Differences between the lower Pliocene planktonic foraminiferal ranges of Italy and southern California include: (1) appearance of *Globorotalia crassaformis* Galloway and Wissler in the lower Pliocene of California whereas it does not appear until the middle Pliocene in Italy; (2) *Turborotalia inflata* (d'Orbigny) first appears as a rare member of *T. puncticulata* populations in the lower Pliocene of southern California whereas it first appears in the upper Pliocene of Italy; and (3) *Globigerina pachyderma* (Ehrenberg) occurs in the lower Pliocene of both areas; it is dextrally coiled in southern California and probably is dextral in Italy as well.

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FORAMINIFERAL TRENDS IN OREGON SUBLITTORAL

Benthic foraminiferal species from a part of the central Oregon shelf are grouped into four distinct bathymetric faunas. *Elphidiella hannai* and *Buccella* spp. are indicative of Fauna A (17–50 m). Fauna B (50–100 m) is characterized by *Buliminella elegantissima* and *Elphidium magellanicum*. In the rocky area off Cape Arago *Cassidulina californica, C. limbata, Cibicides fletcheri,* and *C. lobatulus* become dominant. *Spiroplectammina biformis, Textularia earlandi,* and *Trifarina angulosa* are important species of Fauna C (100–175 m). Abundant species of Fauna D (175–339 m) include *Eggerella advena, Epistominella exigua,* and *Uvigerina juncea.*

Species diversity increases offshore to a maximum of about 35 benthic species near 100 m and then decreases slightly with depth. The standing crop is small nearshore, increases to a maximum of approximately 300 specimens per 20 cm^3 between 125 and 150 m, and then declines. The total benthic population reaches a maximum of approximately 6,000 specimens per sample between depths of 150 and 175 m. Values then decrease to about 2,000 specimens at 339 m. A maximum of 15–20 percent live benthic specimens occurs near 50 m. Planktonic Foraminifera normally constitute less than 10 percent of the total population. Maximum percentages generally are in water shallower than 100 m, whereas maximum specimens per sample are at the deepest stations. Porcelaneous specimens do not exceed 6 percent of the benthic population. Agglutinated Foraminifera are more abundant than calcareous specimens at depths greater than 100 m.

Miscellaneous biofacies trends indicate that: thecameobians are most abundant between 50 and 125 m; statoliths and otoliths are most abundant between 75 and 200 m; the largest number of ostracods are between 25 and 150 m; and radiolarians generally predominate over Foraminifera below 250 m.

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DISTRIBUTION OF FORAMINIFERA ON ALASKAN AND SIBERIAN CONTINENTAL SHELVES

Through the greater part of the inner sublittoral zone of the Alaskan and Siberian shelves, the foraminiferal fauna is dominated by species with an arenaceous test wall. Species are few and generally one species is overwhelmingly dominant, but the dominant species is different from one area to the next as a result of changes in the oceanographic regime.

Oceanographic conditions in the Chukchi Sea are dominated by northward flow of water from the Bering Sea through Bering Strait. In both seas adjacent to the coast of Alaska the water is warmer and less saline and *Eggerella advena* is dominant in bottom sediments. Farther offshore in both seas *Reophax arctica* is dominant. Dominance by these two species extends northward to the limits of the permanent ice pack beyond which *Textularia torquata* is dominant on the Siberian shelf and *Spiroplectammina biformis* on the Alaskan shelf. High relative frequencies of *S. biformis* also characterize the Gulf of Anadyr where very cold bottom waters persist all year.

Two calcareous faunas exist. An *Elphidium clavatum*-dominated fauna is associated with deltaic environments or more polar shelf environments. The other calcareous fauna has a greater diversity, especially in *Elphidium* spp. and *Buccella* spp., and generally is associated with coarser grained sediment in straits and nearshore areas. This latter calcareous fauna may represent, in part, reworked or relict faunas.

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SECONDARY CALCIFICATION IN *Globorotalia Menardii* (FORAMINIFERIDA)

Specimens of the planktonic foraminifer *Globorotalia menardii* (Parker, Jones, and Brady) were examined in bottom samples from three profiles across the continental shelf and slope of the South China Sea. This species is absent in inner shelf assemblages; middle-shelf populations of *G. menardii* are dominated by forms with tests characterized by smooth, thin, translucent walls and unthickened keels (*G. "cultrata"* of authors). Specimens with coarsely crystalline crust covering much of the test wall and keel become increasingly common seaward, although the distribution of crust-bearing forms on the outer shelf is irregular because of current transport. The percentage of incrusted tests in bottom sediments reaches values of 80–100 just beyond the shelf edge (180–275 m), and these values are maintained across most of the continental slope. A narrow zone of high percentages of noncrusted forms occurs in all three profiles on the upper continental slope at depths of 275–500 m; these deposits represent concentrations of small tests swept off the shelf.

Young specimens of *G. menardii* live at relatively shallow depths. By the early adult stage of development, the individual organisms descend in the water column where they continue to grow. At increased depth, development of a secondary crystalline crust begins, first with thickening of the keel and then with incrustation on both dorsal and ventral walls. Secondary calcification on the exterior walls of the last chamber, including the apertural face, is represented by thickening and increased opacity of the wall without the development of a typical crust. Because chambers are added after the onset of crust formation, the lack of secondary calcification on septa and on the ventral walls of chambers enclosed within the last whorl of the test indicates that previously secreted crystalline crust has been resorbed.

