

OSTRACODA FROM VESTFOLD HILL LAKE TERRACES, ANTARCTICA

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Abstract

Six species of ostracodes are recorded from two transects of terraces of Deep Lake, Vestfold Hills, Antarctica. Two species (*Xesteleberis* sp. and *Bradleya dictyon*) range from Cretaceous to Recent, *Poseidonamicus* aff. *P. major* ranges from Oligocene to Recent, while *Krithe tumida* ranges from Pliocene to Pleistocene to Recent. *Paradoxostoma antarcticum* and *Loxoreticulatum fallax* are reported from Antarctica and range from Pleistocene to Recent. *Bradleya* and *Krithe* were typical deep water (psychrospheric) forms during Paleocene to Oligocene as today but they were found in shallow (-45 to -37 m) depths here. Ostracodes are extremely rare as compared to the associated foraminiferal assemblage. Dissolution effect, loss of ornamentation, thinning and fragmentation of the fauna are considered to be mainly due to gradational external stress, and large scale physical environmental shifts such as high salinity, low temperature and high dissolved carbon dioxide content of the Deep Lake waters. Disparity in abundance is attributed to wind erosion, differential deposition after ablation of ice from ice sheets, physiographic variation of the region and high rate of dissolution of calcareous forms including foraminifera.

INTRODUCTION

Vestfold Hills are located on the coast of Princess Elizabeth Land of Antarctica and the Deep Lake is one of the largest thalassic lakes known in the region (Fig. 1). The lake has a maximum depth of 100 m but its present surface level is at 50.4 m below sea level. The salinity of the lake presently is very high (280%), but when it stood at various levels or terraces, it had lower salinity gradients. The very low temperatures and high wind velocities suggest extremely harsh physical conditions in the region (Fig. 2). However, the biotic community of the present lake includes living organisms such as flagellate chlorophyceans, bluegreen algae, diatoms and bacteria which have evolved from forms present in the adjoining sea and adopted progressively to the changing conditions of salinity increase and other parameters (Johnstone *et al* 1973; Kerry *et al* 1974). Fossil remains of gastropods, pelecypods, worm tubes, spines of sea urchins, and sponge spicules found in lake sediments have been identified by various workers. Occurrence of some foraminifera from the Deep Lake terraces were reported by Crespin (1960). They have been studied in greater detail by Setty *et al* (1980).

Several samples were collected from various terraces of the lake especially Stn. Nos. 1-36 from the southeastern terraces and Stn. Nos. 37-72 from the western shore of the lake. Each sample was collected at 1.6 m interval and the first sample was at an elevation of (-) 48.8 m depth while the last sample (no. 72) was from the top of the terrace 4 m above the present sea level.

SEDIMENT COMPOSITION

Samples collected are from generally unconsolidated sediments which are sparsely fossiliferous. The sediment at various levels (terraces) is composed of coarse to rounded grains of sand, silt and clay. Halite and mirabilite crystals are common in unwashed samples. Mineral constituents include pyroxenes, garnet,

