from chlorinated PE solutions under thermal conditions. After 4 hours reaction time, only slight increases of chloroform concentration above the blank value were noted. A 10 mg/liter solution of Cat-Floc-T with a reaction time of 24 hours produced $CHCl_3$ at a concentration of 1.1 μg/liter, compared to 0.5 μg/liter for a reaction time of 4 hours. Larger chloroform concentrations were observed after ultraviolet irradiation of the solution (7). Compared to 0.5 μg/liter $CHCl_3$ after 4 hours of thermal conditions, 7.9 μg/liter was produced after the same Cat-Floc-T solution (10 mg/liter) was irradiated for 1 hour. A similar irradiation of 100 mg/liter Cat-Floc-T resulted in the formation of 29.2 μg/liter $CHCl_3$. These and other results in Table 1 illustrate the photoenhancement of chloroform formations from commercial PE's and chlorine.

Generally, municipal water treatment plants in the northern United States and in Canada are enclosed and shielded from direct sunlight. Therefore, in these plants the thermal reaction will predominate, with only minimal formation of chloroform. In contrast, water treatment plants in which the water is exposed to sunlight, such as open-air plants in more temperate climatic zones, could derive larger amounts of chloroform from PE's by the ultraviolet pathway.

The possibility of chloroform formation from PE's was first raised in the report on the National Organics Reconnaissance Survey for Halogenated Organics in Drinking Water (*1*). It was observed that finished water from treatment plants that used PE's generally had higher total concentrations of trihalomethanes than water from plants that did not use PE's. The average trihalomethane concentration in all 80 cities surveyed was 0.5 μmole/liter (59 μg/liter if this was all present at $CHCl_3$). Sixty-three of the cities employed filtration in their treatment process, and 16 of these used PE's on a regular basis. The cities using PE's had an average trihalomethane concentration 51 percent higher than did cities which employed filtration but not PE's. One should not infer from these results that the excess chloroform is due to the PE's, as many of these cities probably had below-average raw water quality that caused them to switch to PE's in the first place. In general, there is a definite lack of information on the precise chemical composition of commercial PE formulations; their impurities, such as monomers and oligomers; and their removal with the treatment processes. More detailed studies must be undertaken before the relative contributions of PE's, or their impurities, as chloroform precursors can be assessed. Polyelectrolytes are now generally accepted as valuable coagulants for the removal of other, more abundant, potential chloroform precursors, and it may well be that their benefits outweigh any detrimental side reactions, such as that reported above.

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Antarctic Marine Flora: Uniquely Devoid of Kelps

Abstract. *The discovery of embryonic stages of the common large Antarctic brown seaweed* Himantothallus *has led to the conclusion that this plant, hitherto assigned equivocally to the Laminariales (kelps), is a member of the Desmarestiales. Moreover, field study of a large sample of* Himantothallus *and two other enigmatic brown algae,* Phyllogigas *and* Phaeoglossum, *has led to the merger of these three genera with the recognition of a single species,* Himantothallus grandifolius. *The correct placement of these kelp-like algae underscores the uniqueness of the Antarctic marine flora as the only cold-water flora without kelps.*

In Antarctic waters, one of the largest, most abundant, and most widely distributed seaweeds is a kelp-like alga with a relatively short, often spirally twisted, flat stipe attached by a hapteroid holdfast and bearing one to several thick undivided blades up to 10 m long and 1 m broad. The earliest available epithet—*grandifolius*—is indeed appropriate. It was suggested by the Gepps (*1*), who first described this plant as a species of *Lessonia*, a widespread Southern Hemisphere kelp, based on material collected in 1902 by the British Antarctic Expedition. The correct generic name is equivocal. That it is clearly not *Lessonia* was recognized by Skottsberg (*2*), who proposed a new genus, *Phyllogigas*, to receive it. (*Lessonia* is characterized by progressive splitting of the thallus, beginning in the meristematic zone and proceeding toward the apex, a process lacking in the Antarctic plant.) In our opinion, three monotypic genera described from the Antarctic by Skottsberg (*2*), namely, *Phyllogigas*, *Himantothallus*, and *Phaeoglossum*, are growth forms of a single species, which for technical reasons given elsewhere (*3*) we have chosen to call *Himantothallus grandifolius*.

