

FORAMINIFERA FROM THE DEEP LAKE TERRACES, VESTFOLD HILLS, ANTARCTICA

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ABSTRACT

Fourteen species of planktonic and forty-two species of benthonic foraminifera are identified from two transects of terraces near Deep Lake in the Vestfold Hills, Antarctica. All the planktonic and a few of the benthonic species occur on the western shore of the lake in well preserved condition, some of the forms are very small and rare. *Cassidulina* and *Trochammina* are dominant while *Cibicides* and *Globigerina* are common constituents of the foraminiferal faunas. *Neogloboquadrina pachyderma* is significantly absent from all samples. Several of the species in the Deep Lake terraces were previously reported from the Ross Sea, McMurdo Sound, South Georgia, and the Falkland Islands sectors of Antarctica. Three possible explanations regarding disparity in abundance (paucity or even absence) of foraminifera in samples from identical elevations in the two transects are proposed: differential wind erosion occurred and foraminifera were deposited elsewhere; the faunas are remnants of debris

bands from a former ice shelf or ice sheet and were deposited differentially when the ice ablated; variations in physiography and wind erosion, coupled with differing amounts of glacial debris deposited in the terraces, caused the observed distribution pattern.

Globocassidulina bitor and *Cassidulina subglossa* are present in the Deep Lake terraces and have living representatives in nearby areas. Dissolution effects, notably chalky appearance, loss of ornamentation, and thinning and fragmentation of tests were observed and were especially obvious in the genera *Cassidulina*, *Cibicides*, *Nonionella*, *Hyalinea*, and *Truncatulina*. Causative factors for this dissolution include the very high salinity, very low temperature, and high dissolved carbon dioxide contents of the waters of Deep Lake. Terrace samples containing chiefly agglutinated species further suggest dissolution and elimination of calcareous specimens.

INTRODUCTION

Deep Lake, located at 68°34'S and 78°11'E (Fig. 1) within the Vestfold Hills (68°22'S to 68°40'S and 77°49'E to 78°33'E) on the coast of Princess Elizabeth Land, is one of the two most saline lakes (the other being Club Lake) known in Antarctica.

This thalassic lake is also one of the largest (1.1 km by 0.8 km) and has a maximum measured depth of 100

m. Salinity values of 280‰ were measured. The surface level of the lake is 50.4 m below present sea level. Plots of water temperature at various depths, surface air temperature, and wind run for the period from October 1973 through July 1975 are presented in Fig. 2. These data summarize the extreme physical conditions that prevailed at the time collections were made for this study. Values for dissolved oxygen, pH, and Eh for Deep Lake were 1.2 to 2.1 ml/l, 7.4 to 7.5, and +430 mv, respectively.

A variety of planktonic and benthonic coccoid and flagellate chlorophyceans, blue-green algae, bacteria, and diatoms are supported at all depths of Deep Lake (Johnstone and others, 1973; Kerry and others, 1974).

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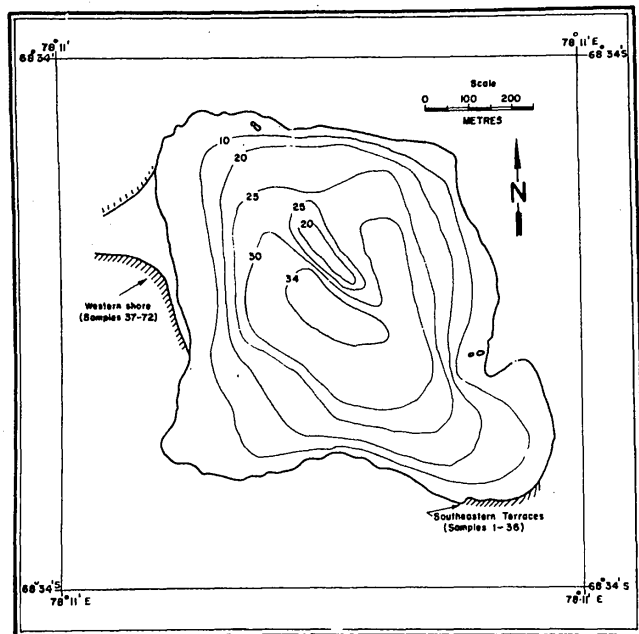


FIGURE 1

Map of Deep Lake and its terraces, Vestfold Hills, Antarctica.

SAMPLE COLLECTION

The seventy-two sediment samples used in this study were collected in December, 1974, by Williams from terraces that exist along the western and southeastern shores of Deep Lake. Samples were collected at 1.6-m intervals from just above present lake level to a prominent shoulder, about 54.5 m above lake level (Fig. 1). Samples 1 to 36 came from the southeastern terraces with sample 1 at an elevation of -48.8 m (1.6 m above the lake). Sample 33 came from the shoulder of the terrace (54.5 m above lake level) and samples 34-36 were collected from the gently sloping top of the terrace.

A second set of samples was collected from terraces along the western shore of the lake (Fig. 1). Sample 37 was collected from 1.6 m above lake level, sample 69 was from the shoulder of the terrace (4 m above present sea level), and samples 70 to 72 were from the top of the terrace.

