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Living Planktonic Foraminifera from the Equatorial and Southeast Pacific

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SUMMARY

1. A study was made of 81 plankton samples, mostly from the equatorial and southeast Pacific Ocean. The distribution patterns of 16 of the more common planktonic species of Foraminifera are as follows: 1) Widespread – *Globigerinella aequilateralis, Globigerinoides ruber, Hastigerina pelagica, Orbulina universa*; 2) Equatorial and southeast-central – *Globigerina eggeri, Globigerinoides conglobatus, G. sacculifer*; 3) Equatorial – *Globigerina conglomerata, G. hexagona, Globorotalia menardii* (few exceptions), *Pullenia-tina obliquiloculata* (one exception); 4) Southeast central and subantarctic – *Globigerina bulloides, G. inflata, Globorotalia punctulata, G. truncatulinoides*; 5) Subantarctic – *Globorotalia scitula*.

2. Temperature may be more critical than salinity in controlling these distributions. No conclusions about the physical limits for survival of the planktonic species can be formed until it is known exactly at what water levels they live.

3. Total populations were largest in the equatorial region, in a small area close to the coast of South America, and at a few stations in the northern part of the subantarctic region. These are the regions richest in nutrients.

4. The largest populations were found in the upper 200 m. In addition, the populations from daytime oblique tows from various depths exceeded by a factor of ten the number found in corresponding night tows at the same station. The possible dependence of the planktonic Foraminifera on symbiotic algae is suggested as the reason for the apparent preference for the euphotic zone. Nothing further can be said until more is known about the habits of the planktonic Foraminifera.

INTRODUCTION

This paper supplements that of Bradshaw (1959) on the North and equatorial Pacific. It extends the study of living planktonic species into the southeast Pacific as well as confirming some of the earlier observations in the equatorial and, to a lesser extent, the northeastern Pacific. The work was supported by the University of California under contract with the Office of Naval Research. John S. Bradshaw made valuable suggestions; Jean Peirson Hosmer drafted the figures.

LOCATION OF SAMPLES AND SAMPLING METHODS

Eighty-one planktonic samples collected from the R/V *Horizon* on the Downwind Expedition of the Scripps Institution of Oceanography (October, 1957–February, 1958) were analyzed (*see* Fig. 1). The area covered extends south of the equator to Lat. 46°45'S., between South America and Long. 149°21'W. Six stations north of the equator lie between Longs. 115°50'W. and 130°31'W., the most northerly being at Lat. 29°25.5'W.

Four types of samples were studied: 1) oblique tows (66) taken with a standard meter net (mesh openings *ca.* 0.65 mm.) from depths of 140 m., 280 m., and 560 m. to the surface; 2) vertical tows (8) from depths of 280–300 m. to the surface taken with a half-meter net (mesh openings *ca.* 0.33 mm.) ; 3) vertical tows (3) from depths of 740 m., or more, to the surface taken with a coarse-mesh net having a fine-mesh cod end (mesh openings *ca.* 0.33 mm.); 4) opening-closing net (mesh openings *ca.* 0.67 mm.) samples (4) taken at various depths.

Table 1 lists the stations, locations, types of tows (given by number as listed above), and the depths fished.

The samples were preserved in a 5–10% solution of formalin. The concentrated formalin had been previously saturated with hexamethylenetetramine to prevent solution of the foraminiferal tests.

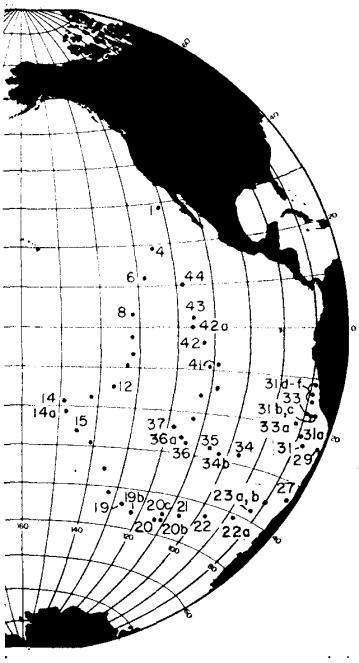

Fig. 1. Station locations

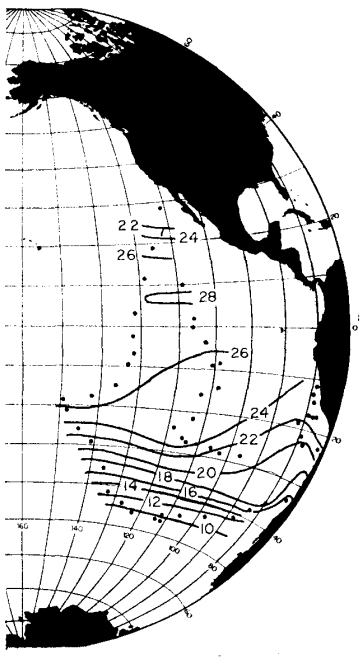

Fig. 2. Surface temperatures (°C)