The taxonomic position of this extraordinary plant has been in doubt from the beginning. Two of its growth forms—*Phaeoglossum* and *Phyllogigas*—were assigned to the Laminariaceae by Skottsberg without reservation, although he was somewhat bothered by their vegetative structure, which suggested Fucales to him. A third growth form—*Himantothallus*—was placed by Skottsberg in the Fucales, but with much reservation. Zinova (*4*) proposed a new family, Himantothallaceae, which she considered to be intermediate between the Fucaceae and the Laminariaceae, and suggested the possible recognition of a new order, the Himantothallales. Skottsberg and Neushul (*5*) took cognizance of this idea, without committing themselves to further action. Reproductive structures, which were expected to help solve the problem, were not reported until 1963 (*6*). They turned out to be unlike those characteristic of either the Laminariales or the Fucales, but somewhat like those in the Desmarestiales.

One of us (R.L.M.) had an excellent opportunity to study this plant in situ and in the laboratory at Palmer Station, Antarctica, during a 15-month tour of scientific duty (*7*). Embryonic thalli in various stages of development were found growing on invertebrates both in *Himantothallus* beds and in laboratory culture. We have now studied these in detail and find that their development is strikingly similar to that in *Desmarestia* (Fig. 1). Reduced to essentials, the course of ontogeny runs as follows. An upright uniseriate filament produces rhizoids from its basal cells and distichously opposite pairs of uniseriate laterals from its upper cells. Three or four pairs of these laterals continue growth as major branches, producing secondary laterals which, in turn, produce tertiary laterals. During embryogeny, some of these major branches become transformed into stipitate blades.

As in *Desmarestia*, growth of the germling filament is effected by intercalary cell divisions, which are partly diffuse and partly localized in the axis a short distance below the apex and near the base of major laterals. Also as in *Desmarestia*, the filamentous system is transformed into an embryonic stipe and embryonic blades by being sandwiched between two monostromatic layers of corticating tissue (embryonic meristoderm). We have also followed the development of somewhat older juvenile stages, the results serving to emphasize the structural similarities between *Himantothallus* and *Desmarestia*. It should be stressed that the basic form of an adult *Himantothallus* (that is, the number and position of the blades) is determined very early, at the latest by the time the germling is 4 mm high. Such variations as length of the axis, degree of