PREVIOUS WORK

The first foraminiferal study of the Antarctic region (South Pacific and Falkland Island areas) was made by d'Orbigny in 1839. This pioneering work was followed by a number of studies of materials collected by various national expeditions, including: the CHAL-

LENGER Expedition 1873-76 (Brady, 1884); the German South Polar Expedition 1901-03 (Weisner, 1931); the SCOTIA Expedition 1903-04 (Pearcey, 1914); the British Antarctic Expedition 1907-09 (Chapman, 1916a, 1916b); the TERRA NOVA Expedition 1910 (Heron-Allen and Earland, 1922); DISCOVERY Reports (Heron-Allen and Earland, 1932; Earland, 1933, 1934, 1936); and the B.A.N.Z. Antarctic Research Expedition 1929-31 (Parr, 1950). More recently, studies of foraminifera have been made from the Lutzow-Holm Bay area (Uchio, 1960), from the Indian Ocean sector of Antarctica (Saidova, 1961), from the Adelie Land coast (McKnight, 1962; Pflum, 1963; Bandy and Echols, 1964; Blanc Vernet, 1965), and from the Ross Sea (Kennett, 1968; Thomas, 1968; Fillon, 1974; Osterman and Kellogg, 1979; Kellogg and others, 1979a, 1979b).

Foraminiferal tests and other fossils were first reported in the sediments of some of the lakes in the Vestfold Hills area by Voronov (1964). He suggested that these foraminifera were deposited in the various terraces in former times when Deep Lake and other lakes in the region were probably more dilute and were standing at considerably higher levels. He observed that the majority of the foraminifera encountered, except for a few hypersaline tolerant species, do not prefer high salinities.

Crespin (1960) made a cursory study of the foraminifera from sediment samples collected from a few lakes in the Vestfold Hills area, but she restricted her report to descriptions of six new species and some of the rarer forms. Our current work is therefore the first detailed report on foraminifera from the Deep Lake terraces.

SEDIMENTARY ENVIRONMENT

Sediment samples from the Deep Lake terraces are unconsolidated and are very sparsely fossiliferous. The sediment is composed of very coarse angular-to-rounded grains that range in the sand- and silt-size fractions. Halite and mirabilite crystals are common in unwashed samples. Other mineral constituents include high percentages of pyroxenes, garnet, biotite, and quartz, and fragments of a variety of gneisses and schists, pyroxenites, quartzites, dike rocks, pegmatites, and glacial debris.

FAUNAL ASSEMBLAGE

Faunal constituents of samples from the Deep Lake Terraces included siliceous sponge spicules, spines and plates of echinoderms (*Sterechinus neumayeri*