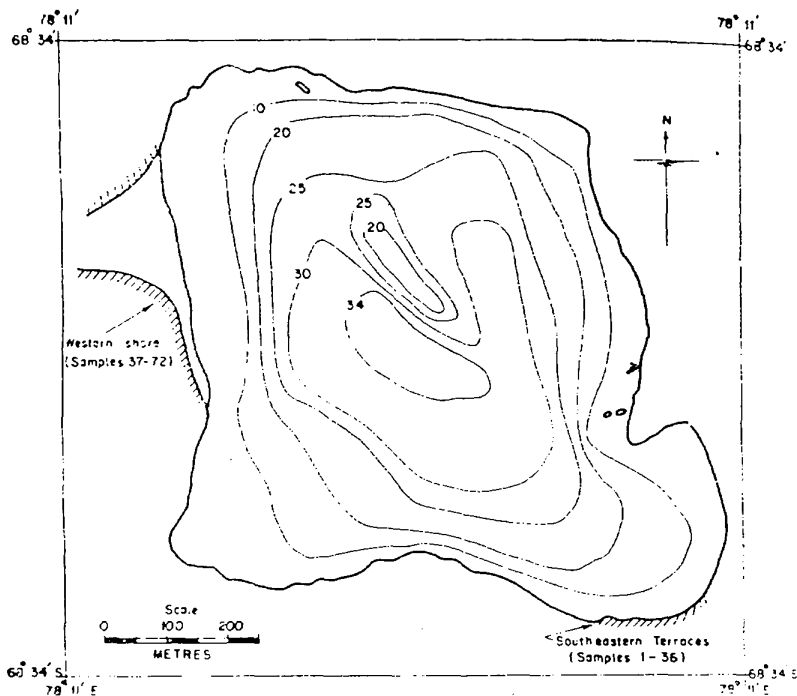


Figure 1. Map of Deep Lake and its terraces, Vestfold Hills, Antarctica (After Setty *et al* 1980).

biotite and quartz with glacial debris such as fragments of dike, quartzite and gneiss.

FAUNAL ASSEMBLAGE AND OSTRACODES

The faunal composition of Deep Lake terraces include a variety of constituents such as ostracodes, diatoms, sponge spicules, spines and plates of echinoids, worm tubes, shell and shell fragments in addition to known fourteen species of planktonic and forty-two species of benthonic foraminifera (Setty *et al* 1980). Some of the specimens were found to be delicately preserved, very small sized, rare forms. Ostracodes were very rare, most of them restricted to one valve only (either right valve or the left valve) which were mostly abraded principally by wind action and thus rendered fragile. A few others were fragmentary and hence remain unidentifiable. The ostracodes show diversity, though very low in number (population). Further, they are sparsely distributed. Most samples collected from various terraces were totally devoid of ostracodes as also foraminifera. Six species of ostracodes which dominated are recorded: They are: *Xestoleberis* sp., *Bradleya B. dictyon*, *Paradoxostoma antarcticum*, *Krithe tumida*, *Loxoreticulatum fallax* and *Poseidonamicus* aff. *P. major*. Three species, namely, *Poseidonamicus* aff. *P. major*, *Krithe tumida* and *Paradoxostoma antarcticum* were found at Stn. No. 3 at (-)45.6 m depth and *Loxoreticulatum fallax* at Stn. No. 7 at (-)34.2 m depth on the southeastern terrace while

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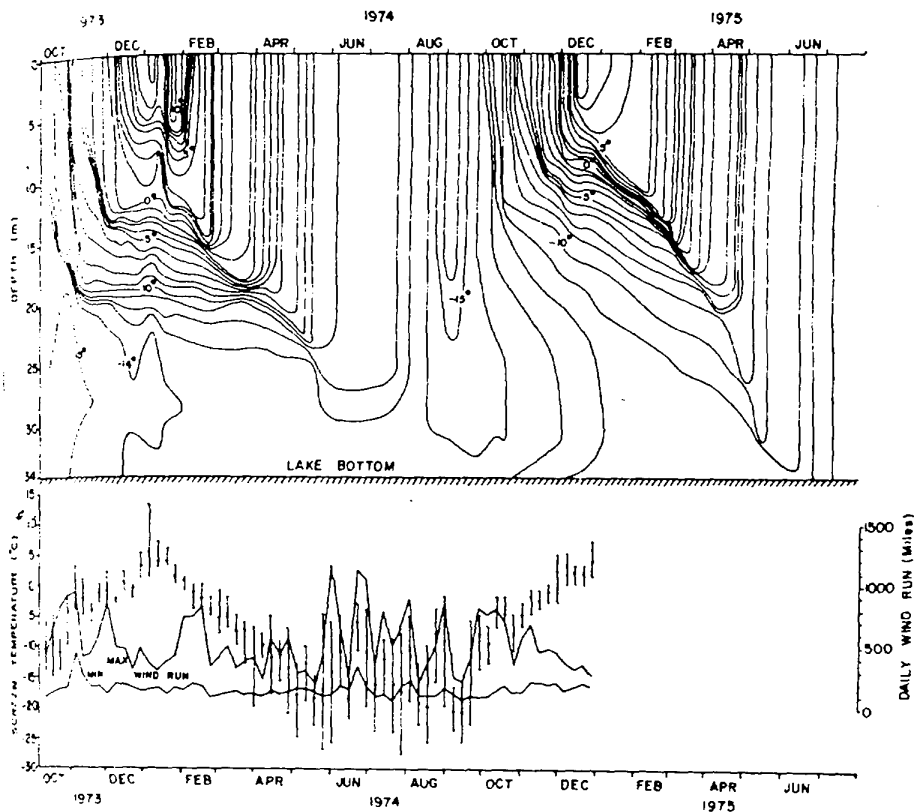