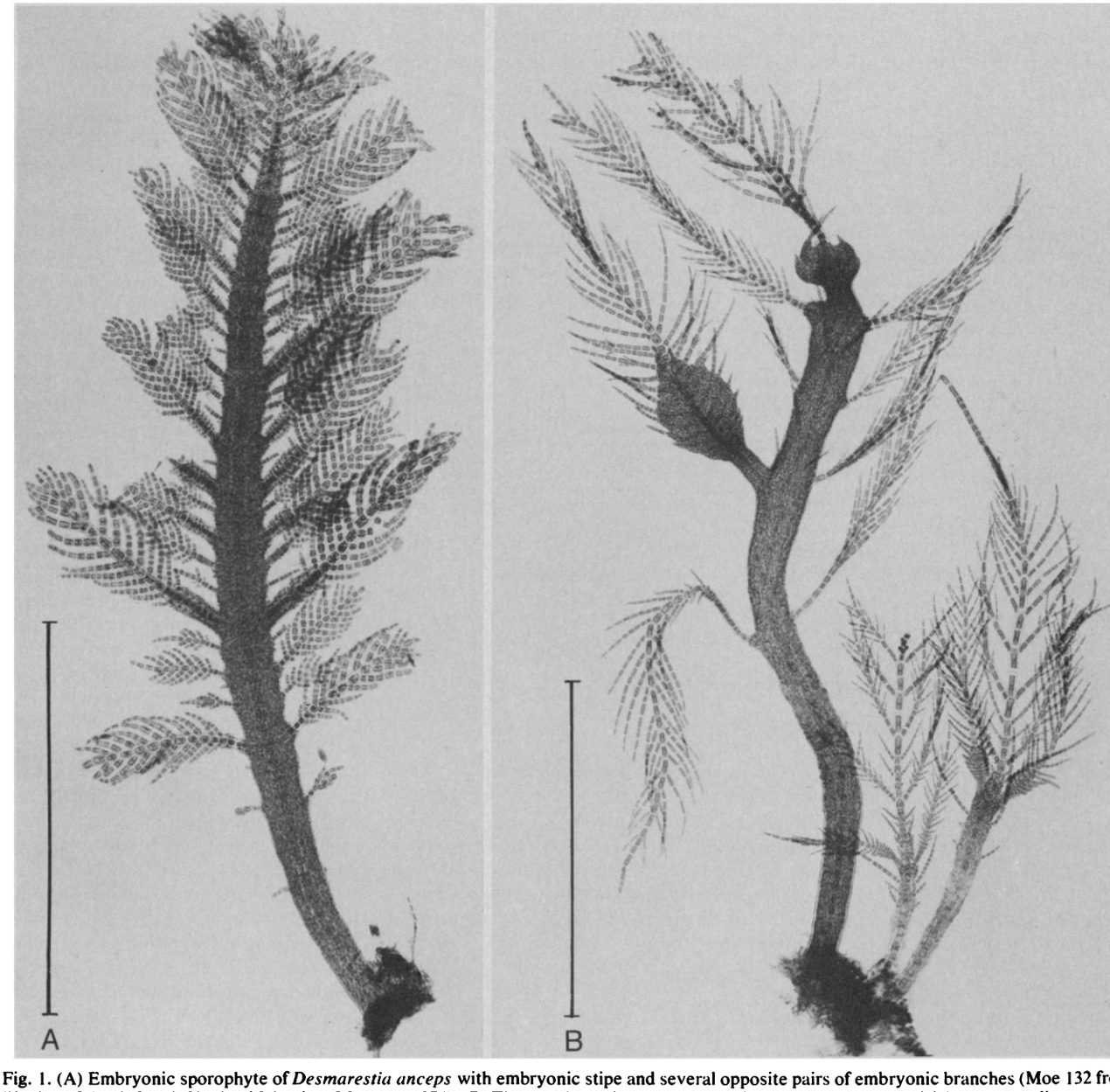

Fig. 1. (A) Embryonic sporophyte of *Desmarestia anceps* with embryonic stipe and several opposite pairs of embryonic branches (Moe 132 from Elephant Island, South Shetland Islands, 15 January 1974). (B) Three embryonic sporophytes of *Himantothallus grandifolius*. A germling (center) has a partially corticated axis; the axial cell row is still clearly visible. The left-hand member of the lowermost pair of major primary laterals is initiating cortication as the first step toward transformation into a blade. A slightly older germling (right) shows the initiation of laminae. The embryonic stage (left) shows an embryonic stipe and two embryonic blades (one lateral and one terminal) (Moe 627 from Palmer Station, Antarctic Peninsula, 3 September 1974) (scale bars, 1 mm).

torsion of the axis and blades, extent of development of haptera, degree of laceration of the blades, and dimensions of the blades are attributable to external factors rather than to inherent ontogenetic differences.

The addition of *Himantothallus* to the select group of three previously known genera of Desmarestiales greatly strengthens the position of Antarctica as the center of distribution (and possibly of origin) of this order. Of the previously known genera, *Desmarestia* is distributed worldwide, but is disproportionately well represented in Antarctic waters, while *Phaeurus* is endemic to the Antarctic Peninsula and the South Shetland Islands. Only *Arthrocladia* is absent from Antarctica, being restricted to the North Atlantic and the Mediterranean.

In Antarctic waters, members of the Desmarestiales provide the bulk of the biomass of benthic seaweeds. They are perennial, covering large areas of bottom to depths of about 40 m. The largest and most abundant species of *Desmarestia* (*D. anceps* and *D. menziesii*) form thickets, but not the protective canopy characteristic of many kelps.