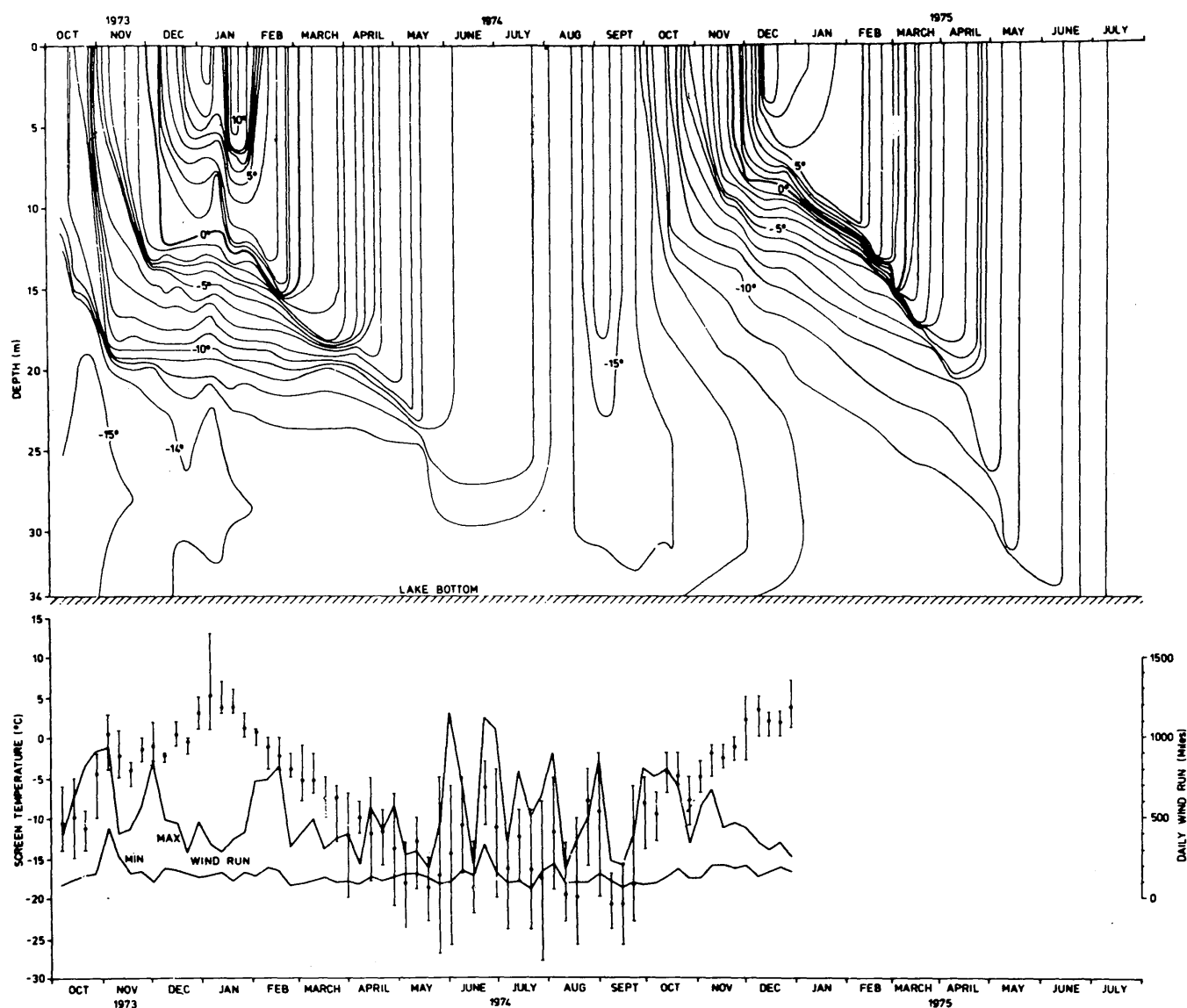


FIGURE 2

Depth, temperature and wind run criteria of Deep Lake, Antarctica (October, 1973–July, 1975 period).

and *Noticidaris* sp.), shell fragments of *Laternula elliptica*, embryonic *Pecten* (*Adamussium*) *colbecki* and *Mallecia pellucida*, *Nacella depressa*, diatoms, and ostracodes. Several planktonic and a large number of benthonic foraminiferal species are present (Pls. 1 and 2), including a few delicately preserved, very small, rare forms. *Cassidulina* is the dominant benthic genus but *Trochammina*, *Cibicides*, and *Globigerina* are often abundant.

Crespin (1960) reported the occurrence of *Lingulina translucida* in the coarse sands but we have not ob-

served it. Similarly, *Lagena gracilima*, *Fissurina revertens*, *Parafissurina fusiliformis*, *Laryngosigma hyalascida*, *Nonion iridea*, *Stainforthia vestfoldensis*, and *S. concisa* were not observed in our samples.

Fifty-six of the species reported in this paper have not been reported previously from the Vestfold Hills area. Foraminifera are well preserved and are the dominant fossils in samples from the western shore of Deep Lake (Fig. 4), where they are present in most samples. Their diversity is quite high although the foraminiferal number is very low. Foraminifera are

sparsely distributed in samples from the southeastern terraces (Fig. 3). Most samples (with three exceptions) were almost devoid of foraminifera.

The microforaminifera (embryonic forms ?) encountered in the Deep Lake terraces include: *Bolivina pseudopunctata*, *Cassidulina islandica*, *C. depressa*, *Buccella frigida*, *Nonionella auricula*, *Cibicides mackanni*, *Epistominella patagonica*, *Textularia paupercula*, and the planktonic species *Globigerina bradyi*, *G. bulloides*, *G. antarctica*, *G. quadriloba*, *G. trilocularis*, *Globigerinita humilis*, *G. glutinata*, *G. uvula*, and *Globigerinella siphonifera*. Other small forms include six species of *Trochammina* (Pl. 2).

