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, there is a minor smoothing of contours around values breaking the general regional trends.

A major change in the pattern of ice-rafting deposition occurred approximately 75,000 years B.P. (Fig. 1, a and b). Prior to this time, deposition for a period of almost 50,000 years (all of isotopic stage 5) was greatest in the northwestern Atlantic near Greenland and Newfoundland (Fig. 1a). The resemblance to the modern distribution of icebergs and sea ice (*9*) suggests a circulation pattern similar to the modern Arctic ice outflow and melting. There is, however, no clear modern analogue for the secondary depositional maximum along 52°N, whether because of insufficient modern iceberg observations to pinpoint such a trend or because of a warmer modern ocean and lesser Northern Hemisphere ice mass than the integrated stage 5 average (*10*). This secondary zonal axis suggests a significant eastward ice trajectory during both the last interglacial maximum (125,000 to 115,000 years B.P.) and the remainder of stage 5 (115,000 to 80,000 years B.P.).

The main glacial pattern during isotopic stages 4 through 2 was very different: the major depositional axis rotated abruptly 1500 km to the southeast (Fig. 1b). This shift must have been caused largely by the simultaneous withdrawal of warm North Atlantic drift waters from the west-central portions of the subpolar gyre at 75,000 years B.P. (*3*). The ice then traveled farther from the pole before reaching water warm enough to cause it to melt (*11*).

The juxtaposition of a northeastern depositional minimum just west of Great Britain and higher values to the northwest near Iceland and Greenland is an indicator of basically cyclonic flow. Because microfossils show that surface waters were generally warmer (and thus more likely to melt ice) near Great Britain than Iceland or Greenland (*2*, *3*), this northeastern depositional minimum must also be a very significant ice-passage minimum. To avoid this region, most Scandinavian ice entering the North Atlantic must have moved in a large counterclockwise loop, passing first westward toward Iceland and then southwestward parallel to the coast of Greenland upon entering the northwestern subpolar Atlantic. Main glacial values in this northwestern region are comparable to or higher than the stage 5 levels, and probably show the initial dropping of bed-load sediment during iceberg passage toward the primary depositional region to the south.

I infer that Laurentide and Greenland glacier ice entering the western North Atlantic through the Labrador Sea traveled east or southeast, joined the Arctic and Scandinavian outflow, and melted in the region of convergence with warmer North Atlantic waters. The ice-rafting depositional maximum in Fig. 1b trending west-southwest, east-northeast along 46°N to 51°N may thus mark the region just to the south of the mean glacial position of the polar front or convergence. This position lies about 5° north of the extreme glacial position of the polar front defined from biotic evidence by Climate: Long-Range Investigation, Mapping, and Prediction Program (CLIMAP) (*12*).

Analysis of five subintervals within the main glacial time span (each subinterval is 1×10^4 to 2×10^4 years in length) shows no geographic change in the depositional axis from 75,000 to 13,000 years B.P. (*2*). Thus, although the main glacial depositional pattern differs greatly from that at stage 5, it demands a similar cyclonic flow.