With the removal of *Himantothallus* (including *Phyllogigas* and *Phaeoglossum*) to the Desmarestiales, Antarctica is seen to possess the only cold-water flora in the world without representation from the Laminariales (kelps). This void is emphasized by the situation in subantarctic waters, where vast stands of kelps (*Macrocystis* and *Lessonia*) produce a prodigious biomass (*8*). The well-known fact that kelp beds harbor characteristic biotas of high species diversity (*9*) raises the question of whether the absence of kelps results in the absence of a significant ecological niche. On the basis of observations made before the correct taxonomic position of *Himantothallus* was appreciated, we can offer some preliminary thoughts. First, even if kelps were present in the Antarctic flora, ice scouring would preclude the development of extensive canopied beds such as those that fringe subantarctic coasts. Second, the subtidal noncanopied forests of *Lessonia* abundant in the subantarctic have their Antarctic ecological counterpart in the thickets of *Desmarestia* and dense stands of *Himantothallus*.

It is hoped that further field and laboratory work will elucidate the ecological differences between desmarestialean and laminarialean communities.

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North Atlantic Ice-Rafting: A Major Change at 75,000 Years Before the Present

Abstract. *During the last interglacial-to-glacial climatic cycle [127,000 to 10,000 years before the present (B.P.)], the fundamental geographic shift in the main axis of ice-rafting deposition occurred at 75,000 years B.P. An earlier meridional depositional maximum along the Greenland-Newfoundland coasts was superseded by a nearly zonal and much stronger axis some 1500 kilometers to the south along 40°N to 50°N. Both depositional patterns are best explained by cyclonic flow in the subpolar gyre, with the depositional shift related to the retreat of warm, ice-melting North Atlantic drift water from the northwestern half of the gyre. Similar shifts must have characterized preceding interglacial-glacial cycles.*

Measurements of the absolute input of ice-rafted detritus in space and time basically define when, where, and at what rates sediment is dropped from melting ice during passage from land to subpolar oceans. In this study I utilized 32 cores taken in the subpolar North Atlantic Ocean (Fig. 1). Shelf areas, shallow plateaus, abyssal plains, channels, canyons, and fans were not sampled. I have focused on a sediment fraction which on the basis of size (> 62 μm) and texture (dispersed and nongraded) can only be an ice-rafted product (*1*). Detailed descriptions on all aspects of this study are available elsewhere (*2*).

Late Quaternary stratigraphic control in the North Atlantic is excellent. I have used four levels located, dated, defined, and discussed in earlier studies (*3*): the zone 1 volcanic ash peak at 9300 years before the present (B.P.); the zone 2 volcanic peak at 65,000 years B.P.; and the warm microfossil-lithologic equivalents of the Barbados high sea levels dated at 82,000 years B.P. and 125,000 years B.P. (*4*). All depth levels in the 32 cores were transformed to time by interpolation with reference to these four control levels. The cores were sampled at depth intervals chosen not to exceed 3300 years of time; 1448 samples were analyzed.

The objective of measuring a demonstrably ice-rafted component (noncarbonate sand) required an initial decision on the appropriate technique for determining the percentages of carbonate. I chose the standard insoluble residue technique, except that the samples were first wet-sieved through a 62-μm screen to isolate the coarse fraction (*5*).

Computation of absolute input rates of noncarbonate sand within specified intervals of core involved three steps. The first, determination of the mean sedimentation rates in centimeters per 10^3 years, is a by-product of the stratigraphic control (*3*). The second step consists of multiplication of all rates determined in step 1 by a sediment bulk density of 800 mg/cm^3 to convert sedimentation rates in centimeters per 10^3 years to absolute input units in milligrams per square centimeter per 10^3 years (*6*). The third step, multiplication by the decimal fraction of noncarbonate sand (by weight) averaged for all samples within the chosen interval of each core, follows directly from the sample analyses. The resulting values mapped (Fig. 1) are input rates of noncarbonate sand in milligrams per square centimeter per 10^3 years.

The precision error on any one sample analysis was large (± 11 percent). Because the study combines many separate analyses into averages integrated over long intervals of time, the precision error of the mapped values is appreciably reduced (*7*).

The absolute input numbers on the two maps (Fig. 1, a and b) are contoured in a literal manner by linear interpolation between actual core values, with two major exceptions. For the pairs of closely spaced cores (pairs with circles touching in Fig. 1, a and b), an average was computed. For the three cores centered on 58°N, 28°W in a province of major sediment redistribution by bottom currents (*8*), I contoured on an average value at their geographic midpoint (small box in the center of Fig. 1a). In addition,