STRATIGRAPHY AND ENVIRONMENT

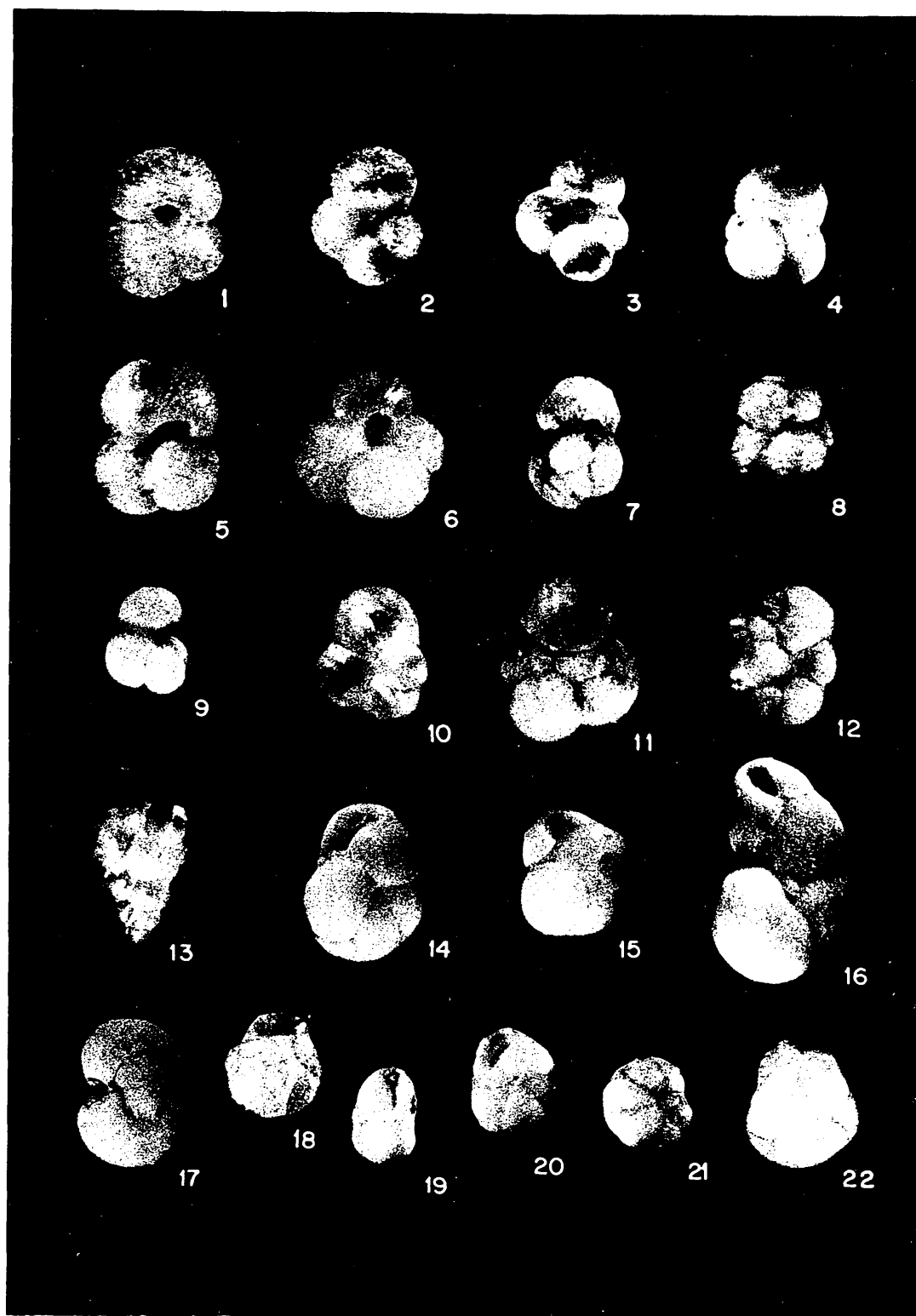
All fourteen planktonic species encountered were found only in samples (47, 48, 61, and 62) from terraces along the western shore of Deep Lake (Fig. 4). Benthonic species (42) were present in 24 of the 70 samples from both transects. *Cassidulina* is the dominant benthic genus and is followed in importance by the *Trochammina*, *Cibicides*, and *Discorbis* groups. Hyaline benthonic species are less abundant. Seven agglutinated species were also encountered. This dis-

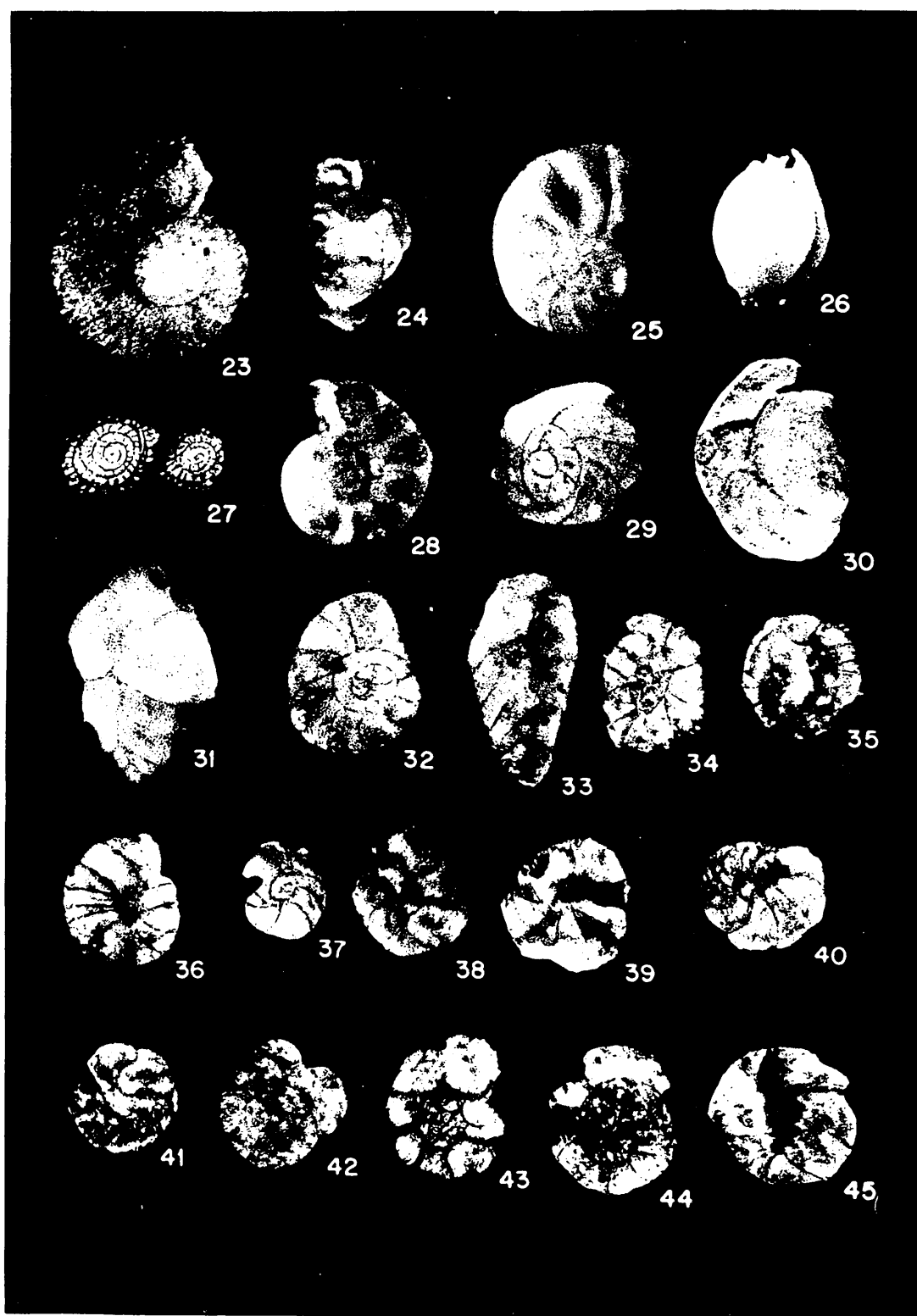
parity in abundance of benthonic species (paucity or even absence at some stations) at identical depth ranges of the lake appears unnatural. We suggest three hypotheses to explain this anomaly:

