Table 1. Removal of Cs^{137} from peeled and sliced potato tubers.

Treatment	Specific activity (10^3 count/min) per g (fresh wt) Before treatment	Specific activity (10^3 count/min) per g (fresh wt) After treatment	Cs^{137} removed (%)
Constant stirring of 2-g pieces in H_2O with cation-exchange resin (K^+ form), 17 hr at 34°C	3.10	0.174	95
Same, with addition of 1.2% KCl to H_2O	22.1	.241	99

be possible. Rohm and Haas' Amberlite IR-120 proved to be such an agent (*4*). Data showing its effectiveness are presented in Table 1.

In the procedure adopted for removal of Cs^{137} the tubers are peeled and cut transversely into slices about 0.5 cm thick. The slices are immersed in an isotonic solution (10 to 15 ml per gram of fresh weight of tuber) consisting of 1.2 percent KCl, 0.16 percent NaCl, and 50 parts per million of $Na_2S_2O_5$ (to retard discoloration) and stirred continuously for 16 hours at 26° to 35°C with the specially prepared cation exchange resin (0.25 g wet resin per gram of fresh weight of tuber). Before use, the resin is converted to the mixed form (both potassium and sodium ions) by equilibrating it with a solution consisting of 4 percent KCl and 0.53 percent NaCl, and then washing it free of chloride with distilled water.

The degree of decontamination for tubers treated in this manner is consistently greater than 95 percent. Nonradioactive tubers subjected to this treatment and then boiled are almost indistinguishable in palatability (appearance, texture, and flavor) from untreated controls as shown by organoleptic tests. If the time of treatment is extended from 16 to 24 hours, the removal of Cs^{137} exceeds 99 percent but the palatability of the subsequently boiled tubers, while still very good, is inferior to that of tubers treated for the shorter time. At temperatures much below 26°C, the degree of decontamination decreases (presumably as a result of slowed diffusion of ions from the cells), while at temperatures in excess of 35°C, quality of the product is detrimentally affected. If the thickness of the tuber slices is increased, the time required for treatment increases, as expected. The potassium and sodium content of the tubers are not altered by the outlined treatment. Thus tubers decontaminated in this manner would provide not only an important source of carbohydrate but also an important source of Cs^{137}-free potassium in the diet, in times of local or national emergency. Clearly, the use of ion-exchange resin in any other than the mixed K^+-Na^+ form described will result in an altered balance of these ions in the decontaminated tubers as would the use of a solution of any other composition than that outlined.

The treated tubers lose 80 percent of their ascorbic acid content. Although in the recommended North American diet potatoes supply as much as 50 percent of the minimal daily requirements of this vitamin, up to 50 percent of the ascorbic acid content is normally lost on cooking, depending upon the method of cooking used (*5*). Since this loss can readily be compensated for by increased consumption of other foods high in vitamin C or by the incorporation of ascorbic acid tablets into the diet, under conditions in which the proposed decontamination procedure would be used this objection is not considered to be important. Although niacin, riboflavine, thiamine, and iron are also likely to be lost by this treatment, low initial contents compared to the minimal daily requirements coupled with losses during cooking (*5*) combine to rank cooked potatoes well below many other foods as a source of these nutrients in a normal North American diet.

This procedure should be easily and economically adaptable to commercial operations: either raw (preserved with metabisulfite) or cooked (as, for instance, potato flakes) Cs^{137}-free tubers could be supplied to the consumer. For domestic use, and at nominal cost, the householder could be supplied with the previously conditioned ion-exchange resin and with KCl in the form of packets resembling tea bags. The metabisulfite could probably be eliminated from a domestic process since it is used primarily for esthetic reasons, slightly discolored tubers being no less nutritious or flavorful (even if less palatable) than normal tubers.

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5. *Handbook of Biological Data*, W. S. Spector, Ed. (Saunders, Philadelphia, 1956).