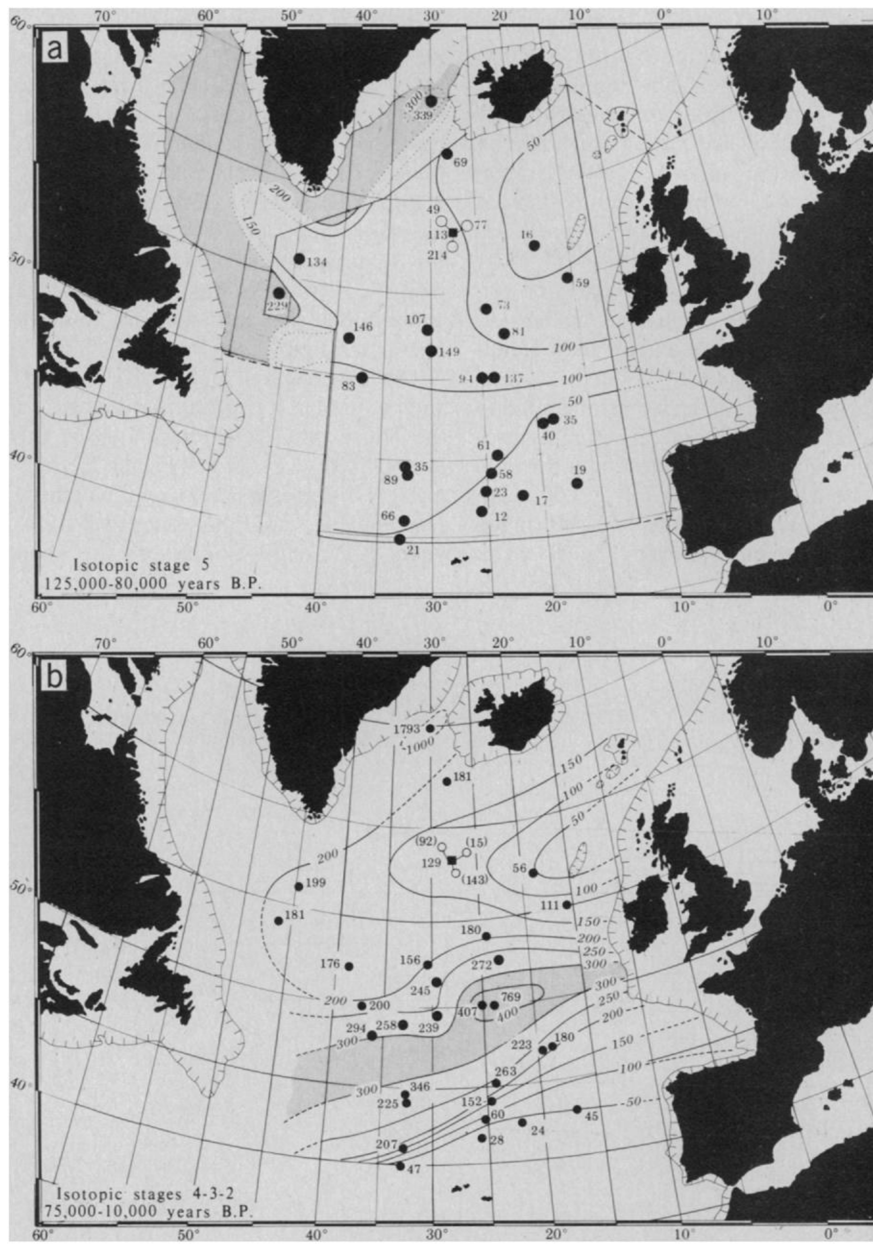

Fig. 1. (a) Absolute input rates of sand-sized ice-rafted detritus in milligrams per square centimeter per 10^3 years during isotopic stage 5 (125,000 to 80,000 years B.P). This interval includes the peak interglaciation (125,000 to 115,000 years B.P.) and the early glaciation (115,000 to 80,000 years B.P.). Maximum values lie in the northwestern Atlantic near the area of presently observed iceberg activity. The hachured line is the continental-shelf break. The thin solid line (central region of primary core coverage) and the thin dashed line (peripheral region of extrapolated contours) enclose regions for which the total mass of ice-rafted input is calculated in Fig. 2. (b) Absolute input in milligrams per square centimeter per 10^3 years for the main Würm glaciation (75,000 to 10,000 years B.P.; isotopic stages 4 through 2). Maximum values lie along an axis trending west-southwest, east-northeast.

Elsewhere (2) I have used these data to calculate the total rate of input of ice-rafted sand per millennium across both the central region of good core coverage outlined in Fig. 1a and the peripheral area of extrapolated (dotted) contours (13). Seven subintervals of the last interglacial-glacial cycle were chosen to show significant changes in ice-rafting. These data (Fig. 2) show a particularly abrupt increase in ice-rafting at about 75,000 years B.P. superimposed on a generally growing input from very low values during the peak of the last interglaciation (125,000 to 115,000 years B.P.) to maximum values late in the Würm (25,000 to 13,000 years B.P.). The timing of this change in input rates matches the geographic shift in ice-rafting patterns and establishes the major ice-rafting transition into the Würm glacial regime at about 75,000 years B.P. in the North Atlantic (14).

Isotopic variations inferred to be primarily indicative of changes in the volume of water stored as Northern Hemisphere glacial ice (15) show a trend roughly parallel to the ice-rafting buildup (Fig. 2). Because there are roughly proportional increases in these two parameters both at 115,000 and at 75,000 years B.P., I conclude that the early Würm ice sheets (formed prior to 75,000 years B.P.) must have nucleated in areas where they could directly or indirectly feed icebergs to the ocean. They could have formed either in coastal areas with icebergs calving directly from marine termini (16) or in regions farther inland, with passage to the ocean by way of ice streams through inland seas (17). The major ice-rafting change at 75,000 years B.P. occurred 40,000 years after the glacial inception and correlates with a second very prominent phase of ice-sheet growth (15).

The total ice-rafted input from 125,000 to 10,000 years B.P. in the North Atlantic exclusive of continental shelves is 1.4×10^{18} g of sand. Data from several eastern North Atlantic cores (18) suggest that the total amount of noncarbonate detritus including silt and clay is higher by a factor of roughly 7.1 than the sand input, or 10×10^{18} g. Part of this total was presumably windblown or deposited from suspension in surface waters, but the bulk appears to have been ice-rafted (18).

