	190.0000	2.0000	5.0000
V 21212 19	0.0000	0.0000	0.0000	170.0000	0.0000	0.0000
V 21212 38	0.0000	0.0000	0.0000	202.0000	1.0000	1.0000
V 21212 59	0.0000	0.0000	1.0000	155.0000	1.0000	4.0000
V 21212 80	0.0000	0.0000	1.0000	264.0000	1.0000	7.0000
V 21212 101	0.0000	0.0000	2.0000	201.0000	0.0000	3.0000
V 21212 121	0.0000	0.0000	2.0000	217.0000	0.0000	6.0000
V 21212 139	0.0000	0.0000	0.0000	211.0000	0.0000	2.0000
V 21212 161	0.0000	0.0000	6.0000	301.0000	1.0000	3.0000
V 21212 180	0.0000	0.0000	0.0000	269.0000	3.0000	5.0000
V 21212 201	0.0000	0.0000	0.0000	165.0000	0.0000	4.0000

SAMPLE NAME	OBLIQUIL	INFLATA	TRUNC L	TRUNC R	CRASSAFM	MENTUM
V 21212 1	5.0000	0.0000	0.0000	0.0000	0.0000	80.0000
V 21212 19	0.0000	0.0000	0.0000	0.0000	0.0000	26.0000
V 21212 38	1.0000	0.0000	0.0000	0.0000	0.0000	52.0000
V 21212 59	4.0000	7.0000	0.0000	0.0000	0.0000	64.0000
V 21212 80	7.0000	3.0000	0.0000	0.0000	3.0000	104.0000
V 21212 101	3.0000	6.0000	0.0000	0.0000	0.0000	115.0000
V 21212 121	6.0000	0.0000	0.0000	0.0000	0.0000	100.0000
V 21212 139	2.0000	0.0000	0.0000	0.0000	0.0000	118.0000
V 21212 161	3.0000	0.0000	0.0000	0.0000	0.0000	101.0000
V 21212 180	5.0000	0.0000	0.0000	0.0000	0.0000	119.0000
V 21212 201	4.0000	0.0000	0.0000	0.0000	0.0000	102.0000

SAMPLE NAME	GLUTINAT	DUTER 5	DUTER 4	THEYERI
V 21212 1	38.0000	161.0000	29.0000	5.0000
V 21212 19	18.0000	153.0000	17.0000	2.0000
V 21212 38	57.0000	160.0000	42.0000	3.0000
V 21212 59	32.0000	120.0000	35.0000	1.0000
V 21212 80	30.0000	236.0000	28.0000	0.0000
V 21212 101	24.0000	176.0000	25.0000	0.0000
V 21212 121	26.0000	185.0000	32.0000	1.0000
V 21212 139	17.0000	187.0000	24.0000	0.0000
V 21212 161	33.0000	268.0000	33.0000	1.0000
V 21212 180	40.0000	236.0000	33.0000	0.0000
V 21212 201	30.0000	141.0000	24.0000	0.0000

SPECIES DATA FOR V21-212 EXPRESSED AS PERCENT RESISTANT FAUNA

SAMPLE NAME	PACHY L	PACHY R	CONGLOMR	OBLIQUIL	INFLATA	TRUNC L
V 21212 1	0.0000	0.0000	0.0000	1.8182	0.0000	0.0000
V 21212 19	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
V 21212 38	0.0000	0.0000	0.0000	0.3922	0.0000	0.0000
V 21212 59	0.0000	0.4329	0.0000	1.7316	3.0303	0.0000
V 21212 80	0.0000	0.2618	0.0000	1.8325	0.7853	0.0000
V 21212 101	0.0000	0.6116	0.0000	0.9174	1.8349	0.0000
V 21212 121	0.0000	0.6154	0.0000	1.8462	0.0000	0.0000
V 21212 139	0.0000	0.0000	0.0000	0.6042	0.0000	0.0000
V 21212 161	0.0000	1.4599	0.0000	0.7299	0.0000	0.0000
V 21212 180	0.0000	0.0000	0.0000	1.2723	0.0000	0.0000
V 21212 201	0.0000	0.0000	0.0000	1.4760	0.0000	0.0000