- 1) The discrepancy is caused by changes in the wind run, velocity, and direction for the region, from those shown in Fig. 2. That is, foraminifera are differentially carried away from the terraces and are deposited elsewhere.
- 2) Foraminifera in the terraces were not deposited *in situ* but were carried to this area as debris bands by a former ice shelf during glacial recession. Foraminifera were deposited and influenced by isostatic (uplift) movements, which have been discussed for the Vestfold Hills area by Gill (1955) and McLead (1963). Similar debris bands containing micro- and macrofossils were described from the McMurdo Ice Shelf by Kellogg and others (1977). The fossils were added to the terrace material when the grounded ice ablated.
- 3) Uneven physiography of the Deep Lake terraces, coupled with differential discharge of debris from various levels of a retreating ice sheet, may have influenced the disparity of faunal content.

PLATE 1

- 1 *Globigerinoides trilobus* (Ruess). Ventral view. Western shore, sta. no. 62 at -8.8-m depth. $\times 350$.
- 2 *Globigerina foliata* Bolli. Ventral view. Western shore sta. no. 47 at -32.8-m depth. $\times 280$.
- 3-4 *Globigerina bulloides* d'Orbigny. Western shore Sta. nos. 47 at -32.8-m and 62 at -8.8-m depth. 3. Ventral view, $\times 350$. 4. Dorsal view showing slightly side view. $\times 350$.
- 5 *Globigerina trilocularis* d'Orbigny. Ventral but slightly side view showing aperture. Western shore, sta. no. 48 at -31.2-m depth. $\times 550$.
- 6 *Globigerina antarctica* Keany and Kennett. Ventral view. Western shore, sta. nos. 49 at -29.6-m and 62 at -8.8-m depth. $\times 550$.
- 7 *Globigerinoides ruber* (d'Orbigny). Dorsal view. Western shore, sta. no. 47 at -32.8-m depth. $\times 240$.
- 8, 11 *Globigerinita glutinata* (Egger). 8. Oblique ventral view. Western shore, sta. no. 62 at -8.8-m depth. $\times 825$. 11. Ventral view. $\times 745$.
- 9 *Globigerina rubescens* Hofker. Side view. Western shore, sta. no. 47 at -32.8-m depth. $\times 300$.
- 10 *Globigerina quadriloba* d'Orbigny. Ventral view. Western shore, sta. no. 62 at -8.8-m depth. $\times 745$.
- 12 *Globigerinita humilis* (Brady). Oblique ventral view. Western shore, sta. no. 62 at -8.8-m depth. $\times 745$.
- 13 *Globigerina bradyi* Weisner. Spiral view. Western shore, sta. no. 62 at -8.8-m depth. $\times 745$.
- 14, 17, 19-21 *Giobocassidulina biora* (Crespin). Western shore sta. nos. 39, 42, 44, 51, 53, 55, 61, 65, 66, 70, and 72 at -45.6, -40.8, -37.6, -26.4, -23.2, -20.0, -10.4, -3.0, -2.4, +4.2 and +7.4 m depth respectively. Also at southeastern terraces sta. nos. 1, 3 and 7 at -48.8, -45.6 and -39.2 m depth respectively. 14. Oblique side view. $\times 120$. 17. Plastogamic form. $\times 210$. 19. Side view showing corrosion effect (aperture face). $\times 85$. 20. Ventral view showing double aperture. $\times 85$. 21. Dorsal view. $\times 85$.
- 15 *Ehrenbergina pupa* d'Orbigny. Oblique spiral view. Southeastern terraces, sta. no. 3 at -45.6-m depth. $\times 435$.
- 16 *Islandiella perrecta* (Heron-Allen and Earland). Side view showing aperture. Western shore, sta. no. 51 at -26.4-m depth. $\times 60$.
- 18 *Buccella frigida* (Cushman). Dorsal view. Southeastern terraces, sta. no. 3 at -45.6-m and 30 at -2.4-m depth. $\times 620$.
- 22 *Cassidulina islandica* Nørvang. Dorsal view. Southeastern terraces, sta. no. 3 at -45.6-m depth. $\times 560$.