Figure 2. Depth, Temperature, and daily wind run data from October 1973 to July 1975 of Deep Lake area, Vestfold Hills, Antarctica (After Setty *et al* 1980).

Bradleya B. dictyon and *Xestoloberis* sp. were found at other stations of the transects. The associated foraminiferal fauna at Stn. No. 3 was rich while at Stn. No. 7 and 44, it was very poor.

SYSTEMATICS

- Subclass: OSTRACODA Latroille, 1806
- Order: PODOCOPIDA Müller, 1894
- Suborder: PODOCOPINA Sars, 1866
- Superfamily: CYTHERACEA Baird, 1850
- Family: PARADOXOSTOMATIDAE Brady and Norman, 1889
- Subfamily: PARADOXOSTOMATINAE Bardy and Norman, 1889
- Genus: *Paradoxostoma* Fischer, 1855
- Paradoxostoma antarcticum* Müller 1908

Fig. 3

Paradoxostoma antarcticum Müller 1908; Benson 1964; p. 11, pl. 1, figs. 1, 2, 4, 5, 9; Text figs. 3, 4.

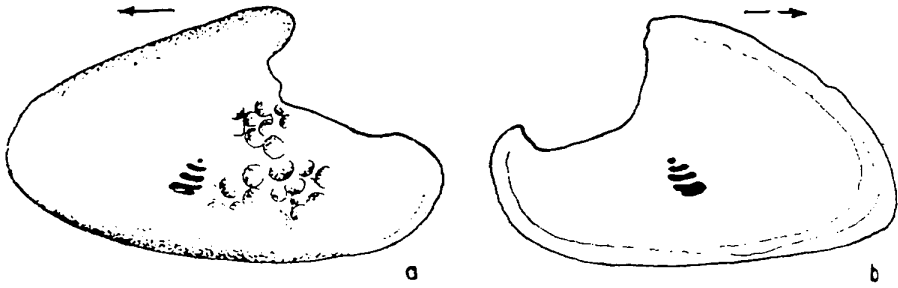


Figure 3. *Paradoxostoma antarcticum* Müller 1908, Benson 1964. (A) Exterior view of right valve (somewhat broken on the upper posterior region) showing muscle scar pattern; (B) Inside lateral view of right valve.

Carapace long, thin, fragile and elongate. Dorsal margin broadly arched, ventral margin sinuate, anterior end narrowly rounded while posterior end broadly rounded and upturned. Surface smooth with no ornamentation. Muscle scars, a row of four scars with lower three elongate. One scar is subdivided but joined in the middle; two lower ones faintly fused. *Dimensions*: Length 0.65 mm; height 0.375 mm, width 0.25 mm. *Material*: Only one right valve (part of the margin broken) found at (-)45.6 m depth (Stn. No. 3) along Southeastern transect.

Remarks: *Paradoxostoma antarcticum* has been reported from Gauss station from 385 m depth, and from McMurdo Sound and Ross Sea, Antarctica. Pleistocene to Recent. *P. antarcticum* is not found in Halley Bay. The South Orkney island species has recently been renamed as *P. scotti* by Hartman (1962).

Family: XESTOLEBERIDIDAE Sars, 1928

Genus: *Xestoleberis* Sars, 1926

Xestoleberis sp.