SAMPLE NAME	TRUNC R	CRASSAFM	MENTUM	DUTER 5	DUTER 4
V 21212 1	0.0000	0.0000	29.0909	58.5455	10.5455
V 21212 19	0.0000	0.0000	13.2653	78.0612	8.6735
V 21212 38	0.0000	0.0000	20.3922	62.7451	16.4706
V 21212 59	0.0000	0.0000	27.7056	51.9481	15.1515
V 21212 80	0.0000	0.7853	27.2251	61.7801	7.3298
V 21212 101	0.0000	0.0000	35.1682	53.8226	7.6453
V 21212 121	0.0000	0.0000	30.7692	56.9231	9.8462
V 21212 139	0.0000	0.0000	35.6495	56.4955	7.2508
V 21212 161	0.0000	0.0000	24.5742	65.2068	8.0292
V 21212 180	0.0000	0.0000	30.2799	60.0509	8.3969
V 21212 201	0.0000	0.0000	37.6384	52.0295	8.8561

ESTIMATES OF SEA SURFACE TEMPERATURE
AND SEASONALITY IN V19-29

SAMPLE NAME	WINTER	SUMMER	SEASON
V 19 29 0	20.6979	26.4111	5.7132
V 19 29 1	20.3778	26.3007	5.9228
V 19 29 11	21.0229	26.4800	5.4570
V 19 29 19	20.6531	26.4480	5.7949
V 19 29 29	20.6586	26.3821	5.7234
V 19 29 39	20.2465	26.0477	5.8012
V 19 29 49	19.4045	25.3535	5.9490
V 19 29 60	20.0152	25.8916	5.8764
V 19 29 80	19.7332	25.6020	5.8688
V 19 29 100	19.0991	24.6444	5.5453
V 19 29 120	18.4843	23.6870	5.2027
V 19 29 140	18.3804	23.5690	5.1885
V 19 29 160	19.1294	24.9751	5.8456
V 19 29 180	17.4678	22.9912	5.5234
V 19 29 200	18.6655	23.6297	4.9642
V 19 29 220	19.5899	24.6017	5.0118
V 19 29 240	19.0360	24.4470	5.4110
V 19 29 260	18.7835	24.1775	5.3941
V 19 29 280	19.0023	24.1504	5.1480
V 19 29 300	19.6444	25.6820	6.0376
V 19 29 320	20.1299	26.0738	5.9439
V 19 29 340	19.8161	25.9350	6.1189
V 19 29 360	20.1958	26.1615	5.9657
V 19 29 380	20.0415	26.1954	6.1538
V 19 29 400	19.7725	26.0541	6.2816
V 19 29 420	19.9295	26.1500	6.2205
V 19 29 440	19.5674	25.8607	6.2934
V 19 29 460	19.7782	25.9884	6.2102
V 19 29 480	20.6428	26.4222	5.7795
V 19 29 500	20.3524	25.8144	5.4620
V 19 29 520	20.0031	25.8419	5.8388
V 19 29 540	20.2361	26.2781	6.0421
V 19 29 560	20.0737	26.0266	5.9529
V 19 29 580	19.9940	25.9544	5.9605
V 19 29 600	20.1181	26.1791	6.0610
V 19 29 620	20.1981	26.2801	6.0821
V 19 29 640	20.2029	26.2523	6.0494
V 19 29 660	20.4073	26.3127	5.9054
V 19 29 680	19.6942	26.0324	6.3382
V 19 29 700	20.1207	26.1505	6.0298
V 19 29 720	19.9992	26.1547	6.1555
V 19 29 740	20.3415	26.2774	5.9359
V 19 29 760	20.1521	26.2156	6.0635