Resolution of the disparity between faunal abundances in terraces at similar levels will depend on studies of lacustrine stratigraphy, sedimentation, and depositional processes, and on an understanding of former ecologic conditions that prevailed in this part of Antarctica. We have been unable to trace any literature on these subjects, but hope that the situation will improve in the near future.

DISCUSSION

Kellogg and others (1977) described two distinct benthic foraminiferal faunas in debris bands on the McMurdo Ice Shelf near Black Island. These deposits contained sponge spicules, echinoid spines, ostracodes, molluscs, and rare specimens of *Globigerina pachyderma*. This faunal composition is identical with that of our material from Deep Lake except for the presence of *Neogloboquadrina* (= *Globigerina*) *pachyderma* in Kellogg's samples. *N. pachyderma* is absent in our samples. This may be accidental as it is rare in the McMurdo Ice Shelf samples, and this species may be found in the future in samples from the Deep Lake area. It is well known that sinistral *N. pachyderma* is ubiquitous in Antarctic waters (Setty, 1977).

Kellogg (written communication, 1980) believes that the microfossils at Deep Lake may have been re-

worked beneath grounded ice during the last glacial maximum. We feel, however, that further extensive field work will be needed to document this hypothesis. Such additional field work will be required in any case to resolve the depositional processes involved with formation of the Deep Lake terraces.

All the planktonic foraminiferal species reported from Mar De la Flota (Bransfield Strait), Antarctica, by Boltovskoy and Boltovskoy (1970) occurred in our samples from Deep Lake, with the exception of *N. pachyderma*. Several of the benthonic species found in the Deep Lake terraces were previously reported by Kennett (1968) and Osterman and Kellogg (1979) from Ross Sea sediments. These species include: *Ehrenbergina pupa*, *Globocassidulina biora*, *Gordiospira fragilis*, *Islandiella porrecta*, *Trochammina squamata*, and *Psammosphera fusca*. Several of the species at Deep Lake were found previously in samples from South Georgia and the Falkland Island sector of Antarctica (Heron Allen and Earland, 1932; Earland, 1933, 1934).

Species common to both the southeastern and western terraces of Deep Lake include: *Globocassidulina biora*, *Cassidulina crassa*, *C. subglobosa*, *C. brazilensis*, *Cibicides praecincta*, *Trochammina kelleltae*, *Pyrgo peruviana*, and *Sorosphaera depressa*. Foraminifera are considerably less abundant in the western terraces than in those southeast of Deep Lake. A large

PLATE 2

- 23 *Cibicides pseudoungharianus* (Cushman), Dorsal view. Western shore, sta. no. 62 at -8.8-m depth. $\times 240$.
- 24 *Psammosphera fusca* Schulze. Pitted appearance. Western shore, sta. no. 45 at -36.0-m depth. $\times 50$.
- 25 *Nonionella auricula* Heron-Allen and Earland. Dorsal view. Western shore, sta. no. 49 at -29.6-m depth. $\times 620$.
- 26 *Pyrgo Peruviana* d'Orbigny. Edge view. Western shore, sta. no. 44, at -37.6-m depth; and Southeastern Terraces, sta. no. 3 at -45.6-m depth. $\times 140$.
- 27 *Patellina corrugata* Williamson. Two specimens (one large and one small) in dorsal view. Southeastern terraces, sta. no. 3 at -45.6-m depth. $\times 300$.
- 28 *Hyalinea balthica* (Schroeter). Side view. Southeastern terraces, sta. no. 7 at -39.2-m depth. $\times 370$.
- 29 *Discorbis cora* d'Orbigny. Dorsal view. Southeastern terraces, sta. no. 3 at -45.6-m depth. $\times 180$.
- 30 *Cibicides praecincta* (Karrer). Top view. Western shore, sta. no. 42, and 47 at -40.8 and -34.4-m depth respectively and Southeastern Terraces sta. no. 1 at -48.8-m depth. $\times 150$.
- 31 *Bulimina marginospinata* Cushman and Parker. Side view. Western shore, sta. no. 62 at -8.8-m depth. $\times 540$.
- 32 *Cibicides mckanni* Galloway and Wissler. Top view. Southeastern terraces, sta. no. 3 at -48.8-m depth. $\times 620$.
- 33 *Textularia paupercula* Heron-Allen and Earland. Side view. Western shore, sta. no. 47 at -32.8-m depth. $\times 550$.
- 34, 35 *Trochammina squamata* Parker and Jones. Opposite side views. Southeastern terraces, sta. no. 3 at -45.6-m depth. $\times 435$.
- 36, 41 *Trochammina kelleltae* Thalmann. Opposite views. Southeastern terraces, sta. no. 3 at -45.6 m depth., $\times 620$; and Western shore, sta. no. 38 at -47.2-m depth. $\times 435$.
- 37, 38 *Rotaliammina mayori* d'Orbigny. Opposite views. Western shore, sta. no. 38 at -47.2-m depth. $\times 385$.
- 39 *Trochammina discorbis* Heron-Allen and Earland. Opposite view. Western shore, sta. no. 38 at -47.2-m depth. $\times 360$.
- 40 *Trochammina glabra* Heron-Allen and Earland. Opposite view. Southeastern terraces, sta. no. 3 at -45.6-m depth. $\times 435$.
- 42 *Trochammina inflata* (Montague). Oblique opposite view. Western shore, sta. no. 49 at -29.6-m depth. $\times 370$.
- 43 *Trochammina malovensensis* Heron Allen and Earland. Oblique opposite view. Western shore, sta. no. 39, at -45.6-m depth. $\times 720$.
- 44, 45 *Trochammina nitida* Brady. Two opposite views. Western shore, sta. no. 39 at -45.6-m depth. $\times 435$.