The long record of core K708-7 (18) shows similar ice-rafting input rates in the North Atlantic through at least the last 600,000 years. North Pacific ice-rafting (19) suggests analogous Northern Hemisphere variations since 1.2×10^6 years B.P.; deposition across this span of time would increase the mass inputs given above by roughly an order of magnitude to 15×10^{18} g of sand and 100×10^{18} g of all detritus (mostly ice-rafted). The latter mass is equivalent to a total wet volume of unconsolidated drift of 120,000 km^3, based on a bulk density of 0.8 g/cm^3. For the full 3×10^6 years of Northern Hemisphere ice-rafting (20), I estimate a total ice-rafted volume of over 200,000 km^3 in the subpolar North Atlantic (2).

This mass of debris could be spread as a uniform layer of wet unconsolidated drift 16 m thick across those portions of the continents that were occupied by the eastern Laurentide, western Scandinavian, Greenland, and Barents ice sheets and which are thought to have fed detritus to the North Atlantic (21). Combined with the roughly 350,000 km^3 of late Pliocene and Quaternary turbidite fill in the vast Sohm Abyssal Plain of the western North Atlantic (22), these deep-sea deposits help explain the lack of thick drift deposits on eastern North America mentioned by Flint (23).

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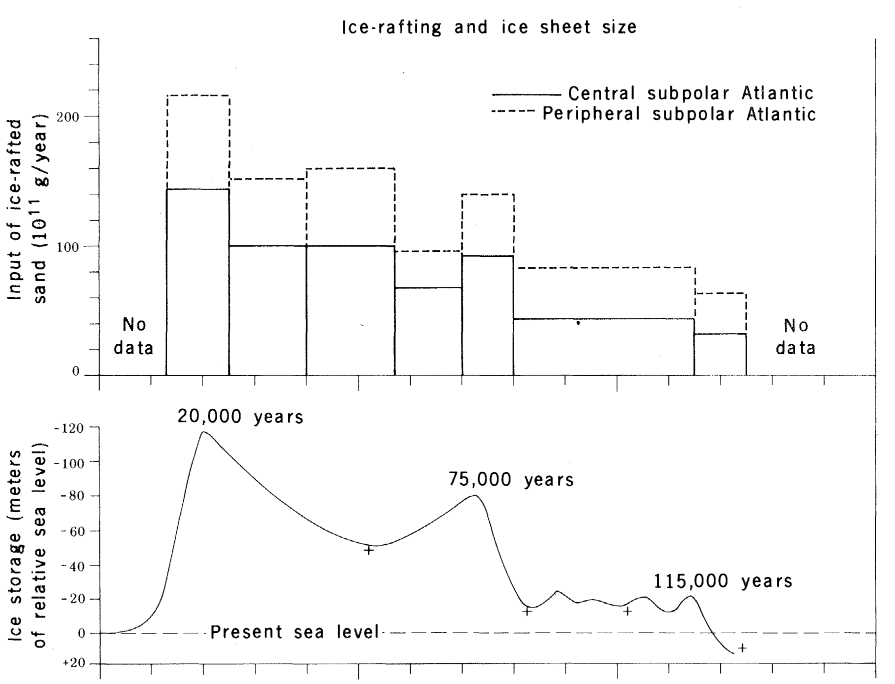

Fig. 2. Total absolute input rate (upper curve) of sand-sized detritus in kilograms per 10^3 years from (2) for seven intervals during the last 127,000 years within the regions of the subpolar North Atlantic shown in Fig. 1a. A marked increase in glaciation at 75,000 years B.P. is indicated by a sudden increase in ice-rafting. The lower curve shows isotopic evidence of rapid ice-sheet growth at 75,000 years B.P. (15). Increased glaciation is coincident with the shift in the ice-rafting depositional pattern (Fig. 1, a and b).

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7. Errors of overestimate on some samples should by statistical chance tend to be balanced by underestimates on others. If the many analyzed samples integrated through each time interval had the same percentage of coarse-fraction noncarbonate, the error would decrease as $\sqrt{N}$. This percentage value is not constant, but the assumption of constancy is a reasonable first approximation. On this basis, I estimate that the $\pm$ 11 percent error for each sample analysis is reduced by an average of roughly $\sqrt{18}$ for the mapped values in stage 5 (Fig. 1a) and by an average of roughly $\sqrt{29}$ for the glacial map (Fig. 1b). The mapped values thus have estimated errors that are probably less than ± 3 percent.
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10. In the last climatic cycle, two prominent high-latitude coolings and periods of ice-sheet growth are recorded, one at about 115,000 years B.P. and the other at 75,000 years B.P. The earlier cooling is here regarded as the glacial inception that ended the peak interglaciation (125,000 to 115,000 years B.P.). During the period 115,000 to 80,000 years B.P., climate varied in an intermediate range between the peak interglaciation and the main portion of the Würm glaciation that followed. This intervening period is here called the early Würm glaciation, despite its partially interglacial characteristics.
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13. Continental shelves and shallow plateaus were excluded, since sediments deposited there are overwhelmingly subject to erosion and redeposition. Only ice-rafted detritus deposited in the predominantly undisturbed realm of the deep ocean is of interest here.
14. Analyses in (*2*) of data in (*5*) show that long-term deposition of noncarbonate sand in the Norwegian Sea was surprisingly constant during the last 127,000 years, averaging about 20 × 10^{11} kg per 10^3 years in the intervals of both stage 5 and stages 4 through 2. There is thus no additional differential effect imposed on trends in Fig. 2 due to changing deposition in that sector.
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Insecticide Solvents: Interference with Insecticidal Action