V	19 29 780	20.0462	26.0672	6.0210
V	19 29 800	20.9982	26.3239	5.3257
V	19 29 820	21.0161	26.4390	5.4229
V	19 29 840	20.9189	26.4921	5.5732
V	19 29 860	20.1829	26.1911	6.0082
V	19 29 880	20.5602	26.3102	5.7501
V	19 29 900	20.7444	26.0545	5.3101
V	19 29 920	20.4387	25.9867	5.5480
V	19 29 940	21.6636	26.6437	4.9801
V	19 29 960	20.8558	26.2808	5.4250
V	19 29 980	19.8329	25.8666	6.0337
V	19 291000	20.3735	25.9953	5.6218
V	19 291020	20.5544	26.2816	5.7272
V	19 291040	20.2184	26.0703	5.8518
V	19 291060	19.9996	25.7286	5.7290
V	19 291080	19.4220	25.4126	5.9905
V	19 291100	19.2045	25.2222	6.0177
V	19 291120	19.4784	25.4278	5.9494
V	19 291140	19.7986	25.6495	5.8509
V	19 291160	20.1179	25.9200	5.8021
V	19 291180	20.1381	25.9052	5.7671
V	19 291200	20.7073	25.9770	5.2697
V	19 291220	20.9494	26.4489	5.4995
V	19 291240	21.6313	26.7423	5.1111
V	19 291260	21.6486	26.7777	5.1290
V	19 291280	20.8695	26.3214	5.4519
V	19 291300	21.1106	26.5506	5.4400
V	19 291320	22.4617	27.1689	4.7072
V	19 291340	20.3598	26.2663	5.9065
V	19 291360	21.5444	26.7774	5.2330
V	19 291380	20.4586	26.1859	5.7274
V	19 291400	19.8407	25.7448	5.9040
V	19 291420	19.7639	25.6287	5.8648
V	19 291440	20.3022	26.0609	5.7587
V	19 291460	20.4280	26.1472	5.7192
V	19 291480	20.3252	26.2521	5.9270
V	19 291500	20.2773	26.1655	5.8881
V	19 291520	20.7468	26.3462	5.5994
V	19 291540	20.0222	26.0903	6.0680
V	19 291560	19.7716	26.0421	6.2705
V	19 291580	19.9390	26.0581	6.1191
V	19 291600	19.4859	25.7916	6.3057
V	19 291620	19.7635	25.9916	6.2280
V	19 291640	20.0043	25.9778	5.9736
V	19 291660	19.8265	25.9235	6.0969
V	19 291680	19.9838	25.8157	5.8320
V	19 291690	20.0188	25.9612	5.9424

ESTIMATES OF DEPTH OF THE MIXED LAYER IN V19-29

SAMPLE NAME	WINTER	SUMMER
V 19 29 0	31.5460	16.6611
V 19 29 1	33.3842	17.6256
V 19 29 11	29.0357	15.0566
V 19 29 19	32.3542	17.3378
V 19 29 29	31.7439	16.7308
V 19 29 39	33.9436	17.4963
V 19 29 49	38.5005	19.0113
V 19 29 60	34.9654	17.8000
V 19 29 80	37.4703	19.0126
V 19 29 100	39.4601	17.9421
V 19 29 120	54.8028	28.2797
V 19 29 140	51.3635	25.1426
V 19 29 160	41.7700	20.8147
V 19 29 180	50.3198	21.3485
V 19 29 200	57.8540	30.4229
V 19 29 220	50.8070	27.8502
V 19 29 240	54.8991	30.1851
V 19 29 260	58.5925	32.3462
V 19 29 280	59.4931	32.8861
V 19 29 300	41.8827	22.7622
V 19 29 320	37.5112	20.3057
V 19 29 340	37.9702	20.1116
V 19 29 360	34.6438	18.2124
V 19 29 380	36.6830	19.7712
V 19 29 400	37.7561	20.0732
V 19 29 420	36.6138	19.4560
V 19 29 440	38.7223	20.2957
V 19 29 460	36.7822	19.1840
V 19 29 480	32.0985	17.0728
V 19 29 500	35.1468	18.2777
V 19 29 520	38.1858	20.3365
V 19 29 540	34.9669	18.6922
V 19 29 560	36.3102	19.2118
V 19 29 580	35.7467	18.5346
V 19 29 600	35.8928	19.1803
V 19 29 620	35.0858	18.7738
V 19 29 640	34.8791	18.5686
V 19 29 660	33.4793	17.7560
V 19 29 680	37.9024	20.0642
V 19 29 700	35.2906	18.6531
V 19 29 720	35.8139	18.9443
V 19 29 740	34.4247	18.4013
V 19 29 760	35.9049	19.2796
V 19 29 780	35.3775	18.4823