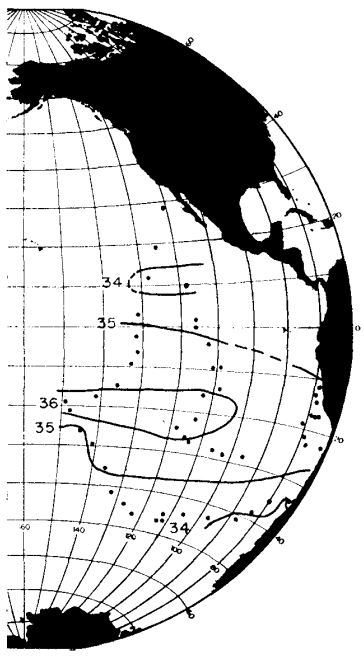

Fig. 3. Surface salinities (‰)

Table 1

Station	Location		Type of tow	Depth sampled in meters
	Latitude	W. Longitude		
1	29°25.5′N.	120°26.5′	1	301
4	19°34.5′N.	125°00′	1	353
6	11°00′N.	128°30′	1	230
8	3°14′N.	130°31′	1	230
9	2°08′S.	131°27′	1	306
10	6°05′S.	131°31′	1	386
11	9°59′S.	133°20′	1	452
12	14°27′S.	135°25.5′	1, 3	301, 740
13	18°16.5′S.	141°22′	1	258
14	19°22′S.	149°21′	1	346
14 a	21°26′S.	148°21′	1	514
15	24°57′S.	145°01.5′	1	298
16	29°53′S.	140°06′	1, 1	123, 424
17	34°50′S.	135°53′	1, 1	287, 575
18	40°33′S.	131°50′	1, 1	283, 565
19	44°20′S.	127°15′	1, 1	283, 565
19 b	46°25′S.	123°38′	1	565
20	46°44′S.	113°09′	1	848
20 b	46°45′S.	112°50′	1	283
20 c	44°36′S.	112°08′	1	565
21	43°50′S.	105°30′	3, 1	1250, 306
22	42°54′S.	97°08′	1, 1	283, 565
22 a	40°39′S.	88°02′	1, 1, 1	129, 257, 612
23 a	38°46′S.	83°20′	2	352
23 b	35°02′S.	80°01.5′	2	338
27	33°10.5′S.	73°10′	2	355
29	22°38′S.	72°00′	1, 1	258, 515
31	22°27′S.	78°26′	1	278
31 a	21°19′S.	79°09.5′	2	326
31 b	17°18.5′S.	78°18′	1	283
31 c	17°10′S.	77°01′	2	347
31 d	14°02.5′S.	78°25′	2, 4	347, 141- 283
31 e	12°53′S.	79°43.5′	1	339
31 f	11°49.5′S.	79°05.5′	1	141
33	17°15′S.	79°00′	1	283
33 a	19°02.5′S.	80°21′	1	257
34	28°00′S	96°54′	2, 1, 1	358, 368, 536
34 b	29°15′S.	102°25.5′	1, 1	136, 273
35	28°45.5′S.	106°07′	1, 1, 3	136, 273, 2680
36	27°23.5′S.	113°43′	1, 1	292, 585
36 a	26°41′S.	114°45′	1	1830
37	23°39′S.	118°12′	1, 1, 1	141, 283, 514
38	21°10′S.	113°45.5′	1, 1	283, 565
39	15°45′S.	112°07′	1, 1	153, 306
40	14°17′S.	108°52′	1, 1	173, 346
41 (day)	9°42′S.	110°11′	1, 1, 1	141, 283, 555
41 (night)	9°13′S.	109°42′	1, 1, 1	158, 283, 555
42	4°05′S.	113°13′	1, 1	164, 328
42 a	00°00′S.	116°32′	1, 4, 4	71, 64-129, 100-258
43	2°01′N.	115°50′	4	141- 283
44	10°01.5′S.	118°58′	1	141

LABORATORY METHODS

Most of the samples were examined completely and all the Foraminifera counted. A few contained very large numbers of Foraminifera or other plankters; half of these were examined and the totals estimated. The data on total populations (*see* Fig. 20) are given in