Abstract. *Several commercial solvent mixtures commonly used as insecticide carriers in spray formulations increase by more than threefold the microsomal* N-*demethylation of* p-*chloro* N-*methylaniline in midgut preparations of southern armyworm* (Spodoptera eridania) *larvae exposed orally to the test solvents. Under laboratory conditions, the same solvent mixtures exhibit a protective action against the in vivo toxicity of the insecticide carbaryl to the larvae. The data are discussed with respect to possible solvent-insecticide interactions occurring under field conditions and, more broadly, to potential toxicological hazards of these solvents to humans.*

Studies in recent years have established that insects have active microsomal mixed-function oxidase (MFO) systems which are mediated by cytochrome P450; these systems appear similar in all important characteristics measured to date to those occurring in mammals (*1*). The oxidase systems take part in the metabolism of insecticides and of other foreign lipophilic compounds (*2*), and as a consequence they often dictate the duration and intensity of action of many toxicants and other biologically active materials.

One important characteristic of the MFO system is its ability to become rapidly induced after the exposure of organisms to any of a large number of drugs, insecticides, and other chemicals, many of which are MFO substrates (*3*). The induction process, which enhances enzyme activity through an increase in de novo protein synthesis (*3*), often has a marked effect on the susceptibility of an organism to a given toxicant.

There have been numerous reports of MFO induction in insects (*1, 4*), and studies with the southern armyworm (*Spodoptera eridania*, Cramer) have shown that MFO activity in the midgut tissues, the major site of localization of the enzymes in Lepidoptera (*1*), is highly responsive to the inducing action of various alkylbenzenes administered in the diet (*5*).

In that xylenes and other aromatic hydrocarbon compounds are frequently employed as solvents in concentrates and other formulations, it is of interest to investigate the potential inducing capacity of such materials.

Experiments were conducted with sixth (last) instar larvae of the southern armyworm; the larvae were reared under greenhouse conditions (*6*) and carefully synchronized with respect to age (± 1 hour) at the time of the fifth molt. Groups of 30 newly molted sixth-instar larvae were given free access to the semidefined diets, which are based on agar (*5*), either with or without (control) the addition of various concentrations of the test compounds (*7*). After 24 hours, the midgut tissues were removed by dissection, cleaned, and homogenized to provide the enzyme preparation employed (*6*). Microsomal enzyme activity was measured by the *N*-demethylation of *p*-chloro *N*-methylaniline as described (*5*). Although our data were obtained only with crude midgut homogenates, *N*-demethylase activity has been shown to be located in the microsomal fraction of these homogenates (*5*).

The inducing capacities of the 13 commercial solvents evaluated (*7*) and of several standard materials included for comparison are shown in Table 1. At a dietary concentration of 0.2 percent (weight to volume), several of the solvent mixtures were potent inducers of microsomal *N*-demethylation, the most potent ones Amsco-Solv E-98, Mentor 28, and HAN increasing the level of enzyme activity to 449, 399, and 380 percent of the controls, respectively. Panasols AN-2 and AN-2K and Hess odorless spray base were only slightly less potent, the two former causing a greater than 2.5-fold increase at a dietary concentration of 0.05 percent. Under identical test conditions, phenobarbital, which induces hepatic MFO activity in mammals, caused a threefold increase in *N*-demethylase activity. Although detailed analyses of these solvent mixtures are not available, all such mixtures are known to contain high percentages (83 percent for HAN) of alkylated benzenes and naphthalenes, along with lesser amounts of other aromatic hydrocarbons. The data for the two simple alkylnaphthalenes included in Table 1 demonstrate the high inducing capacity of such compounds, which might constitute major components in the solvent mixtures. Neither unsubstituted benzene nor naphthalene had any effect on enzyme activity.

In an attempt to assess the possible in vivo effects of the solvents on the toxicity of insecticide to insects, groups of 20 sixth-instar armyworms that had been denied access to food for 4 hours after molting were allowed to feed on the leaves of "two-leaf-stage" kidney bean plants that had been sprayed (less than 10 minutes before) as evenly as possible with a Chromatosprayer (Applied Science Laboratories) with 5-ml portions either of acetone solutions of carbaryl (1-