Fig. 4

Xestoleberis Sars, 1866; Van Morkhoven, 1963, pp. 440-443.

Carapace small, fragile, slightly depressed; dorsal margin slightly rounded but ventral margin straight to slightly convex. Surface smooth, hinge hemimerodont.

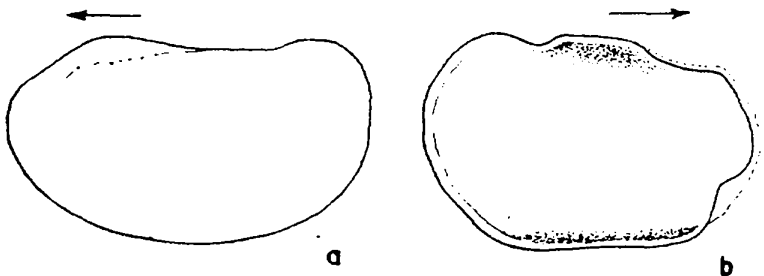


Figure 4. *Xestoleberis* sp. (A) Interior view of left valve; (B) Exterior lateral view showing ridge or flange on the dorsal side.

the median hinge element composed of a strongly curved ridge or flange corresponds to the groove in the right valve. Adductor muscle scars not clearly visible.

Dimensions: Length 0.38 mm; height 0.50 mm.

Material: Only one left valve found at (-)37.6 m depth (Stn. No. 44) along Western Shore transect.

Remarks: Hinge very similar to that of *X. arcturi* Triebel (Van Morkhoven 1963, Fig. 745, p. 440). Reported from McMurdo Sound at 57 m depth of water, at Halley Bay, and Kerguelen Island regions. Appears to be worldwide; most species inhabit littoral to epi-neritic, brackish and saline tidal environments (Van Morkhoven, 1963), cosmopolitan. Cretaceous to Recent.

Family: CYTHERIDEIDAE Sars, 1925

Subfamily: KRITHINAE Mandelstam, 1958

Genus: *Krithe* Brady, Crosskey and Robertson 1874

Krithe tumida (Brady)

Fig. 5

Krithe Brady, Crosskey and Robertson 1874, p. 183.,

Van Morkhoven, 1963, pp. 340-343., Swain 1971b, pp. 597-599,
Pl. 43.1, Fig. 4, Pl. 36.1, Fig. 2.

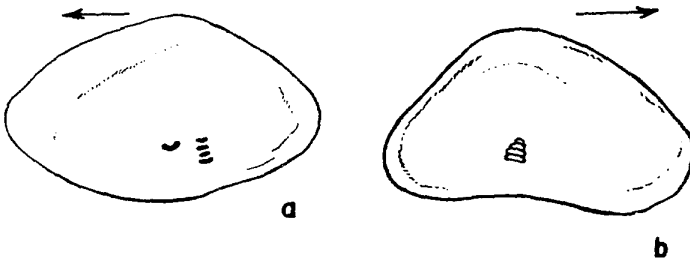


Figure 5. *Krithe tumida* Neale 1967. (A) Inside lateral view showing a right row of four adductor muscle scars arranged in a row; (B) Exterior view of the valve.

Carapace ovate, simple, small and fragile; dorsal margin convex, ventral margin faintly convex, sinuous; moderate to strongly tumid in dorsal view; anterior end broadly rounded, posterior end obliquely truncated; surface smooth. Hinge, simple, a small locellate groove in the right valve; muscle scars in vertical row of four slightly tilted.

Dimensions: Length 0.425 mm, height 0.275 mm, width 0.113 mm.

Material: Only one small right valve (possibly a penultimate instar) found at (-)45.6 m depth (Stn. No. 3) along southeastern transect

Remarks: *Krithe tumida* has been reported from the cores of early Pliocene sediments (N19) of southwest Pacific and Indian Oceans (DODO 57 p: 70-110 cm), Pliocene and RIS 34 G. 50-110 cm (Southeastern Pacific Ocean); Pleistocene zone 2 Swain, 1971a). Pleistocene zone 2 (Swain, 1971b).