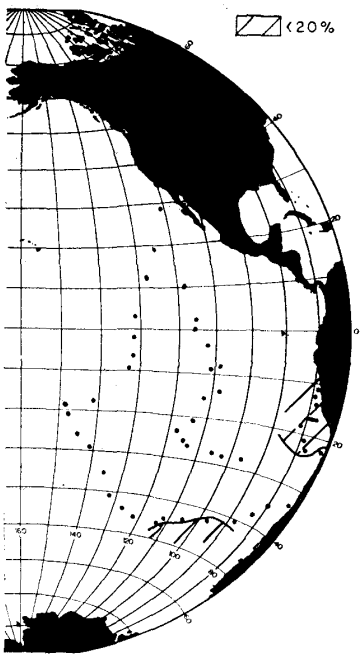

Fig. 4. Globigerina bulloides

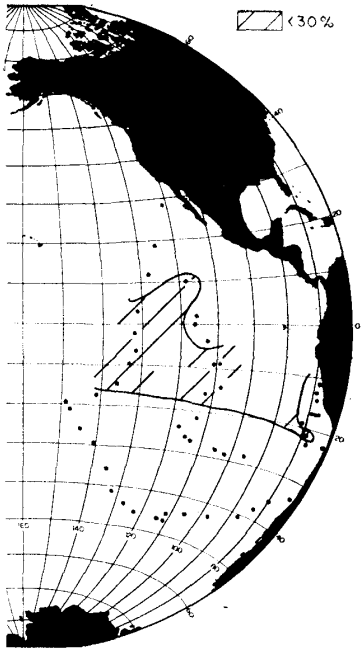

Fig. 5. Globigerina conglomerata

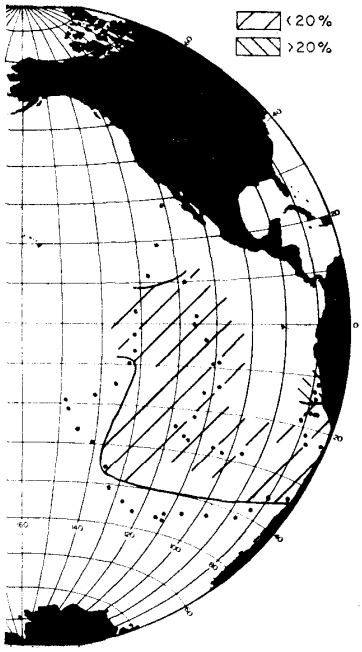

Fig. 6. Globigerina eggeri

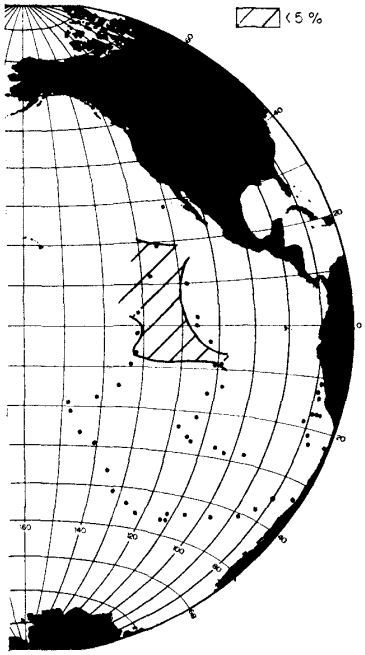

Fig. 7. Globigerina hexagona

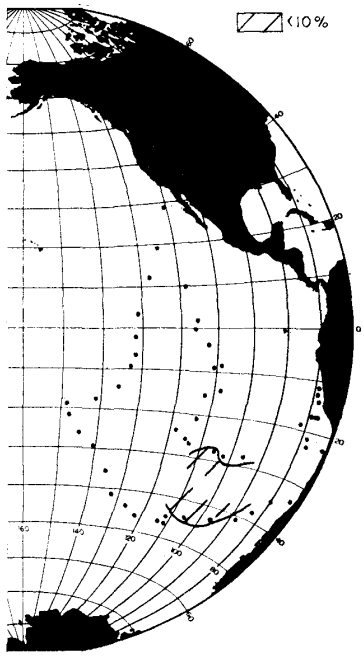

Fig. 8. Globigerina inflata

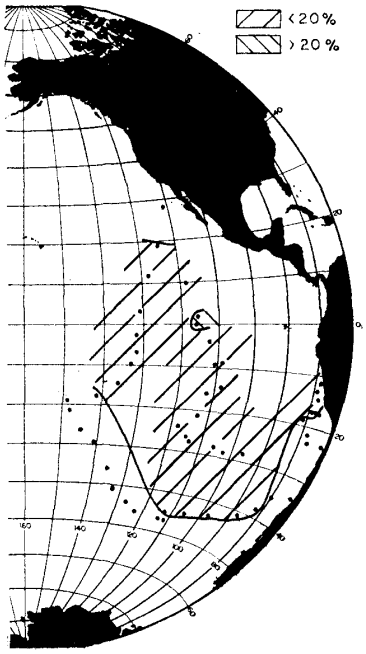

Fig. 9. Globigerinella aequilateralis

numbers of individuals per 1000 cubic meters, since this is the standard method of presenting plankton data. The specimens from all the tows at any one station were used in calculating the percentage frequencies of species (*see* Figs. 4–19). This adds to the validity of the percentages, since the number taken in any one tow was frequently small. For discussions of the problems involved in different sampling methods, variations due to patchiness, etc., the reader is referred to the papers of Bé (1959) and Bradshaw (1959).

DESCRIPTION OF THE AREA

Many diverse upper water masses were traversed in the course of the expedition. Sverdrup *et al.* (1942, fig. 209b) show the temperature-salinity relationships of these water masses in the Pacific Ocean (*see* also Bradshaw, 1959). Each follows a characteristic pattern. By analyzing the data obtained at the Downwind hydrographic stations, it is possible to get at least a general idea of the conditions at the time of sampling. Station 1 appeared to be in water that was transitional from subarctic to equatorial water; stations 4–11, 31b–f, 33, 41–44 in equatorial water; stations 12–17, 28–31a, 34–40 in southeast central water; stations 23a ?, 23b, and 27 in water that was transitional from southeast central to subantarctic water, at least in the upper few hundred meters; stations 18–22a in subantarctic water (also probably somewhat transitional in character).

The surface temperatures taken on the Downwind Expedition are illustrated (*see* Fig. 2). At station 1 the temperature was 20.6°C. Surface temperatures increased to the south reaching 27°C. between stations 4 and 6. In the central area, including stations 8–14, 42–44, they were 27–28°C. To the south there was considerable variation between the eastern and western stations. The central group, stations 36–41, registered 24–26°C. The western group registered decreasing temperatures to the south, stations 19b, 20, and 20b being in water colder than 10°C. at the surface. The eastern group of stations was in relatively colder water than the central or western group due to the cold Peru Current flowing north along the coast of South America. An exception to this occurred at station 29, which was in a warm tongue of water close to the coast.