V	19 29 800	30.4938	15.9786
V	19 29 820	29.4669	15.3305
V	19 29 840	31.7194	17.1780
V	19 29 860	34.7106	18.3039
V	19 29 880	34.0115	18.3511
V	19 29 900	29.2306	14.1141
V	19 29 920	31.4294	15.5107
V	19 29 940	23.7178	11.5327
V	19 29 960	28.9488	14.4453
V	19 29 980	36.3786	18.7074
V	19 291000	32.4498	16.3036
V	19 291020	31.3748	16.1381
V	19 291040	33.3934	17.0575
V	19 291060	34.6876	17.2647
V	19 291080	38.1888	18.8925
V	19 291100	39.7974	19.6020
V	19 291120	37.6901	18.5770
V	19 291140	36.1879	18.1119
V	19 291160	34.0571	17.2186
V	19 291180	35.6296	18.5291
V	19 291200	29.4871	14.1319
V	19 291220	29.3067	15.1479
V	19 291240	27.8375	15.1415
V	19 291260	29.8662	16.8865
V	19 291280	33.8437	18.5403
V	19 291300	29.5243	15.6774
V	19 291320	29.2515	17.7901
V	19 291340	33.5014	17.6424
V	19 291360	29.9083	16.8208
V	19 291380	33.0844	17.2675
V	19 291400	35.9892	18.1759
V	19 291420	35.9168	17.8155
V	19 291440	33.0113	16.8198
V	19 291460	32.1732	16.4179
V	19 291480	33.4925	17.5725
V	19 291500	33.8729	17.6808
V	19 291520	30.7741	15.9630
V	19 291540	35.2621	18.4011
V	19 291560	36.7032	19.2014
V	19 291580	35.6946	18.6025
V	19 291600	38.9503	20.2699
V	19 291620	37.6454	19.8719
V	19 291640	37.1062	19.6801
V	19 291660	36.3076	18.7563
V	19 291680	35.2164	17.8291
V	19 291690	35.6512	18.4872

ESTIMATES OF THE DEPTH OF THE CENTER OF THE EUPHOTIC THERMOCLINAL LAYER AT SITE V19-29

SAMPLE NAME	WINTER	SUMMER
V 19 29 0	50.4423	35.2905
V 19 29 1	52.6629	36.8808
V 19 29 11	47.2487	32.3547
V 19 29 19	51.4769	36.6138
V 19 29 29	50.7221	35.3905
V 19 29 39	53.9426	36.4923
V 19 29 49	60.3738	38.5509
V 19 29 60	55.2879	36.8321
V 19 29 80	59.4798	38.8960
V 19 29 100	62.4287	35.6874
V 19 29 120	107.9243	49.2175
V 19 29 140	96.8023	44.7589
V 19 29 160	69.4805	40.8660
V 19 29 180	80.1634	38.7145
V 19 29 200	119.4484	50.5654
V 19 29 220	105.8209	48.3538
V 19 29 240	111.5490	51.9092
V 19 29 260	118.0334	55.6073
V 19 29 280	123.1837	54.9653
V 19 29 300	69.3163	45.4800
V 19 29 320	59.1350	42.0804
V 19 29 340	59.5695	41.2055
V 19 29 360	54.5097	37.8787
V 19 29 380	57.7219	40.6601
V 19 29 400	58.3202	41.1180
V 19 29 420	56.8534	39.9250
V 19 29 440	59.7721	41.3429
V 19 29 460	57.0172	39.3358
V 19 29 480	51.2834	35.9958
V 19 29 500	59.9164	37.4202
V 19 29 520	63.2183	41.0672
V 19 29 540	54.7535	38.8265
V 19 29 560	57.5524	39.6921
V 19 29 580	56.4313	38.2633
V 19 29 600	56.4427	39.6722
V 19 29 620	54.8573	38.9801
V 19 29 640	54.7087	38.5592
V 19 29 660	52.8797	37.1848
V 19 29 680	58.3387	40.9931
V 19 29 700	55.7393	38.5643
V 19 29 720	56.0853	38.9951
V 19 29 740	54.4927	38.3726