Family: CYTHERURIDE MULLER, 1894

Genus: *Loxoreticulatum* Benson, 1964

Loxoreticulatum fallax (Müller) 1908, Benson (n. comb)

Fig. 6

Cythere foveolata Brady, Chapman 1919, p. 381, Pl. 4, Fig. 2.

Loxoreticulatum fallax (Müller) 1908, Benson 1964, p. 19,
Pl. 3, Figs. 1, 2, 3, 6; Text Figs. 11, 12.

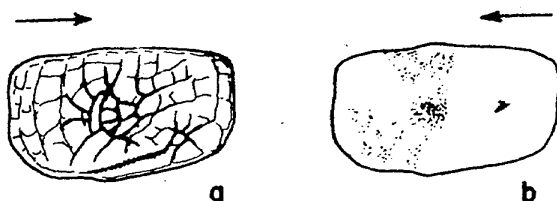


Figure 6. *Loxoreticulatum fallax* Müller 1908, Benson 1964, (a) Exterior view of the left valve of a very immature instar showing surface reticulation; (b) Inside lateral view of the same specimen.

Carapace small, rectangular in lateral outline; valves strongly inflated; dorsal margin straight but slightly curved near posterior; ventral margin almost straight; surface reticulate with depressed floors. Hinge antimerodont (?).

Material: A very immature instar of left valve found at (-)39.2 m depth (Stn. No. 7) along southeastern transect.

Remarks: Most of the features of the interior such as hinge line, caudal processes, muscle scars and concrescence of the carapace are not clearly visible as the instar is very small and highly abraded. Reticulate ornamentation is faintly visible. This specimen looks somewhat similar to *Henryhowella* sp. and *Puriana* sp. in outline, small size and ornamentation, but on close examination, it is similar to the description of Benson (1964). This species was earlier reported from Gauss Station and at McMurdo Sound by Benson. Also reported from Iles de Kerguelen and Heard islands (Neale, 1967).

Family: TRACHYLEBERIDIDAE Sylvester-Bradley, 1948

Genus: *Bradleya* Hornibrook, 1952

Bradleya dictyon (Brady) 1880

fig. 7.

Bradleya? dictyon (Brady) 1880; Benson, 1964 p. 33-34,

Text fig. 24; Neale, 1967,

p. 38, figs. 13a-c, 14., Swain, 1971b, p. 597-599, Pl. 43. 1, fig. 4.

Carapace subrectangular, dorsal and ventral margins subparallel, broadly rounded anterior end. Surface reticulate, with subdued subcentral tubercle; conspicuous ventro-lateral ridge. Ventral rib very strong. Line of concrescence parallel to outer margins. Selvage strong. Small marginal denticles on anterior margin seen. Reticular pattern of ridges radiating from central tubercle. One conspicuous ridge

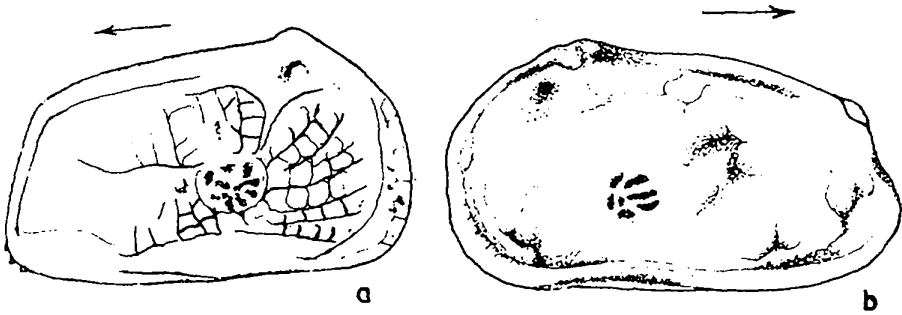


Figure 7. *Bradleya B. dictyora* (Brady) 1930, Swain 1971, (A) Inside lateral view showing a row of muscle scars arranged in the subcentral tubercle; (B) Exterior view of the right valve.

runs from the subcentral tubercle towards the eye tubercle. Hinge holamphidont with pyramidal posterior tooth. Muscle scar pattern seen in the subcentral tubercle.