The surface salinities obtained on the expedition (*see* Fig. 3) varied from 34–35 ‰ between Lats. 0–30°N,. except for a narrow tongue of lower salinity water (less than 34 ‰) along Lat. 10°N. South of the equator the surface salinities were higher, 35–36 ‰, with even higher values of over 36 ‰ in a tongue of water between Lats. 15–25°S. South of Lat. 25°S. in the western part of the area, Lat. 35°S. in the central part, and Lat. 25°S. in the eastern, the surface salinities were 34–35 ‰.

DISTRIBUTION OF SPECIES

The distributions of the various species are given below. Only the larger specimens are represented due to the relatively coarse-mesh nets used in collecting. These distributions, therefore, do not represent the complete foraminiferal faunas to be found in the waters of the area studied.

The frequency data are given (Figs. 4–19) in most cases using Bradshaw's (1959)

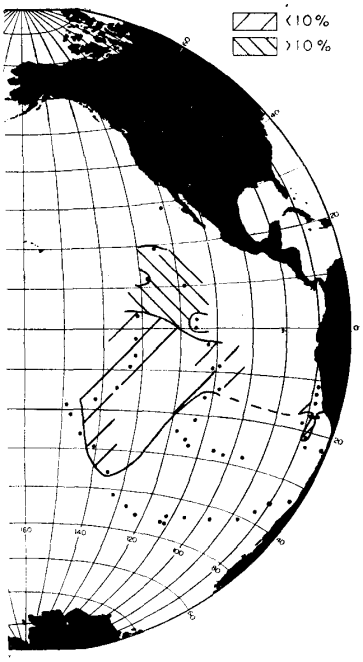

Fig. 10. Globigerinoides conglobatus

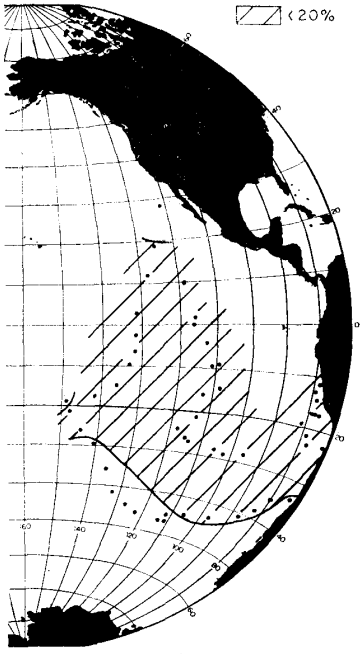

Fig. 11. Globigerinoides ruber

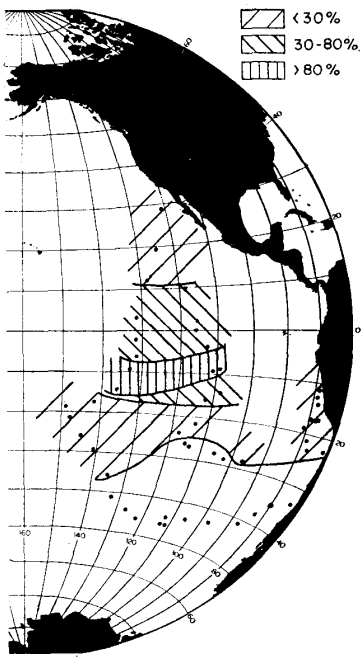

Fig. 12. Globigerinoides sacculifer

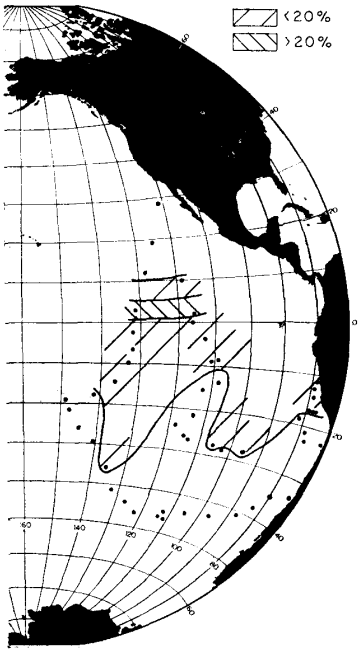

Fig. 13. Globorotalia menardii

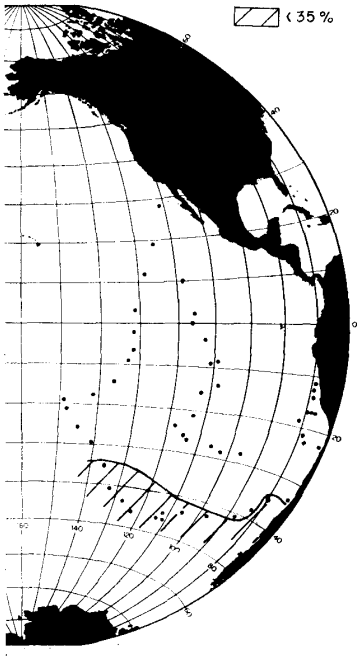

Fig. 14 Globorotalia punctulata

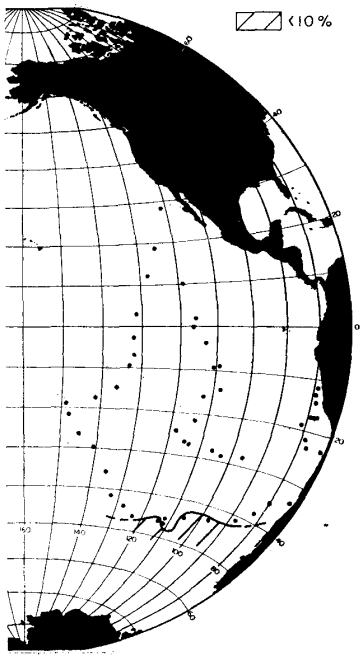

Fig. 15. Globorotalia scitula

figured percentage groups, for convenience of comparison. His identifications are repeated here and reference is made to his figured specimens. The writer is presently working on the taxonomy of the planktonic species in the Pacific sediments and this will probably lead to some changes in this nomenclature. Hofker (1959) has expressed the opinion that some of the presently accepted genera are polyphyletic and that others are based on reproductive stages only. A careful study of large suites of specimens, including developmental stages, is necessary to understand the variation to be expected within a species or genus. The plankton samples taken in the Pacific have not provided these.

Globigerina bulloides d'Orbigny (Bradshaw, 1959, p. 33, pl. 6, figs. 1–4) (*see* Fig. 4) was found at two stations south of Lat. 40°S. and at several stations near the coast of South America between Lats. 10–25°S. (up to 11%). Surface salinities at these stations range from 34–35.3 ‰, surface temperatures from less than 10–24°C. The northern group near the South American coast appeared to be