V	19	29 760	56.2448	39.9677
V	19	29 780	55.4992	38.2446
V	19	29 800	50.8254	34.0278
V	19	29 820	48.0462	32.9233
V	19	29 840	51.2466	36.6053
V	19	29 860	54.4916	38.0349
V	19	29 880	54.3069	38.5990
V	19	29 900	47.7844	30.0803
V	19	29 920	50.6340	32.6372
V	19	29 940	40.0419	25.6336
V	19	29 960	47.2113	30.8815
V	19	29 980	56.9683	38.4673
V	19	291000	52.0678	34.2018
V	19	291020	50.0785	34.0552
V	19	291040	52.8928	35.5475
V	19	291060	55.6133	35.6189
V	19	291080	59.7854	38.3323
V	19	291100	62.2090	39.4724
V	19	291120	59.1581	37.7530
V	19	291140	57.1738	37.2187
V	19	291160	54.0762	35.7679
V	19	291180	57.4744	38.2879
V	19	291200	48.2847	30.0601
V	19	291220	47.5138	32.4695
V	19	291240	46.4125	33.2002
V	19	291260	49.6791	36.8052
V	19	291280	54.9736	39.3628
V	19	291300	48.1008	33.7435
V	19	291320	49.8097	39.4143
V	19	291340	52.9018	36.9013
V	19	291360	49.5493	36.5030
V	19	291380	52.8326	36.2780
V	19	291400	56.7315	37.4027
V	19	291420	56.6781	36.5669
V	19	291440	52.6833	35.1392
V	19	291460	51.3606	34.4954
V	19	291480	52.8115	36.7148
V	19	291500	53.5418	36.8968
V	19	291520	49.5539	33.9254
V	19	291540	55.1540	38.0373
V	19	291560	56.6884	39.3394
V	19	291580	55.6219	38.3526
V	19	291600	60.0721	41.1945
V	19	291620	58.3583	40.7107
V	19	291640	58.4134	40.6511
V	19	291660	56.9594	38.4631
V	19	291680	55.7671	36.8689
V	19	291690	56.1503	38.2492

ESTIMATES OF TEMPERATURE AT THE CENTER
OF THE EUPHOTIC THERMOCLINAL LAYER
AT SITE V19-29

SAMPLE NAME	WINTER	SUMMER
V 19 29 0	19.6973	21.3968
V 19 29 1	19.5637	21.3248
V 19 29 11	19.8638	21.5339
V 19 29 19	19.6721	21.3682
V 19 29 29	19.6720	21.3724
V 19 29 39	19.3818	21.0709
V 19 29 49	18.8121	20.4799
V 19 29 60	19.2603	20.9786
V 19 29 80	18.9538	20.5867
V 19 29 100	18.4562	19.9826
V 19 29 120	14.7007	19.2455
V 19 29 140	14.8809	19.1026
V 19 29 160	16.2184	20.1259
V 19 29 180	15.1558	18.9080
V 19 29 200	14.6199	19.6216
V 19 29 220	15.3495	20.1524
V 19 29 240	15.1420	20.1367
V 19 29 260	14.7931	19.6846
V 19 29 280	14.8428	19.9884
V 19 29 300	18.6660	20.3852
V 19 29 320	19.1663	20.7017
V 19 29 340	19.1147	20.8240
V 19 29 360	19.4196	21.1582
V 19 29 380	19.3300	21.1207
V 19 29 400	19.2342	21.0341
V 19 29 420	19.3574	21.1949
V 19 29 440	19.0837	20.8729
V 19 29 460	19.2557	21.0837
V 19 29 480	19.6779	21.4060
V 19 29 500	19.0757	20.7255
V 19 29 520	18.9947	20.7337
V 19 29 540	19.4789	21.2373
V 19 29 560	19.2297	20.9018
V 19 29 580	19.2457	20.9695
V 19 29 600	19.3573	21.1011
V 19 29 620	19.4713	21.2464
V 19 29 640	19.4639	21.2400
V 19 29 660	19.5568	21.2935
V 19 29 680	19.2313	21.0733
V 19 29 700	19.3788	21.1616
V 19 29 720	19.3790	21.2235
V 19 29 740	19.4755	21.1939