Dimensions: Length 0.92 mm; Height 0.52 mm; Width 0.19 mm.

Material: One immature right valve found in this material, at (-) 37.6 m depth (Stn. No. 44) along Western Shore transect.

Remarks: It is highly abraded and fragile, but on close examination it is found to be similar to the description of Benson (1964, p. 33-34). This species is reported from many parts of the Southeastern Hemisphere not only at deep water stations (296-1375-2200 m depth) having bottom temperatures from 0.4°-1.6°C but also from shallow water stations ranging from 290-375 m (Brady 1880 'Challenger' Stations; Chapman 1919, Aurora stations', Müller 1908, Neale 1967, Fig. 1 and 14), however, it is seldom abundant and exhibits a morphological variability which poses a taxonomic problem (Benson 1964, p. 34)—Upper Cretaceous to Recent.

Genus: *Poseidonamicus*

Poseidonamicus major Benson, 1972

Fig. 8

Poseidonamicus aff. *P. major* Benson 1972,

Pl. 1, Fig. 6, p. 1043

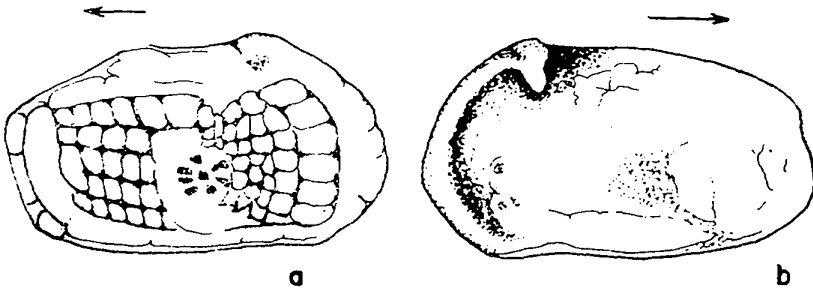


Figure 8. *Poseidonamicus* aff. *P. major*. Benson 1964, (A) Exterior view of the right valve showing surface reticulation, subcentral tubercle; (B) Interior lateral view of the same specimen showing muscle scar pattern present in the subcentral tubercle, and stepped anterior tooth.

Carapace subrectangular, dorsal and ventral margins subparallel, broadly rounded anterior end. Surface reticulate, with ridges and a subcentral tubercle. Ridges and reticular pattern very prominent radiating from subcentral tubercle. Muscle scar pattern seen in the tubercle forming a ring of scars.

Dimensions: Length 0.825 mm; Width 0.175 mm; Height 0.425 mm.

Material: Only one right valve found at (-) 45.6 m depth (Stn. No. 3) along Southeastern transect.

Remarks: It is nearly similar to Benson's (1972) illustration. It exhibits a high degree of abrasion due to heavy wind action. It also bears resemblance to *Patagonacythere longiducta antarctica*, Benson 1964. Benson (1972) illustrated one left valve (female) of this species from the upper Miocene at DSDP Site 237.

DISCUSSION

The faunal remains of foraminifera, ostracoda, diatom or other invertebrates in all samples of both the transects is generally poor excepting at very few stations. The disparity in abundance of foraminifera, paucity or even absence at identical stations on both transects is attributed to three possible conditions (Setty *et al* 1980). Briefly, they are—(1) changes in the wind run, velocity, and direction for the region and differential transport from the original sites and deposition elsewhere; (2) deposition at present locations as debris bands by former ice shelf during glacial recessions and also supplemented to the terrace material when the grounded ice ablated; and (3) uneven physiography of the lake terraces coupled with differential discharge of debris from various levels of a retreating ice sheet. Considering these factors, an extensive survey and larger collection of samples is recommended for a richer yield of the populations.

