rates, blanks, calibration, and recovery. These results show that the average Po^{210} activity in the New Zealand grown leaf samples tested is 0.15 pc/g, compared with 0.49 pc/g in the United States samples. Our results for United States leaf are somewhat higher than the mean value 0.37 pc/g for 15 samples of post-1950, flue-cured, United States tobaccos recently reported (*3*). Although fewer samples were analyzed for the remaining two countries, it would appear that the level in South African tobacco is approximately the same as, or a little less than, United States tobacco, and the level in Rhodesian tobacco is significantly higher than that in United States tobacco. These comparisons are in approximate agreement with Marsden's values (*4*) for total alpha activity of tobacco.

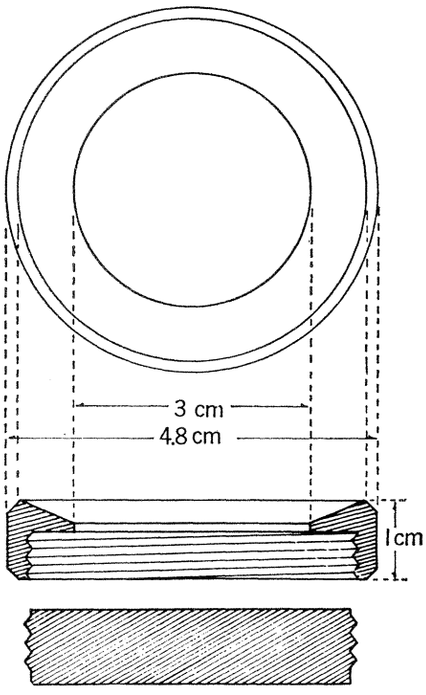

Fig. 1. Polytetrafluoroethylene holder for silver foils.

Table 2. Polonium–210 radioactivity in manufactured tobacco products.

Product	Radioactivity
I. Tobacco blends	(pc/g)
Cigarette blends	
Blend A	0.370 ± .021
Blend B	.386± .024
Blend C	.457 ± .029
Blend D	.339 ± .022
Blend E	.228 ± .015
"Roll your own" blends	
Blend F	.174 ± .013
Blend G	.108 ± .010
Blend H	.222 ± .015
Pipe tobacco blends	
Blend I	.123 ± .011
Blend J	.228 ± .016
Blend K	.192 ± .015
II. Manufactured cigarettes	(pc/cigarette)
Brand A	0.428 ± .027
Brand B (filter)	.319 ± .021
Brand C (filter)	.452 ± .028
Brand D (filter)	.344 ± .023
Brand E	.235 ± .016
Brand F	.235 ± .016
Brand G	.252 ± .016
Brand H (filter)	.236 ± .015

Tobacco manufacturers here are required to use a minimum of 30 percent New Zealand leaf in their overall production. In practice about 50 percent New Zealand leaf is used. They are free to blend this as they wish, however, and they may make a brand of all New Zealand tobacco or all imported tobacco if they so desire. About two-thirds of the manufactured products listed in Table 2 have been obtained directly from the manufacturer and have been made from the leaf samples listed in Table 1. The measured results agree with calculated results in those cases where information on leaf types and proportion has been made available to us. The remainder of the manufactured products listed have been purchased from normal retail outlets. The lower level of Po^{210} in New Zealand leaf is reflected in the results for those manufactured products, notably "roll your own" and pipe tobacco blends, where a relatively high proportion of New Zealand leaf is used. It may be interesting to note that the popularity of "roll your own" cigarettes has been a characteristic of New Zealand smoking habits.

The reason for the lower level of Po^{210} in New Zealand tobacco is not fully understood. The main tobacco growing area is Nelson, at the northern end of the South Island, relatively near the coast. A possible explanation is that much of the radon diffusing from the land's surface is dispersed over the sea. The resulting natural fallout of the lead-120 precursor of Po^{210} may well be significantly less over a country with a predominantly insular climate.

L. P. GREGORY
National Radiation Laboratory, Department of Health, Christchurch, New Zealand

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5. I thank the director of the laboratory, G. E. Roth, for encouragement; H. J. Yeabsley, for valuable guidance and helpful discussions; the Tobacco Research Station of the Department of Scientific and Industrial Research and the tobacco companies, who kindly supplied samples of leaf and manufactured products; and Dr. D. P. Kennedy, Director-General of Health, for permission to publish.

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Release of Dissolved Amino Acids by Marine Zooplankton

Abstract. *Marine net zooplankton release dissolved amino acids into the water. Release rates are positively correlated with temperature and can be estimated by the equation: Release rate (milligrams of alpha-amino nitrogen per gram dry weight of zooplankton per day) = 1.0 × temperature (°C) − 5.9. Release rates appeared to be independent of the taxonomic composition of the test samples, which were variously dominated by copepods, salps, chaetognaths, coelenterates, or radiolarians. These amino acids constitute an important source of dissolved organic matter in the sea.*

The origins of dissolved organic matter in sea water have been the subject of much recent research and discussion (*1–4*). A number of workers have reported the release of dissolved organic matter by phytoplankton, and it is this source that has received most attention (*2*). Duursma (*3*), on the other hand, believes that dissolved organic matter in the North Sea "mainly originates from particulate matter con-

sisting of dead cells and detritus." Dissolved organic phosphorus has been reported from zooplankton excretions (*4*). The relative importance of phytoplankton, zooplankton, and detritus as sources of dissolved organic matter is not known.