V	19	29 760	19.3762	21.0938
V	19	29 780	19.3392	21.0962
V	19	29 800	19.6410	21.2066
V	19	29 820	19.8038	21.4235
V	19	29 840	19.6836	21.2400
V	19	29 860	19.4389	21.2012
V	19	29 880	19.4737	21.0482
V	19	29 900	19.6543	21.3121
V	19	29 920	19.4970	21.1899
V	19	29 940	20.2882	21.9769
V	19	29 960	19.7830	21.4962
V	19	29 980	19.1851	20.9300
V	19	291000	19.4350	21.1057
V	19	291020	19.6601	21.4179
V	19	291040	19.4467	21.2126
V	19	291060	19.1784	20.8765
V	19	291080	18.8662	20.5733
V	19	291100	18.6852	20.3597
V	19	291120	18.8984	20.6065
V	19	291140	19.0693	20.7415
V	19	291160	19.3228	21.0403
V	19	291180	19.1765	20.8156
V	19	291200	19.5981	21.2288
V	19	291220	19.8391	21.5277
V	19	291240	19.9986	21.4184
V	19	291260	19.8587	21.1328
V	19	291280	19.4242	20.7696
V	19	291300	19.8499	21.4478
V	19	291320	20.0297	20.9410
V	19	291340	19.5353	21.2832
V	19	291360	19.8781	21.2444
V	19	291380	19.4860	21.1408
V	19	291400	19.1329	20.8351
V	19	291420	19.0857	20.7951
V	19	291440	19.4478	21.1782
V	19	291460	19.5398	21.2667
V	19	291480	19.5356	21.3046
V	19	291500	19.4588	21.1901
V	19	291520	19.7022	21.3855
V	19	291540	19.3711	21.1695
V	19	291560	19.3029	21.1740
V	19	291580	19.3400	21.1541
V	19	291600	19.0415	20.8424
V	19	291620	19.1984	20.9799
V	19	291640	19.1609	20.7777
V	19	291660	19.2269	21.0398
V	19	291680	19.2010	20.8825
V	19	291690	19.2537	20.9519

CALCULATED VALUES OF DELTA THERMOCLINE IN V19-29

SAMPLE NAME	WINTER	SUMMER
V 19 29 0	1.0006	5.0143
V 19 29 1	0.8141	4.9759
V 19 29 11	1.1591	4.9461
V 19 29 19	0.9810	5.0798
V 19 29 29	0.9866	5.0097
V 19 29 39	0.8647	4.9768
V 19 29 49	0.5924	4.8736
V 19 29 60	0.7549	4.9130
V 19 29 80	0.7794	5.0153
V 19 29 100	0.6429	4.6618
V 19 29 120	3.7836	4.4415
V 19 29 140	3.4995	4.4664
V 19 29 160	2.9110	4.8492
V 19 29 180	2.3120	4.0832
V 19 29 200	4.0456	4.0081
V 19 29 220	4.2404	4.4493
V 19 29 240	3.8940	4.3103
V 19 29 260	3.9904	4.4929
V 19 29 280	4.1595	4.1620
V 19 29 300	0.9784	5.2968
V 19 29 320	0.9636	5.3721
V 19 29 340	0.7014	5.1110
V 19 29 360	0.7762	5.0033
V 19 29 380	0.7115	5.0747
V 19 29 400	0.5383	5.0200
V 19 29 420	0.5721	4.9551
V 19 29 440	0.4837	4.9878
V 19 29 460	0.5225	4.9047
V 19 29 480	0.9649	5.0162
V 19 29 500	1.2767	5.0889
V 19 29 520	1.0084	5.1082
V 19 29 540	0.7572	5.0408
V 19 29 560	0.8440	5.1248
V 19 29 580	0.7483	4.9849
V 19 29 600	0.7608	5.0780
V 19 29 620	0.7268	5.0337
V 19 29 640	0.7390	5.0123
V 19 29 660	0.8505	5.0192
V 19 29 680	0.4629	4.9591
V 19 29 700	0.7419	4.9889
V 19 29 720	0.6202	4.9312
V 19 29 740	0.8660	5.0835
V 19 29 760	0.7759	5.1218
V 19 29 780	0.7070	4.9710