Xestoleberis and *Bradleya* have a range from Cretaceous to Recent, while *Kriehumida tumida* from Pliocene to Recent, and *Paradoxostoma antarcticum* and *Loxoreticulatum fallax* from Pleistocene to Recent. *Poseidonamicus* has a range from Oligocene to Recent. *Poseidonamicus*, *Henryhowella*, *Agrenocythere*, *Abyssocythere* with *Bairdia*, *Bythocypris*, *Cytherella* and *Kriehumida* lived in Oligocene seas at depths of 1000-1500 m as today in the Caribbean of North Atlantic (Benson, 1972; Keen, 1977; Van den Bold, 1977). *Bradleya* is also associated with *Poseidonamicus* and *Agrenocythere* and *Abyssocythere* in the South Atlantic (Van den Bold, 1977). *Poseidonamicus*, *Agrenocythere* and *Abyssocythere* are very well-known psychrospheric forms. (40 million years ago, early Oligocene marks the beginning of psychrosphere). The associated benthic foraminifera of the Lake terraces (*Cassidulina*, *Trochanmina* and *Cibicides* have similar depth ranges from 8 to > 2000 m). But these psychrospheric Ostracodes and depth oriented benthic foraminifera presently occur at (-) 37.6 to (-) 45.6 m depth along with foraminifera such as *Discorbis*, ranging from 0.50 m depth; *Patellina* at 0 to 100 m, *Bucella* and *Nonion* ranging from 0 to 180 m depth, and ostracodes like *Xestoleberis* which are characteristic of littoral to epineritic environment. Müller (1908) found some species of *Xestoleberis* at 385 m depth in Antarctica. This anomalous occurrence of a deep water psychrospheric fauna (*Poseidonamicus* and *Bradleya*) in Lake terraces is intriguing. But Benson (1975) observed 'that the thermospheric ostracode faunas that have lived on the flooded shelf and epeiric sea floors of the last 50 million years have evolved many families' and 'that at one time in the past it was easier for the shelf faunas to have member species

successfully invade the abyss', as 'depth alone does not seem to be a barrier'. Further, as Kerry *et al* (1974) observed, the biotic community of the Lake presently includes organisms which have evolved from forms present in the adjoining sea and progressively adopted to the changing of salinity increases and other conditions. In this context, the variability is understandable. All the ostracod specimens do not possess/preserve good surface ornamentation but rather appear to be an index of rigors of the environment (very much worn out or abraded). Neale (1967) contends that the incidence of left or right valves does not make any significant difference as the carapaces are rare. While examining the Recent deep sea Uvigerinids of south-east Indian Ocean, Corliss (1979) observed that no distinct relationship exists between surface ornamentation and depth. But in this case it is not the lack of ornamentation but erosion caused mainly by gradational external stress (wind action), large physical environmental shifts such as continuous dissolution effect caused due to high salinity, low temperature and dissolved carbon dioxide content of lake waters which are responsible.

The high diversity of ostracode fauna of these lake sediments suggests a commensurately higher biologic order but the physical environmental stress conditions may have prevented preservation of populations resulting in rarefaction. Therefore, the variation is more than expected. Thus there is a striking decrease in the number of individuals found in fossil record.

In McMurdo region Kellogg *et al* (1977) found several planktonic foraminifera, sponge spicules, rare to abundant ostracodes and fragmented other fauna from the debris bands from Black island to the northern edge nearly 40 km away. This faunal composition is equivalent to that of Deep Lake fauna, excepting for the non-occurrence of *Neoglobobadrina pachyderma*.

The very high salinities associated with very low temperatures and high dissolved CO₂ contents of water alter the water chemistry as seen in Rose Sea Waters (Kennett, 1968). Deep Lake may favour dissolution of calcareous foraminifera, ostracodes, and other tests through intense periods of calcium carbonate dissolution. The intensified dissolution may result in total elimination or weakened remains selectively or give rise to chalky appearance, degraded ornamentation, thinning of tests and carapaces and finally to fragmentation. Therefore, the rarity and impoverishment in abundance of the faunal remains reflects only weaker dissolution effect implying absence of solution resistant fauna.

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