in equatorial water and the southern group in subantarctic water. Bradshaw found a similar distribution along the South American coast and suggests that occurrences here may be due to life at greater depths. The Downwind specimens were from tows taken from depths of 283–347 m. to the surface. It is possible that study of a larger number of specimens from the sediments of these regions will show that there are two species or subspecies.

Globigerina conglomerata Schwager (Bradshaw, 1959, p. 33, pl. 6, figs. 6, 7) (*see* Fig. 5) occurred in the equatorial region and at three stations near the northern limit of what appears to be southeast-central water, north of Lat. 22°S. near the coast of South America and of Lat. 15°S. to the west (up to 7%). Surface salinities at these stations ranged from *ca.* 34–36 ‰, surface temperatures from *ca.* 26–28°C. The distribution extended farther south than the southern limit found by Bradshaw (*ca.* Lat. 6°S.).

Globigerina eggeri Rhumbler (Bradshaw, 1959, p. 35, pl. 6, figs. 5, 10) (*see* Fig. 6) was found from Lat. 10°N. to Lat. 35°S., the most westerly occurrence being at Long. 135°53'W. (up to 52%). It was most abundant near the coast of South America. The species, therefore, occurred in equatorial, southeast-central and transitional (to subantarctic) waters. Surface salinities at the stations ranged from *ca.* 34–36.4 ‰ and surface temperatures from *ca.* 16–27°C. The species, as defined here, is the "typical adult *G. eggeri*" of Bradshaw. Since he also included small forms which may not be referrable to this species, the present distributions cannot be compared with his, although for the typical form recognized here they appear to be similar.

Globigerina hexagona Natland (Bradshaw, 1959, p. 36, pl. 6, figs. 11–15) (*see* Fig. 7) was confined to equatorial water between Lats. 20°N. and 10°S. (up to 3%). Surface salinities at the stations ranged from 34.7–35.7 ‰, surface temperatures from 24.4–26.7°C.

Globigerina inflata d'Orbigny (Bradshaw, 1959, p. 36, pl. 6, figs. 16–18) (*see* Fig. 8) occurred at two stations in subantarctic water and one in southeast-central water, all south of Lat. 25°S. Surface salinities at the stations ranged from 34–35.7 ‰, surface temperatures from *ca.* 10–23.4°C. Bradshaw found the species in the North Pacific, north of Lat. 25°N.

Globigerinella aequilateralis (Brady) (Bradshaw, 1959, p. 38, pl. 7, figs. 1, 2) (*see*