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Pteropod Ooze from Bermuda Pedestal

Abstract. *Twenty pteropod species and two subspecies are present in the Bermuda Pedestal pelagic sediments. Some species having thin, fragile shells were absent from the sediments but present in the deep water off Bermuda. The subarctic species was present only in the sediments, which indicates that the subarctic current probably invaded the Bermuda region some time ago.*

Recent deposits of typical pteropod ooze are limited almost entirely to the vicinity of oceanic islands or to the summits and sides of submarine elevations in tropical and subtropical areas (*1*). The pteropod ooze from Bermuda Pedestal is one of the best examples. This study compares the species composition and abundance of the pteropod ooze from the Bermuda Pedestal pelagic sediments with those of living shell-bearing pteropods from the overlying water column. Subsequently these data might be applied to paleoecological interpretation of Cenozoic and Cretaceous marine sediments in which pteropod fossil assemblages occur.

Pteropod ooze was used by Murray and Renard (*2*) to designate deep-sea deposits in which a very large part of the calcareous organisms consists of the dead shells of pteropods and heteropods, along with the shells of other pelagic and larval mollusks. Pteropod ooze was defined by Sverdrup *et al.* (*3*) as pelagic deposits with more than 30 percent calcium carbonate of organic origin, pteropod and other pelagic mollusk shells being the most important constituents.

Pelseneer (*4*) was the first to record pteropod species from pelagic sediments at various stations of the Challenger Expedition during 1873–76. Stubbings (*5*) and Rehder (*6*) reported pteropod shell assemblages from the ocean floor of the Arabian Sea and the area between Newfoundland and Ireland, respectively.

The pteropod assemblages in 45 post-Wisconsin cores of Bermuda Pedestal examined in this study are on file in the core laboratory at the Lamont Geological Observatory of Columbia University. When available, at least one or more samples were selected from every 200-m depth range of the Bermuda Pedestal region to determine the relation of the abundance of pteropod individuals to the depth of the ocean bottom. After the core samples were washed, the pteropods were found concentrated in the coarse fraction (> 74 μ) and their abundance was based on the number of individuals per milligram of the coarse fraction.

The submarine geology, the topography, and the physical oceanography of the Bermuda area are well known (*7–9*). In general, the core sediment of post-Wisconsin age is composed of light tan to brown calcilutite, containing corals, foraminifers, and pteropods. Two categories of the pelagic sediments have been recognized: sediments that accumulated slowly and continuously, and sediments that were deposited catastrophically by turbidity currents (*10*). The percentage of calcium carbonate in pelagic sediments from the Bermuda Pedestal is more than 80 percent at water depths less than 3650 m, 77 percent at 3800 m, and less than 70 percent below 4200 m.

Twenty species and two subspecies of shell-bearing pteropods from the Bermuda Pedestal pelagic sediments (Table 1) can be grouped in three broad categories. The latter are based on the ecological information obtained from surface, vertical, and oblique tows made at various depths down to 1000 m off Bermuda, and from surface tows of four North Atlantic weather stations: Bravo (56.5°N, 51°W), Charlie (52°45′N, 35.5°W), Delta (44°N, 41°W), and Echo (35°N, 48°W) (*11*).

Category I includes only a single subarctic species, *Limacina retroversa* (Fleming), found off Bermuda in the pelagic sediments but not in the overlying water column.