STATION NUMBER	DEPTH (m)	FORAMINIFERAL DISTRIBUTION (SOUTH EASTERN TERRACES OF DEEP LAKE, VESTFOLD HILLS, ANTARCTICA)
36	(+) 7.4	NO FORAMINIFERA
35	(+) 5.8	
34	(+) 4.2	
33	(+) 2.6	NO FORAMINIFERA
32	(+) 1.2	
31	(-) 0.8	
30	(-) 2.4	<i>Buccella frigida</i>
29	(-) 3.0	NO FORAMINIFERA
28	(-) 5.6	
27	(-) 6.2	
26	(-) 8.8	
25	(-) 10.4	
24	(-) 11.0	
23	(-) 13.6	NO SAMPLE
22	(-) 15.2	NO FORAMINIFERA
21	(-) 16.8	
20	(-) 18.4	
19	(-) 20.0	
18	(-) 21.6	
17	(-) 23.2	
16	(-) 24.8	
15	(-) 26.4	
14	(-) 28.0	
13	(-) 29.6	
12	(-) 31.2	
11	(-) 32.8	
10	(-) 34.4	
9	(-) 36.0	
8	(-) 37.6	
7	(-) 39.2	
6	(-) 40.8	<i>Globocassidulina biora</i> <i>Cassidulina braziliensis</i> <i>Hyalina balthica</i>
5	(-) 42.4	NO SAMPLE
4	(-) 44.0	NO FORAMINIFERA
3	(-) 45.6	NO FORAMINIFERA
2	(-) 47.2	
1	(-) 48.8	
0	(-) 50.4	
		<i>Ehrenbergina pupa</i> <i>Globocassidulina biora</i> <i>Cassidulina islandica</i> <i>C. crassa</i> <i>C. subglobosa</i> <i>Trochammina squamata</i> <i>T. glabra</i> <i>T. killeitae</i> <i>Discorbis cora</i> <i>Patellina corrugata</i> <i>Buccella frigida</i> <i>Cibicides mckanni</i> <i>Nonion labradoricum</i> <i>Pyrgo peruviana</i>

FIGURE 3

Foraminiferal distribution along southeastern terraces, Deep Lake, Vestfold Hills, Antarctica.

number of species are represented in the southeastern transect at an elevation of -45.6 m, whereas in the western transect they are more abundant at an elevation of -8.8 m. In the southeast transect only three benthonic species were encountered at an elevation of -39.2 m and foraminifera were totally absent from the same level in the western terraces. The disparity in foraminiferal abundance between the two transects may be attributed to variations in the physiographic control of the terraces, to differential wind erosion, or to the amount of debris deposited by receding grounded ice in the area, as discussed above.

Globocassidulina biora, a species that is present in the Deep Lake terraces, was first described from Pleistocene sediments in the Vestfold Hills by Crespin (1960). Fillon (1974) found *G. biora* in normally magnetized Ross Sea sediments that contained a Gauss-