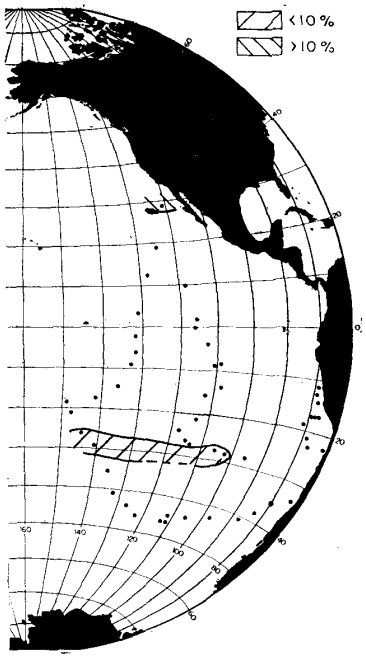

Fig. 16. Globorotalia truncatulinoides

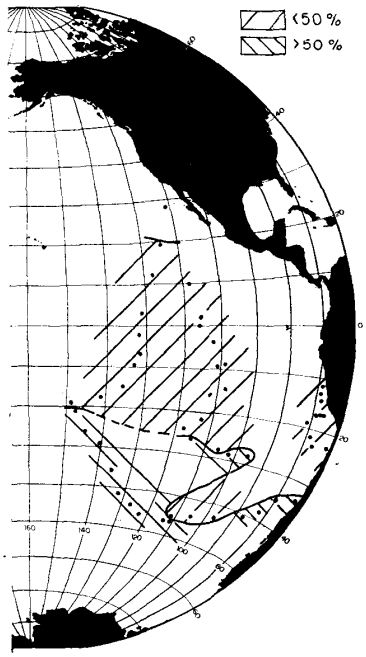

Fig. 17 Hastigerina pelagica

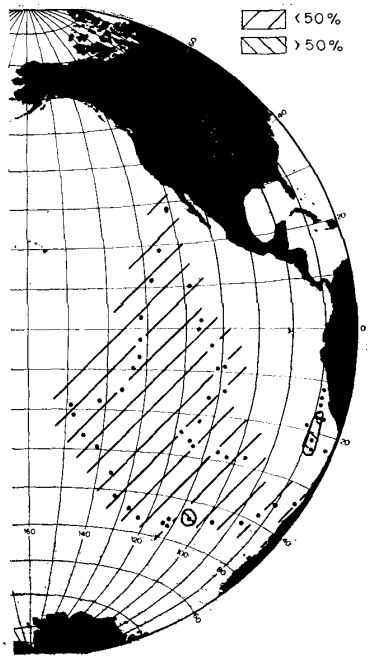

Fig. 18. Orbulina universa

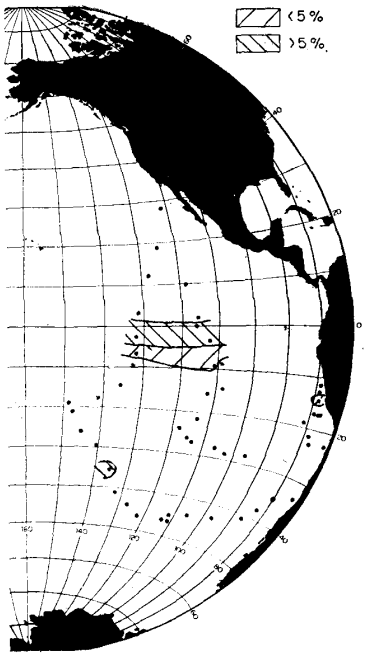

Fig. 19. Pulleniatina obliquiloculata

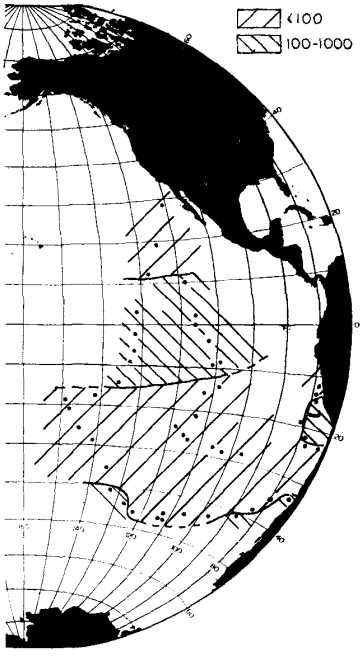

Fig. 20. Total populations / 1000 m^3

Fig. 9) had a widespread distribution, with the highest frequencies at the equator (up to 33%). It occurred in equatorial, southeast-central, and subantarctic waters from Lats. 20°N. to 40°S. Surface salinities at the stations ranged from *ca.* 34–36 ‰, surface temperatures from *ca.* 10–24°C.

Globigerinoides conglobatus (Brady) (Bradshaw, 1959, p. 40, pl. 7, figs. 5, 6, 16, 17) (*see* Fig. 10) was confined to equatorial and southeast-central waters (Lats. 20°N. to 35°S.) with the highest frequencies in the former (up to 32%). Surface salinities at the stations ranged from 34.7–36.3 ‰, surface temperatures from 17.7–27.3°C. Bradshaw's form "*Globigerinoides* sp." (pl. 7, figs. 16, 17) is considered to be synonymous with *G. conglobatus* since there appears to be a complete series of specimens from those with narrow apertures to those with widely opened ones.

Globigerinoides ruber (d'Orbigny) (Bradshaw, 1959, p. 42, pl. 7, figs. 12, 13) (*see* Fig. 11) was found in equatorial and southeast-central waters, and at the most northerly stations in subantarctic water (Lats. 20°N. to 44°S.) Surface salinities at the stations ranged from *ca* 34–36.5 ‰, surface temperatures from 10–27.3°C. The species, as defined here, includes both typical and high-spired specimens, the latter possibly referrable to *G. elongata* (d'Orbigny) or *G. pyramidalis* (vanden Broeck).

Globigerinoides sacculifer (Brady) (Bradshaw, 1959, p. 42, pl. 7, figs. 14, 15, 18) (*see* Fig. 12) was one of the most abundant species. It occurred in transitional (to subantarctic), equatorial, and southeast-central waters, with the highest frequencies in the southern part of the equatorial region (up to 97%). Surface salinities at the stations ranged from 34.7–36.5 ‰, surface temperatures from 17.7–28°C.