V	19	29 800	1.3572	5.1173
V	19	29 820	1.2123	5.0155
V	19	29 840	1.2353	5.2521
V	19	29 860	0.7440	4.9899
V	19	29 880	1.0865	5.2620
V	19	29 900	1.0901	4.7424
V	19	29 920	0.9417	4.7968
V	19	29 940	1.3754	4.6668
V	19	29 960	1.0728	4.7846
V	19	29 980	0.6478	4.9366
V	19	291000	0.9385	4.8896
V	19	291020	0.8943	4.8637
V	19	291040	0.7717	4.8577
V	19	291060	0.8212	4.8521
V	19	291080	0.5558	4.8393
V	19	291100	0.5193	4.8625
V	19	291120	0.5800	4.8213
V	19	291140	0.7293	4.9080
V	19	291160	0.7951	4.8797
V	19	291180	0.9616	5.0896
V	19	291200	1.1092	4.7482
V	19	291220	1.1103	4.9212
V	19	291240	1.6327	5.3239
V	19	291260	1.7899	5.6449
V	19	291280	1.4453	5.5518
V	19	291300	1.2607	5.1028
V	19	291320	2.4320	6.2279
V	19	291340	0.8245	4.9831
V	19	291360	1.6663	5.5330
V	19	291380	0.9726	5.0451
V	19	291400	0.7078	4.9097
V	19	291420	0.6782	4.8336
V	19	291440	0.8544	4.8827
V	19	291460	0.8882	4.8805
V	19	291480	0.7896	4.9475
V	19	291500	0.8185	4.9754
V	19	291520	1.0446	4.9607
V	19	291540	0.6511	4.9208
V	19	291560	0.4687	4.8681
V	19	291580	0.5990	4.9040
V	19	291600	0.4444	4.9492
V	19	291620	0.5651	5.0117
V	19	291640	0.8434	5.2001
V	19	291660	0.5996	4.8837
V	19	291680	0.7828	4.9332
V	19	291690	0.7651	5.0093

ESTIMATES OF SEA-SURFACE TEMPERATURE
AND SEASONALITY IN V21-29

SAMPLE NAME	WINTER	SUMMER	SEASON
V 21 29 1	22.8575	26.1565	3.2990
V 21 29 25	26.1897	27.0838	0.8940
V 21 29 45	23.7084	26.3092	2.6008
V 21 29 65	24.4983	26.7780	2.2797
V 21 29 85	24.0548	26.3531	2.2983
V 21 29 105	24.6767	26.3284	1.6517
V 21 29 125	24.5014	26.1918	1.6904
V 21 29 145	23.9061	26.0544	2.1483
V 21 29 165	24.5975	26.6947	2.0972
V 21 29 185	24.2680	26.0354	1.7673

APPENDIX H TABLE 7

ESTIMATES OF THE DEPTH OF THE MIXED LAYER IN V21-29

SAMPLE NAME	WINTER	SUMMER
V 21 29 1	36.5000	20.0038
V 21 29 25	14.4338	4.9560
V 21 29 45	31.7920	17.3875
V 21 29 65	22.6921	11.3962
V 21 29 85	27.8134	14.4939
V 21 29 105	20.9420	8.8809
V 21 29 125	25.1287	12.2623
V 21 29 145	28.5803	14.4315
V 21 29 165	24.0056	12.4980
V 21 29 185	25.7672	12.2659

ESTIMATES OF THE DEPTH OF THE CENTER OF THE EUPHOTIC THERMOCLININAL LAYER IN V21-29

SAMPLE NAME	WINTER	SUMMER
V 21 29 1	58.8772	20.0038
V 21 29 25	26.2685	4.9560
V 21 29 45	55.9657	17.3875
V 21 29 65	41.5736	11.3962
V 21 29 85	50.6421	14.4939
V 21 29 105	40.4617	8.8809
V 21 29 125	51.3249	12.2623
V 21 29 145	54.7483	14.4315
V 21 29 165	47.5454	12.4980
V 21 29 185	52.4148	12.2659

APPENDIX H TABLE 9

ESTIMATES OF TEMPERATURE AT THE CENTER OF THE EUPHOTIC THERMOCLINAL LAYER IN V21-29

SAMPLE NAME	WINTER	SUMMER
V 21 29 1	17.0727	20.6358
V 21 29 25	19.5327	23.1526
V 21 29 45	17.3094	20.8356
V 21 29 65	18.2263	22.0744
V 21 29 85	17.5988	21.2210
V 21 29 105	18.2292	22.0405
V 21 29 125	17.7051	21.5233
V 21 29 145	17.3910	21.1769
V 21 29 165	18.0305	21.9680
V 21 29 185	17.6087	21.5179

