Vertical Zonation of Antarctic and Subantarctic Benthic Marine Algae

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Continued analysis of field data and collections (22, 23) made in the Ross Sea during two summer seasons (1963-1965) has revealed a well-marked zonation of the marine algal vegetation. This zonation is traceable as far down as the depths which were indicated by Kjellman in 1877 as the elittoral region (10, 11).

Vertical Distribution in the Ross Sea

The different regions and the vertical distribution of the algal covering in the Ross Sea are as follows:

1. Epilittoral (or supralittoral) region, above the mean extreme high water spring tide. Characteristic are only two species: *Ulothrix australis* Gain and *Prasiola crispa* (Lightf.) Menegh. ssp. *antarctica* (Kütz.) Knebel f. *antarctica* Knebel.

2. Littoral (or mediolittoral) region, between the mean extreme high and the mean extreme low water spring tide. Both levels are characterized by a brown, diatomaceous layer. This region is destitute of algae due to the severe ice conditions.

3. Sublittoral (or infralittoral) region, between the mean extreme low water spring tide and 37 meters.

a. There is an upper belt in this region which could best be named sublittoral fringe; it goes down to a depth of about 10 meters. Algal growth is abundant here, also under shore-fast ice of 2- to 3-meter thickness (22). The dominant species are *Monostroma hariotii* Gain, *Hildenbrandia lecannellieri* Hariot, *Phyllophora antarctica* A. et E. S. Gepp, and *Iridaea obovata* Kütz. *I. obovata* often grows in beds several kilometers long.

b. The lower sublittoral belt extends between 10 and 37 meters depth. The dominant species growing in this belt can be seen in fig. 1. Some of these have not been found south of 73° S. (fig. 2).

4. Elittoral (or circalittoral) region, from 37 meters down to the limit of attached macroscopic algal growth.

The lower limit seems to be in the Ross Sea at a depth of 668 meters. The 10 species occurring here are shown in fig. 1. There is one, *Ballia callitricha* (C. Ag.) Kütz., with an upper limit of 37 meters. This can be considered to be a true elittoral species.



Fig. 1. Vertical Distribution of the Dominant Species of Benthic Marine Algae in the Western Part of the Ross Sea and around the Balleny Islands.

Most of the elittoral algae collected were still attached to their substratum. They were fresh, had their natural shape and colors, and were often fruiting. Therefore, it is very unlikely that these algae are drift deposits and had been transported by floating icebergs as was suggested in the past (10). While camping along the coasts of the Ross Sea, it was observed that transportation of bottom material by floating icebergs normally does not cover any distance of importance. In the process of thawing, pieces of ice drop off constantly; the iceberg then turns partly over and exposes other parts to the sun. Consequently, the attached bottom vegetation is returned to the sea bottom much closer to the place from which it was picked up than has been suggested in the past.

Vertical Distribution in Antarctic and Subantarctic Seas Outside the Ross Sea

In checking the records of a number of former expeditions (literature 1-14, 16-20 and 24), I found that the vertical distribution was reported accurately for 353 species.

Two hundred of these species are adapted to the shallow water conditions of the littoral and down to a depth of 10 meters. For these species, I propose the term steno-littoral. The other 76 species occurring in these regions are eury-littoral.

In the lower sublittoral, between 10 and 37 meters, there are 30 species, or 8.5 percent. These I will call steno-sublittoral species.

Below a depth of 37 meters, there are 23 species, or 6.6 percent; these are the *steno-elittoral* algae.

Since all depths were recorded by the ship's sonar depth finder, the depths are accurate.

Therefore, the present investigations, together with those of former expeditions, are indisputable evidence of the existence of an elittoral benthic algal flora.

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Fig. 2. Horizontal Distribution of the Dominant Species of Marine Algae in the Ross Sea. The Approximate Southernmost Limit of each Species is Indicated by the Latitude Opposite the Name of the Species.



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Table 1. Vertical Distribution of 353 Species of Antarctic and Subantarctic Benthic Marine Algae as Reported in the Literature

Depth in Division	m	Autochthon	Excl. Littoral	Occurring between 0 & 10	Occurring between 11 & 37	Occurring between 38 & 95	Occurring between 96 & 150	Occurring between 151 & 219	Occurring Below 220
Chlorophyta	Nos.	53	22	28	7	3	2	0	0
	%	15.0	6.2	7.9	2.0	0.9	0.6	0.0	0.0
Phaeophyta	Nos.	. 95	25	63	27	5	2	1	1
	%	26.0	7.1	17.9	7.8	1.5	0.6	0.3	0. 3
Rhodophyta	Nos. %	205 59.0	38 10.7	123 34.3	96 27.2	31 9.0	12 3.6	3 0.9	$1 \\ 0.3$
Totals	Nos.	353	85	214	130	39	16	4	2
	%	100.0	24.0	60.6	37.0	11.4	4.8	1.2	0.6
Ratio $\frac{(\mathbf{Rh})}{(\mathbf{F}_1)}$		2.3	1.5	1.9	3.5	6.0	6.0	3.0	1.0

Study of Parasites of Antarctic Vertebrates and Invertebrates

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The collection phase of this study began in 1959 at McMurdo Station and continued through 1962 with other field parties at Wilkes Station and aboard USNS *Eltanin*. Comparison collections of host materials have been made from these stations and along the coasts of Chile, Australia, and New Zealand. Other antarctic collections have been provided by Dr. Harry L. Holloway of Roanoke College. Of the parasites removed from the host materials at Virginia Institute of Marine Science, the digeneids have been given to Dr. Mitchell Byrd of William and Mary College for study and the acanthocephalans and nematodes to Dr. Holloway. The Australian and Chilean comparison collections are still being processed.

During 1965-1966, the major laboratory effort was devoted to studying the parasites of antarctic fishes. In all, 610 individual fishes of 15 species were examined and the parasites removed and prepared for examination. The drawings and descriptions have been made, and several manuscripts are in advanced stages of preparation. Involved are several new species and one new genus. A paper on antarctic parasites by three prominent Russian scientists has been translated into English as an aid in the taxonomic studies.

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A Study of Articulate Brachiopods in the Antarctic Region

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The antarctic brachiopod fauna is suited for a study of behavior and ecology because of its abundance and variability, representing cosmopolitan, endemic, and recent immigrant genera. Six species of brachiopods were found on Cruise 21 of USNS *Eltanin*. Two species were cosmopolitan, abyssal forms; the other four species occurred on the continental slope and shelf. Prior to the departure of *Eltanin* on Cruise 21, the University of Chile's Marine Biological Station at Viña del Mar generously allowed full use of its vessel for trawling and diving for brachiopods in Valparaíso Bay. After Cruise 21, the dory aboard *Eltanin* was