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SIZE-DEPTH VARIATION IN FORAMINIFER *Cyclammina Cancellata* BRADY FROM PERU-CHILE TRENCH AREA

Cyclammina cancellata Brady shows marked variations of diameter and thickness in Holocene sediments from depths of 500 m to more than 3,500 m in the Peru-Chile Trench area. The mean diameter increases consistently to a maximum of 5 mm at 2,000 m. Fluctuations between 4 and 5 mm follow from 2,000 to 3,500 m, and a decreasing trend characterizes deeper samples. The mean thickness increases steadily downward to about 3,500 m where a slight decrease sets in.

Using mean diameter, thickness, and a ratio between both, populations of this study can be characterized as to depth zones. Thus, small and relatively thick forms appear at about 500 m; larger and proportionally thinner forms live deeper than 1,000 m; large but relatively thick specimens characterize depths of about 2,000 to 3,500 m; and somewhat smaller and thicker ones are typical for depths below 3,500 m.

Temperature may be the principal factor affecting size, because it increases markedly to about 2,000 m—which coincides with the greatest size change in the populations. In deeper water other factors may play a role. Oxygen, salinity, and nitrate values do not show significant trends. Pressure alone is not directly involved, because off southern California similar size variations occur in different depth zones.

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GEOLOGIC SIGNIFICANCE OF *Prunopyle Titan* CAMPBELL AND CLARK

The radiolarian *Prunopyle titan* Campbell and Clark has been shown by Ingle to be an index of the upper Miocene in California. Its greatest abundance is within the upper Mohnian of southern California where it occurs with sinistrally coiled populations of *Globigerina pachyderma* (Ehrenberg), a cold-water index. In deep-sea cores from high latitudes, *Prunopyle titan* has an upper stratigraphic limit within what is termed by some authors the "Gauss Normal Magnetic Epoch" and a bottom limit below what has been termed the "Gilbert Reversed Magnetic Epoch." The range of *Prunopyle titan* is below the zone of *Pterocanium prismatium* Riedel; the latter is considered to be an index of the Pliocene.

In land sections, K-Ar dates indicate that the upper limit of *Prunopyle titan* is about 9–10 m.y. before the present; in deep-sea cores the upper stratigraphic level of *P. titan* is equated with an age of about 3 m.y. or less. At least three upper Miocene radiolarians are associated with *P. titan* in both its occurrences in deep-sea cores and in the upper Miocene of southern California. No Pliocene radiolarian indices occur in the *P. titan* zone of deep-sea cores. If the paleomagnetic record of deep-sea cores is correctly related to that of volcanic rocks, and the radiometric dates of the latter are valid, the radiometric dates for the later Tertiary marine section of California are about three times too old.

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ULTRASTRUCTURE STUDIES OF SELECTED BENTHIC FORAMINIFERA

Electron microscopy of benthic calcareous Foraminifera reveals the presence of a calcite layer on both external and internal test surfaces. This layer is analogous to the calcite crust which has been reported on external surfaces of planktonic Foraminifera. The crust was observed on two granular-walled species, *Nonionella scapha* and *Nonionella miocenica,* and on two radial-walled species, *Cancris indicus* and *Bolivina spissa.* On these four species, the crust is a very thin layer which occurs only on specimens from the greater depth ranges. Where no crust is present, test surfaces of granular- and radial-walled species have different appearances at high magnifications. However, crusts may cause surfaces on both groups to appear similar. On the radial-walled species *Bolivina argentea,* crust is noticeable on specimens from shallow water and becomes progressively thicker, reaching a maximum thickness of more than 4 μ at the lower end of the depth range. Specimens of *B. argentea* from a low oxygen environment have thinner crusts than specimens from a normal environment of the same depth. The crust is not a postmortem feature because it is found on specimens which have absorbed a rose bengal stain. The crust is generally thicker on early than on late chambers, indicating its probable secondary origin.

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TERTIARY FORAMINIFERAL PALEOECOLOGY AND BIOSTRATIGRAPHY OF PART OF OREGON CONTINENTAL MARGIN

Several thousand feet of late Tertiary marine sediments crop out across Heceta Bank on the central Oregon shelf. Rock samples from two east-west profiles (44°05′ and 44°10′ N) have yielded large, well-preserved foraminiferal faunas. The stratigraphic sequence of the samples has been determined using sparker subbottom profiles.

Two possible stratigraphic units are delineated on the basis of their foraminiferal content, seismic-reflection characteristics, and lithology. The older is characterized by *Bolivina seminuda foraminata, B. semiperforata, B. spissa, Bulimina subacuminata, B. subcalva, Buliminella* cf. *B. exilis, Epistominella pontoni californica,* and *Uvigerina peregrina;* less than 10 percent planktonic foraminifers; and right-coiling *Globigerina pachyderma.* This fauna represents paleodepths of 500–1,000 m and is dated as Pliocene. The younger unit is characterized by *Cassidulina minuta, Eilohedra levicula, Epistominella exigua, Nonionella* spp., *Trifarina angulosa,* and *Uvigerina juncea;* more than 50 percent planktonic foraminifers; and left-coiling *G. pachyderma.* This unit was deposited at depths of 100–200 m. This fauna could be Pliocene or Pleistocene. Paleoenvironmental data require minimal uplifts ranging from approximately 1,000 m for the oldest sampled strata to 100 m for the youngest. There was a general shoaling throughout the deposition of the units.

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CORRELATION OF MARINE MIDDLE TERTIARY STAGES OF CALIFORNIA WITH TROPICAL PLANKTONIC ZONES

The Oligocene-Miocene boundary is equated with