Globorotalia menardii (d'Orbigny) (Bradshaw, 1959, p. 44, pl. 8, figs. 3, 4, 10–12) (*see* Fig. 13) was found in equatorial and southeast-central waters (Lats. 10°N. to 35°S.) with the highest frequencies at the equator (up to 21%). Surface salinities at the stations ranged from *ca.* 34–35.9 ‰, surface temperatures from 17.7–27.3°C. (with one exception all were higher than 22°C.). The minimum of 17.7°C. was at station 17 where *Pulleniatina obliquiloculata* also was found. No specimens of typical *Globorotalia tumida* (Brady) were observed. Specimens having the shape of this species, but lacking the typically coarsely crystalline test walls, were included with *G. menardii* and occurred in the western part of the area of distribution (*see* Bradshaw, 1959, pl. 8, figs. 10–12).

Globorotalia punctulata (d'Orbigny) (Phleger *et al.*, 1953, p. 20, pl. 4, figs. 8–12) (*see* Fig. 14) occurred in its typical form in subantarctic, transitional (from subantarctic to southeast-central, one station), and southeast-central (one station) waters. The species was confined to the region south of *ca.* Lat. 35°S. (up to 34%). Surface salinities at the stations ranged from *ca.* 34–35 ‰, surface temperatures from *ca.* 9–18°C.

This species appears to be identical with Atlantic specimens. It is reported by Bé (1959) in the plankton of the western North Atlantic as a "warm-tolerant species". It was not observed by Bradshaw(1959) in the North and equatorial Pacific.

Globorotalia scitula (Brady) (Bradshaw, 1959, p. 44, pl. 8, figs. 5, 6) (*see* Fig. 15) was confined to subantarctic water south of Lat. 40°S. Surface salinities at the stations were *ca.* 34 ‰; surface temperatures ranged from 9.2–11.5°C. No specimens were observed in

the equatorial region, as reported by Bradshaw.

Globorotalia truncatulinoides (d' Orbigny) (Bradshaw, 1959, p. 44, pl. 8, figs. 7, 8) (*see* Fig. 16) was found in southeast-central water from Lats. 25–30°S. and at station 1 in water transitional from equatorial to subantarctic. Surface salinities at the stations ranged from 34.8–35.7 ‰, surface temperatures from *ca.* 20.6–23.5°C. This distribution agrees with that found by Bradshaw in the North Pacific. There were insufficient specimens to determine coiling-direction ratios but most specimens were right-coiling.

Hastigerina pelagica (d'Orbigny) (Bradshaw, 1959, p. 47, pl. 8, figs. 14, 15) (*see* Fig. 17) was found in most of the area except station 1, occurring in comparatively large numbers especially south of Lat. 20°S. (up to 99%). This is in great contrast to its relative scarcity in the sediments, due probably to its extreme fragility. Surface salinities at the stations ranged from *ca.* 34–36.5 ‰, surface temperatures from *ca.* 9–27°C.

Orbulina universa d'Orbigny (Bradshaw, 1959, p. 49, pl. 8, fig. 18) (*see* Fig. 18) was an ubiquitous species like *Hastigerina pelagica* but occurred in smaller numbers. It was found at more stations north of the equator and fewer in the subantarctic region than *H. pelagica* (up to 88%). Surface salinities at the stations ranged from 33.6–36.5 ‰, surface temperatures from 9.2–27.6°C. It is possible, as suggested by Hofker (1959), that this "species" represents reproductive stages of several forms. This would account for its wide distribution. No bilobate specimens were seen.

Pulleniatina obliquiloculata (Parker and Jones) (Bradshaw, 1959, p. 49, pl. 8, figs. 19, 20) (*see* Fig. 19) was confined to a narrow belt at the equator, one station off the coast of South America north of Lat. 15°S., and at station 17, which was mentioned previously as containing an unusual fauna. Surface salinities at the stations ranged from *ca.* 34.5–35 4 ‰, surface temperatures from *ca.* 24–27°C. (excluding station 17 where the surface temperature was 17.7°C.).

Rare species. There were a few rare species. These included: *Candeina nitida* d'Orbigny (Bradshaw, 1959, pl. 7, fig. 9), station 4; *Globigerina digitata* Brady (1884, pl. 80, figs. 6–10; *not* pl. 82, figs. 6, 7), station 19; *Globigerinella* sp. (Bradshaw, 1959, pl. 7, figs. 3, 4), stations 40, 42; *"Globigerinita" glutinata* (Bradshaw, 1959, pl. 7, figs. 7, 8), stations 8 ?, 21, 23b ?; *Sphaeroidinella dehiscens* (Parker and Jones) (Bradshaw, 1959, pl. 8, figs. 21–23), stations 3, 44; *Globigerina* spp. (juvenile ?), stations 4, 17, 20, 37. In addition, a presently unidentified form of *Globigerina* was widespread; it is possible that more than one species was represented but the specimens were too few to determine this. Some of the specimens resemble the form figured by Bradshaw (1959, pl. 6, figs. 19, 26–28).