Dissolved amino acids are present in sea water (*5*), but little is known of their sources. We report here that dissolved amino acids are released by living zooplankton. Samples of zooplankton were collected from waters of the continental shelf off Georgia and the continental shelf, Gulf Stream, and Sargasso Sea off the Carolinas. A coarse (No. 0) net was used in order to exclude phytoplankton and detritus. The mixed zooplankton samples were incubated at collection temperature (7.0° to 25.6°C) for periods of from 20 to 285 minutes. Animals were observed carefully during the tests. Movement was used as a criterion of vigor in all organisms but radiolarians. Samples were discarded if any doubt arose concerning the condition of the animals. Samples were filtered through a membrane filter that had a porosity of 0.45 μ, preserved with a drop of chloroform, and frozen for subsequent analysis.

Total α-amino nitrogen was estimated by a slight modification of the copper method of Pope and Stevens (*6*). This modified method resulted in recoveries in the range of 70 to 90 percent for typical amino acids added to sea water at concentrations comparable to those observed in the filtrates.

Release rates of dissolved amino acid based on 24 samples ranged from 2.4 to 30.5 mg of α-amino nitrogen per gram dry weight of zooplankton per day, and were positively correlated with temperature, $r = 0.92$. The regression of dissolved amino acid release rate (E) on temperature (T) is estimated by the equation, $E = 1.0\ T\ (°C) - 5.9$. No significant correlation between release rates and duration of the test was observed.

There were no gross differences in release rates attributable to differences in taxonomic composition of the sample. However, chromatographic analyses of seven of the samples indicated that different zooplankton populations release different assemblages of individual amino acids, although arginine and taurine have been identified in all seven samples. Taurine is among the most abundant amino acids in the free amino-acid pools of marine invertebrates (*7*).

By using our data and the published data on primary production and density of net zooplankton in the Sargasso Sea and the Gulf Stream off the Carolinas (*8*), an estimate can be made of the amount of carbon in dissolved amino acids released by zooplankton as compared to the organic carbon produced by phytoplankton. This percentage approximates

$$\frac{4Z(T - 5.9)}{P} \times 100,$$

where Z is total dry weight in the water column; T, the mean temperature of the water column; P, the mean daily primary production of the water column (grams of carbon per m^2); and 4 is the factor for converting α-amino nitrogen to amino-acid carbon. Released amino-acid carbon is estimated to be 22 and 25 percent of primary organic production in the Sargasso Sea and Gulf Stream, respectively (*9*). These estimates indicate that dissolved-amino-acid release by zooplankton constitutes an important metabolic pathway in the plankton ecosystem.

R. E. JOHANNES
KENNETH L. WEBB*
University of Georgia Marine Institute, Sapelo Island, Georgia

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9. These values are subject to at least two sources of error. (i) Crowding of zooplankton in experimental containers may result in increased metabolic rates (M. Satomi and L. R. Pomeroy, *Ecology*, in press) and measured release rates were probably higher than release rates of net zooplankton in nature. Experimental densities ranged from 0.6 to 9.2 g dry weight per liter. Over this range we found no significant increase in release rates associated with density when temperature was held constant in the statistical analysis. (ii) These experiments do not take into account zooplankton which are too small to be retained in plankton nets, but which constitute a metabolically important fraction of the zooplankton [R. E. Johannes, *Science* **146**, 923 (1964)]. These two sources of error tend to offset one another.
10. This research was performed in part during cruises of the Duke University Marine Laboratory research vessel, *Eastward*. We are grateful for the cooperation extended to us by the officers and crew and by various members of the Duke staff. We thank Dr. L. R. Pomeroy who read and criticized the manuscript. Supported by NSF grant GB-1040 and by grants from the Sapelo Island Research Foundation. Contribution No. 93 from the University of Georgia Marine Institute.

* Present address: Virginia Institute of Marine Science, Gloucester Point 23062.

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Abnormal Corallites

In "Neoplasia in a coral?" [*Science* **148**, 503 (1965)] Donald F. Squires describes growths that are certainly neoplasms in the general sense of aberrant new growths. Some readers may infer that they are the special types of malignant neoplasms called "cancers." I should like to warn against this interpretation and at the same time offer an alternative.

Malignant neoplasms usually arise as discrete, unique events initially involving single cells. These altered single cells multiply to produce cancers. While reversion of such growth to normal is not unknown, it is certainly rare. Squires' Fig. 2 shows two *similar* "abnormal" corallites, separated by about 20 "normal" individuals. A third is described but not illustrated. In such colonies each corallite arises by the vegetative budding of a single previous individual. The colony is a clone. In this particular colony of 239 individuals the same type of abnormality has arisen three times and in each case has been followed by complete reversion to normal, without intergrades. That these three similar transformations represent separate events of the malignant type surpasses probability.

These growths, however, bear extraordinary resemblances, both in apparent structure and in distribution, to the "galls" which are common on many plants and which result from the continued presence of a great variety of sedentary predators. Such predations are not unknown in aquatic