CALCULATED VALUES OF DELTA THERMOCLINE IN V21-29

SAMPLE NAME	WINTER	SUMMER
V 21 29 1	5.7848	5.52Ø7
V 21 29 25	6.657Ø	3.9312
V 21 29 45	6.399Ø	5.4736
V 21 29 65	6.272Ø	4.7Ø36
V 21 29 85	6.456Ø	5.1321
V 21 29 1Ø5	6.4475	4.2879
V 21 29 125	6.7963	4.6685
V 21 29 145	6.5151	4.8775
V 21 29 165	6.567Ø	4.7267

ESTIMATES OF SEA-SURFACE TEMPERATURE AND SEASONALITY IN V21-212

SAMPLE NAME	WINTER	SUMMER	SEASON
V 21212 1	24.8571	27.2634	2.4063
V 21212 19	23.2230	26.5713	3.3482
V 21212 38	24.7850	27.1813	2.3963
V 21212 59	25.4742	27.3483	1.8742
V 21212 80	24.3262	27.0165	2.6904
V 21212 101	24.9386	27.2295	2.2909
V 21212 121	24.8816	27.2481	2.3666
V 21212 139	24.8658	27.2977	2.4319
V 21212 161	24.0724	26.8728	2.8004
V 21212 180	24.6482	27.1918	2.5436
V 21212 201	25.2390	27.4468	2.2078

APPENDIX H TABLE 12

ESTIMATES OF THE DEPTH OF THE MIXED LAYER IN V21-212

SAMPLE NAME	WINTER	SUMMER
V 21212 1	41.5383	27.4959
V 21212 19	38.2766	22.4754
V 21212 38	34.3362	21.7882
V 21212 59	38.9600	26.2017
V 21212 80	43.4620	28.2052
V 21212 101	47.1076	31.6781
V 21212 121	42.9551	28.5356
V 21212 139	46.4460	31.1792
V 21212 161	41.9567	26.5822
V 21212 180	43.4082	28.6374
V 21212 201	46.6305	31.7481

ESTIMATES OF THE DEPTH OF THE CENTER OF THE EUPHOTIC THERMOCLINAL LAYER IN V21-212

SAMPLE NAME	WINTER	SUMMER
V 21212 1	68.0397	58.6114
V 21212 19	60.9826	47.2222
V 21212 38	57.4752	47.3894
V 21212 59	67.7881	55.9565
V 21212 80	71.0402	59.4311
V 21212 101	77.5373	66.2956
V 21212 121	70.1476	60.6112
V 21212 139	74.8261	65.6039
V 21212 161	67.9886	56.2019
V 21212 180	70.4725	60.6489
V 21212 201	75.2790	66.8654

APPENDIX H TABLE 14

ESTIMATES OF TEMPERATURE AT THE CENTER OF THE EUPHOTIC THERMOCLINAL LAYER IN V21-212

SAMPLE NAME	WINTER	SUMMER
V 21212 1	17.2336	19.5348
V 21212 19	17.1664	20.5062
V 21212 38	17.5753	20.3310
V 21212 59	17.3417	19.6042
V 21212 80	16.9958	19.4738
V 21212 101	16.9425	18.9656
V 21212 121	17.1596	19.3553
V 21212 139	17.0522	19.0947
V 21212 161	17.0178	19.6427
V 21212 180	17.1110	19.4114
V 21212 201	17.1510	19.0185

CALCULATED VALUES OF DELTA THERMOCLINE IN V21-212

SAMPLE NAME	WINTER	SUMMER
V 21212 1	7.6235	7.7286
V 21212 19	6.0566	6.0651
V 21212 38	7.2097	6.8503
V 21212 59	8.1325	7.7441
V 21212 80	7.3304	7.5427
V 21212 101	7.9961	8.2639
V 21212 121	7.7220	7.8928
V 21212 139	7.8136	8.2030
V 21212 161	7.0546	7.2301
V 21212 180	7.5372	7.7804
V 21212 201	8.0880	8.4283