POPULATION VARIATIONS

Total populations (*see* Fig. 20) were smaller, in general, than those recorded by Bradshaw (1959). The largest populations (100–1000 specimens/cu.m.) were found along the equator from Lat. 10°N. to Lat. 15°S., in a small area along the coast of South America from *ca.* Lats. 15–20°S., and at a few stations south of Lat. 40°S.

The largest populations obtained by the standard meter net were usually in the

oblique tows from *ca* 0–200 m., the next largest from *ca.* 0–400 m., and the smallest from *ca.* 0–800 m. The largest populations, therefore, were in tows which fished for a longer period at the shallower depths. This was shown also by a series of opening-closing net tows at station 42a, where 309 specimens were obtained from 64–129 m. and 163 specimens from 100–258 m. The same species were obtained in both these tows with the exception of single specimens of *Globigerinoides ruber* in the shallower one and *Globigerina eggeri* in the deeper. There were more specimens of *Globigerinoides sacculifer* in the shallower tow and more *Globorotalia menardii* and *Hastigerina pelagica* in the deeper one. *Globigerinella aequilateralis* and *Pulleniatina obliquiloculata* were fairly evenly distributed. Two additional opening-closing net tows from 141–283 m. contained : *Globigerina eggeri, G.* sp., *Globigerinella aequilateralis, Globigerinoides ruber, G. sacculifer, Globorotalia menardii,* and *Hastigerina pelagica.*

Most of the tows were made at night since this is the time when much of the zooplankton is near the surface. At station 41, however, a series of day and night oblique tows from various depths was made. The day group consistently contained about ten times as many Foraminifera as the night group (when comparing tows from equal depths).

DISCUSSION

The species distributions may be divided approximately into five groups as follows :

1. Widespread (surface salinities 33.6–36.5 ‰, surface temperatures 9–27.6°C.) : *Globigerinella aequilateralis, Globigerinoides ruber, Hastigerina pelagica, Orbulina universa.*

2. Equatorial and southeast-central (surface salinities 34–36.5 ‰, surface temperatures 16–28°C.) : *Globigerina eggeri, Globigerinoides conglobatus, G. sacculifer.*

3. Equatorial (surface salinities 34–36 ‰, surface temperatures 24–28°C.) : *Globigerina conglomerata, G. hexagona, Globorotalia menardii, Pulleniatina obliquiloculata.* The last two species occurred rarely elsewhere.

4. Southeast-central and subantarctic (surface salinities 34–35.7 ‰, surface temperatures 9–24°C.) : *Globigerina bulloides, G. inflata, Globorotalia punctulata, G. truncatulinoides.*

5. Subantarctic (surface salinities *ca.* 34 ‰, surface temperatures 9.2–11.5°C.) : *Globorotalia scitula.*

These groups agree in general with Bradshaw's (1959) distributions although there are minor differences, already pointed out in the species discussions. A study of the physical conditions leads to the suggestion that temperature may be more critical than salinity but no definite conclusions concerning the physical requirements to the species can be arrived at until more is known concerning the exact levels at which they live. Surface salinities and temperatures are given to provide some basis for discussion; an entirely different set of data may be the critical one.

The largest populations occurred in the regions which were richest in nutrients. Inorganic phosphate can be used as an index of the relative presence of nutrients (Bradshaw, 1959). Phosphate measurements at stations 1–23 showed the highest values between

Lats. 0–10°S. and south of Lat. 40°S. No measurements were made off the coast of South America but it is well-known that upwelling, bringing nutrient-rich water to the surface, occurs in that region.

The observation of larger populations at the shallower depths (and during the day at station 41) agrees with those of most earlier workers and suggests the dependence of planktonic Foraminifera on the abundant plant life in the euphotic zone. Whether it is a purely mechanical process (Bradshaw, 1959), a food necessity, or a dependence on a symbiotic relationship is a matter of speculation. The writer suggests that the symbiotic relationship of the Foraminifera with the various forms of plant life observed in the protoplasm of many species may be the critical factor. It must be emphasized, however, that much more work must be done before the habits of the planktonic Foraminifera are known and conclusions concerning them drawn.

REFERENCES

Bé, A.W.H. (1959) : Ecology of Recent planktonic Foraminifera. Pt. 1, Areal distribution in the western North Atlantic. Micropaleontology, Vol. 5, No. 1, pp. 77–100, pls. 1, 2.

Bradshaw, J.S. (1959) : Ecology of living planktonic Foraminifera in the North and equatorial Pacific Ocean. Contr. Cushman Found. Foram. Research, Vol. 10, pt. 2, pp. 25–64, pls. 6–8.

Brady, H.B. (1884) : Report on the Foraminifera dredged by H.M.S. "Challenger", during the years 1873–1876. Rept. Voy. *Challenger*, Zoology, Vol. 9, 814 pp., 115 pls.

Hofker, Jan. (1959) : On the splitting of *Globigerina*: Contr. Cushman Found. Foram. Research, Vol. 10, pt. 1, pp. 1-9.

Phleger, F.B, Parker, F.L., and Peirson, J.F. (1953) : North Atlantic Foraminifera. Repts. Swedish Deep-Sea Exped., Vol. 7, No. 1, pp. 1–122, pls. 1–12.

Sverdrup, H.U., Johnson, M.W., and Fleming, R.H. (1942) : The oceans, their physics, chemistry and general biology. Prentice Hall, New York, 1087 pp.

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