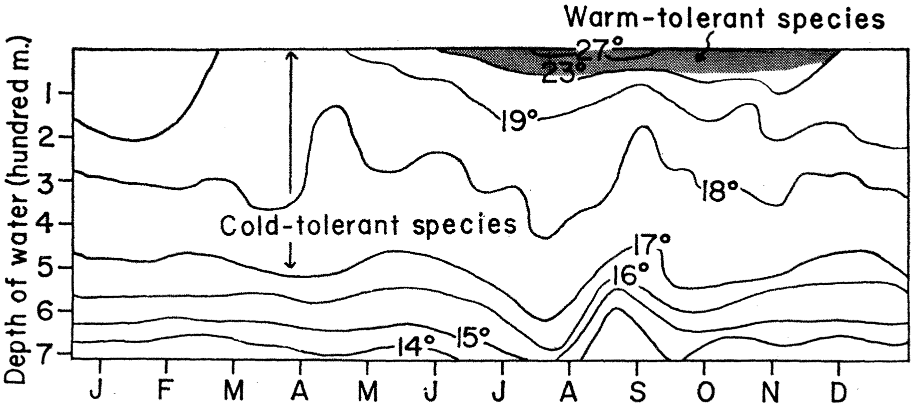

Fig. 1. Seasonal and bathymetric distributions of cold- and warm-tolerant pteropods off Bermuda. Temperature variation is after Menzel and Ryther (*8*).

Category II consists of 12 species and one subspecies of cold-tolerant pteropods. They are abundant when the water temperature range is between 18° and 22°C. During the colder months these species are predominant from surface to 500 m but prefer to live in subsurface waters during the warmer months.

Category III is composed of seven species and one subspecies of warm-tolerant pteropods which are predominant in surface waters during the warmer months when the temperature range is from 23° to 27°C. They are rare or absent during the colder months.

Figure 1 shows the variation of water temperatures off Bermuda with regard to depth and season. The distribution of warm-tolerant species (category III) follows approximately the 23°C isotherm in the upper 50 m of water from June to November. The species stratification can be observed during the summer; the cold-tolerant species (category II) is abundant between 50 to 500 m. The species stratification disappears during the winter when the cold-tolerant species of category II are

Table 1. Abundances of pteropod species from the core (post-Wisconsin) of the Bermuda Pedestal, from the vertical tows (0 to 500 m), and from the surface tows (0 to 10 m) of overlying water column. The core samples represent the mean number of specimens per milligram of the coarse fraction sediment. The vertical and surface tows represent the mean number of specimens per 1000 m³ of water.

Species	Core samples	Vertical tows	Surface tows
	Category I		
Limacina retroversa	0.1		
	Category II		
Limacina lesueuri	13	28	2
L. inflata	243	344	188
L. bulimoides	24	80	40
Clio pyramidata	10	30	2
C. cuspidata	0.5	1	
C. polita	1	2	0.3
Creseis virgula clava	7	20	10
Styliola subula	70	50	20
Cuvierina columnella	Trace	1	
Diacria trispinosa	7	5	1
D. quadridentata	0.2	2	1
Peraclis reticulata	0.7	7	
P. moluccensis	Trace	2	
	Category III		
Limacina trochiformis	16	5	50
Creseis virgula	Trace	1	0.6
Creseis virgula conica	27	10	50
C. acicula	75	15	60
Hyalocylix striata	Trace	1	
Cavolinia longirostris	Fragment	1	2
C. gibbosa	Fragment	Trace	
C. inflexa	2.7	3	15

present throughout the 500-m water column. To date no living pteropods have been found at depths below 500 m. The ratio of cold- to warm-tolerant species is about 6.8 : 1 in depths of 0 to 500 m, 1.5 : 1 in the surface water, whereas it is about 3 : 1 in the Bermuda Pedestal pelagic sediments.

The dead assemblages of the subarctic species, *Limacina retroversa*, were found on the ocean floor but not in the overlying water column. This may be explained by the fact that (i) the dead empty shells were allochthonous, or that (ii) the living individuals were transferred southward to the Sargasso Sea by a subarctic current. The first explanation requires transportation of the empty shells for several hundred miles across the abyssal plain and then deposition on the shallower Bermuda Pedestal. It appears, therefore, that the second explanation is more plausible. The presence of the empty shells of subarctic species was probably due to a subarctic current which invaded the Bermuda area some time ago.