STATION NUMBER	DEPTH (m)	FORAMINIFERAL DISTRIBUTION (WESTERN SHORE OF DEEP LAKE, VESTFOLD HILLS, ANTARCTICA)
72	(+) 7.4	<i>Patellinoides depressa</i> <i>Globocassidulina biora</i> <i>Cassidulina depressa</i>
71	(+) 5.8	NO FORAMINIFERA
70	(+) 4.2	<i>Globocassidulina biora</i> <i>Cassidulina depressa</i> <i>C. braziliensis</i> <i>Sigmulina sigmoidea</i> <i>Gordospira fragilis</i>
69	(+) 2.6	NO FORAMINIFERA
68	(+) 1.2	
67	(+) 0.8	
66	(-) 2.4	<i>Globocassidulina biora</i> <i>Cassidulina depressa</i>
65	(-) 3.0	<i>Cibicides lobatulus</i>
64	(-) 5.6	NO FORAMINIFERA
63	(-) 6.2	<i>Globigerina bulloides</i> <i>G. antarctica</i> <i>G. calida</i> <i>G. bradyi</i> <i>G. quadriloba</i> <i>Globigerinoides trilobus</i> <i>Globigerinella siphonifera</i> <i>Globigerinita glutinata</i> <i>G. humilis</i> <i>G. uvula</i> <i>Cibicides pseudoungaricus</i> <i>Bulimina marginospinata</i> <i>Bolivina pseudopunctata</i> <i>Epistominella patagonica</i> <i>Cassidulina depressa</i> <i>Eponides patagonica</i>
62	(-) 8.8	<i>Globocassidulina biora</i>
61	(-) 10.4	NO FORAMINIFERA
60	(-) 11.0	NO FORAMINIFERA
59	(-) 13.6	<i>Cancris aurculus</i>
58	(-) 15.2	NO FORAMINIFERA
57	(-) 16.8	
56	(-) 18.4	
55	(-) 20.0	
54	(-) 21.6	<i>Globocassidulina biora</i>
53	(-) 23.2	<i>Globocassidulina biora</i>
52	(-) 24.8	NO FORAMINIFERA
51	(-) 26.4	<i>Islandiella porrecta</i> <i>Globocassidulina biora</i> <i>Cassidulina subglobosa</i>
50	(-) 28.0	NO FORAMINIFERA
49	(-) 29.6	<i>Trochammina inflata</i> <i>Globigerina antarctica</i> <i>Nonionella auricula</i> <i>Cassidulina subglobosa</i>
48	(-) 31.2	<i>Globigerina trilobularis</i>
47	(-) 32.8	<i>Globigerina bulloides</i> <i>G. rubescens</i> <i>G. foliata</i>
46	(-) 34.4	NO FORAMINIFERA
45	(-) 36.0	<i>Globigerinoides ruber</i> <i>Textularia paupercula</i> <i>Cibicides praecincta</i>
44	(-) 37.6	<i>Psammospaera fusca</i>
43	(-) 39.2	<i>Globocassidulina biora</i> <i>C. subglobosa</i> <i>Pyrgo peruviana</i>
42	(-) 40.8	NO FORAMINIFERA
41	(-) 42.4	<i>Globocassidulina biora</i> <i>Cibicides praecincta</i> <i>Bathysiphon sp</i>
40	(-) 44.0	NO FORAMINIFERA
39	(-) 45.6	<i>Globocassidulina biora</i> <i>Trochammina nitida</i> <i>T. malovensis</i>
38	(-) 47.2	<i>Rotaliammina mayuri</i> <i>Trochammina discorbis</i> <i>T. killeitae</i>
37	(-) 48.8	<i>Pelosina fusiformis</i>
0	(-) 50.4	PRESENT WATER LEVEL DEEP LAKE, ANTARCTICA

FIGURE 4

Foraminiferal distribution along terraces, western shore of Deep Lake, Vestfold Hills, Antarctica.

aged radiolarian fauna. He subsequently assumed that *G. biora* was a Gauss indicator for this reason and because he found no recent literature describing living specimens. One of us has found living *G. biora* in two grab samples from McMurdo Sound (R.W., unpublished). The two grab samples were collected at water depths of 5.13 and 12.47 m. A nearby sample contain-

ing pelecypods and gastropods (DVDP 10) collected at a depth of 24 m was radiocarbon dated at less than 6000 B.P. This data suggests that Fillon's (1974) assignment of a Gauss age to *G. biora* is incorrect. Kellogg and Truesdale (1979a, b) similarly disagreed with Fillon on the age of *G. biora*. They found this species sporadically within radiocarbon-dated Unit A from the Ross Sea. These Holocene sediments contained relatively rare specimens of *G. biora* (although one sample, EL27-8, contained abundant *G. biora*) in association with Recent diatom assemblages.

Fillon (1979a, b) suggested that Kellogg and Truesdale (1979a) had mistaken *G. biora* for juvenile specimens of *G. subglobosa* and that his previous Gauss age assignment for *G. biora* was still correct. Kellogg and Truesdale (1979b) replied by showing the distribution of *G. biora* in Pleistocene sediments from the McMurdo Sound region and by a discussion of taxonomic problems with the two species. Our data support the contention of Kellogg and Truesdale (1979a, 1979b), that *G. biora* is a Pleistocene to Recent species. We see no reason to believe that the presence of *G. biora* or *G. subglobosa* in Brunhes Ross Sea sediments should indicate reworking, as implied by Fillon (1979); hence his subsequent arguments based on the age of *G. biora* are invalid.

The very high salinities, very low temperatures, and high dissolved CO₂ contents of the waters (similar to those of the Ross Sea, Kennett, 1968; Osterman and Kellogg, 1979) of Deep Lake may favor dissolution of calcareous foraminiferal tests. Solution effects on the Deep Lake specimens include chalky appearance, loss of ornamentation, fragility, thinning of shells, and fragmentary nature of specimens. These characteristics are especially noticeable in *Cibicides praecincta*, *Pyrgo peruviana*, *Sigmoilina sigmoidea*, *Patellinoides depressa*, *Eponides patagonica*, and several species of *Cibicides*. Similar effects were also noted in whole and fragmented mollusk shells. Many samples contain chiefly agglutinated forms (*Trochammina*, *Bathysiphon*, *Psammosphaera fusca*, and *Sorosphaera depressa*) and further indicate loss of calcareous species by dissolution. This impoverishment by dissolution may even result in the total absence of foraminiferal specimens, as observed at several stations in both transects at Deep Lake.

ACKNOWLEDGMENTS

Grateful thanks are due to Drs. Thomas B. Kellogg of the Institute of Quaternary Research, University of Maine at Orono, and Robert Ellison of the University of Virginia for critical reading of the manuscript and

helpful suggestions for its improvement. The first author is thankful to Dr. S. Z. Qasim, Director, National Institute of Oceanography, Goa for permission to undertake the work as an International Collaborative Project and publication of the results, and to Shri V. M. Date for assistance in photomicrographic work.

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Revised Ms accepted June 1980