Some rare species, *Peraclis triacantha* (Fischer), *P. apicifulva* Meisenheimer, and *P. bispinosa* Pelseneer, have not been found in the pelagic sediments but are known to inhabit the deep waters off Bermuda. The shells of these species are very thin and fragile and more easily dissolved than those of other species. The delicate surface textures of hexagonal reticulation of *Peraclis reticulata* (d'Orbigny) were obscured after deposition on the ocean floor, probably because of greater solution of projecting ridges.

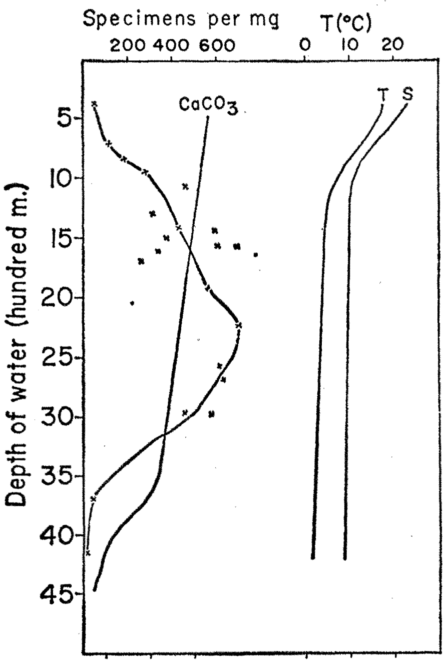

Fig. 2. Correlation between the depth range distribution of pteropod specimens per milligram from Bermuda Pedestal with the percentage of calcium carbonate ($CaCO_3$) in the sediments, and temperature (*T*) and salinity (*S*) of bottom water. Data of temperature and salinity are those of Fuglister (*9*).

The depth range distribution of pteropod shells from the pedestal is 350 to 4200 m. The maximum number of pteropod shells is about 700 per milligram of dry sediment of the coarse fraction at a depth of about 2200 m (Fig. 2). An abnormally high number of specimens is recorded between 1000 and 1600 m. Such concentrations may be due to slumping. A few traces of pteropod shells have been found at depths of 4400 and 4600 m on the Bermuda Apron. They were probably displaced by slumping from the steep pedestal to the gentle slope of the apron where they were rapidly buried and thus protected from dissolving normally with the passage of time (*12*).

My findings show that the abundance of pteropod shells in the Bermuda Pedestal pelagic sediments correlates with the calcium carbonate content of the sediments and the water depth range. The number of specimens decreases considerably in the sediment containing less than 80 percent $CaCO_3$ at water depths greater than 3650 m. No pteropod shells were found in the sediments containing less than 70 percent $CaCO_3$ below 4200 m.

Pteropod shells are composed entirely of aragonite which is less stable than calcite. Solution of calcium carbonate, temperature, salinity, or pressure may affect the depth distribution of the pteropod shells. Bramlette (*13*) has recognized that solution of calcium carbonate is important on the deeper parts of the ocean floor. He stated that: "What may be called a compensation condition, where supply does not exceed the solution, and thus with no net accumulation of calcium carbonate, includes obvious factors other than depth and rate of supply. Conditions related with marked deviations to unusually great depths, or rates of supply, or other factors will be apparent, but the depth of compensation remains surprisingly near limits between 4000 and 5000 meters."

Bramlette's opinion on pressure was as follows: "The increased solution from hydrostatic pressure does not seem to be a major factor. It may be worth additional investigation, however, for with pressures below 4000 meters becoming rather critical, it could explain the sharp limits indicated for the compensation depth." Concentrations of pteropod shells on the ocean floor are greatest at 2200 m; they diminish gradually to 4200 m, and subsequently disappear. In this zone (2200 to 4200 m) the temperature and salinity ranges are about 2°C and 0.1 per mille, respectively (Fig. 2). Since temperature and salinity have narrow ranges of variation in bottom waters, these are probably not the chief factors in the solution of pteropod shells. On the other hand, pteropod shells decreased considerably in the sediment containing about 80 percent $CaCO_3$ and disappeared when the content was less than 70 percent.

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