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UPTAKE OF IODINE-131 BY THE RED ALGA ASPARAGOPSIS TAXIFORMIS

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ABSTRACT

Specific activity measurements, radiochemical analyses, and half life studies were made of the red alga, Asparagopsis taxiformis, collected at Eniwetok Atoll in March, April, and May, 1954. The results of these studies show that this alga, more than any other tested, concentrated the I^{131} produced by the nuclear weapons tests at Bikini and Eniwetok Atolls during this period. This alga may prove useful as an indicator of radioactive fallout from nuclear detonations.

INTRODUCTION

During the weapons testing program of Operation Castle at Bikini and Eniwetok Atolls in the spring of 1954, the Applied Fisheries Laboratory of the University of Washington carried out studies on the uptake of radioactive materials in a variety of aquatic and terrestrial plants and animals. In addition to the programmatic studies, exploratory studies also were continued, including a study of the reef algae.

Collections of algae from near the Marine Biological Laboratory on Parry Island, Eniwetok Atoll, indicate that a small red alga (Asparagopsis) has a remarkable affinity for iodine as measured by the uptake of I^{131} immediately following weapon detonations at the Pacific Proving Ground.

COLLECTION OF MATERIAL

Immediately following the March 1, 1954 experiment at Bikini Atoll, it was observed that the background level of radioactivity on the reef of the seaward side of Parry Island had increased. Most of the algae growing on this reef had only slightly higher readings than the background level. However, the level for Asparagopsis taxiformis (Delile) Collins and Hervey, a delicate, branching red alga, was unexpectedly high.

Radioassays were made of algae collected at Parry and Bogombogo Islands during March, April, and May, 1954. The results of these studies are given in Table I.

It was thought that the radioactivity in the samples of Asparagopsis collected in early March might be due to a short half life isotope resulting from the test of March 1, 1954 at Bikini. In order to verify this assumption series of counts for determining radioactive half life were initiated at the Eniwetok laboratory. Duplicate samples were sent to the home laboratory at the University of Washington for more complete analyses. The results of tests conducted on samples collected at Eniwetok and Rongelap Atolls from March through June are given in Table II.

Plots of the radioactive decay of three samples of Asparagopsis are shown in Figure 1.

DISCUSSION

The results of the half life studies and radiochemical analyses* indicate that at least 90 per cent of the radioactivity

*The radiochemical method for determination of I^{131} was adapted from Glendenin et al. (2) and is as follows: The dried algae were heated several minutes with NaClO and 0.1 N NaOH containing iodine carrier (added as KI), filtered, and discarded. The iodine in the solution was reduced with hydroxylamine hydrochloride, extracted into CCl_4, and re-extracted into water containing a little bisulfite. The aqueous solution was acidified and treated with sodium nitrate. The extraction into carbon tetrachloride and into water was repeated. The iodine was precipitated from the resulting solution as silver iodide and counted in an internal gas-flow counter.

Table I. Radioactivity of Algae Collected at Eniwetok Atoll March, April, May, 1954.

Values expressed in thousands of d/m/g of wet weight.

Species	Date Collected (1954)	Location	d/m/kg
Asparagopsis taxiformis	3/6	Parry I. (seaward reef)	3.92
			2.03
			1.59
Enteromorpha sp.	"	" "	.195
Halimeda tuna	"	" "	.113
Padina commersonnii	"	" "	.307
Asparagopsis taxiformis	4/3	" "	12.4
			11.4
Dictyota pinnatifida	"	" "	.12
Asparagopsis taxiformis	4/25	Bogombogo (lagoon reef)	2.4
			4.42
Spyridia filamentosa	"	" "	5.6
			5.02
Asparagopsis taxiformis	5/19	" "	39,000.
			21,000.
Caulerpa racemosa	"	" "	4,540.
			2,420.
			916.
Halimeda opuntia	"	" "	6,750.
			5,610.

Figure 1. Decay curves of Asparagopsis collected at Eniwetok Atoll. (A) Whole sample from Parry Island, 3/19/54 (x 1); (B) whole sample from Bogombogo Island, 5/19/54 (x 100); (C) extractable I^{131} from sample "B" (x 10).

Table II. Results of Radiochemical and Half-life Studies of Samples Collected March, April, May, 1954.

Species	Date collected (1954)	Location, Atoll - Island	Half life Half life	I^{131} per cent of total activity*
Asparagopsis taxiformis*	3/10	Eniwetok - Parry	7.9	
" "	3/19	" "	8.2	
" "	"	" "		90.
	4/3	" "	8.5	
Caulerpa racemosa	3/26	Rongelap - Kabelle		0.16
Udotea indica	"	" "		0.29
Boerhaavia tetrandra**	"	" Labaredj		0.23
Morinda citrifolia**	"	" "		0.38
Guettarda speciosa**	"	" "		3.5
Asparagopsis taxiformis	5/19	Eniwetok - Bogombogo	7.6	90.
" "	"	" "	8.2	
" "	"	" "		

*Rare earths, 2.8; Zr^{95}, 1.0; unidentified, 6.2 per cent of total activity.

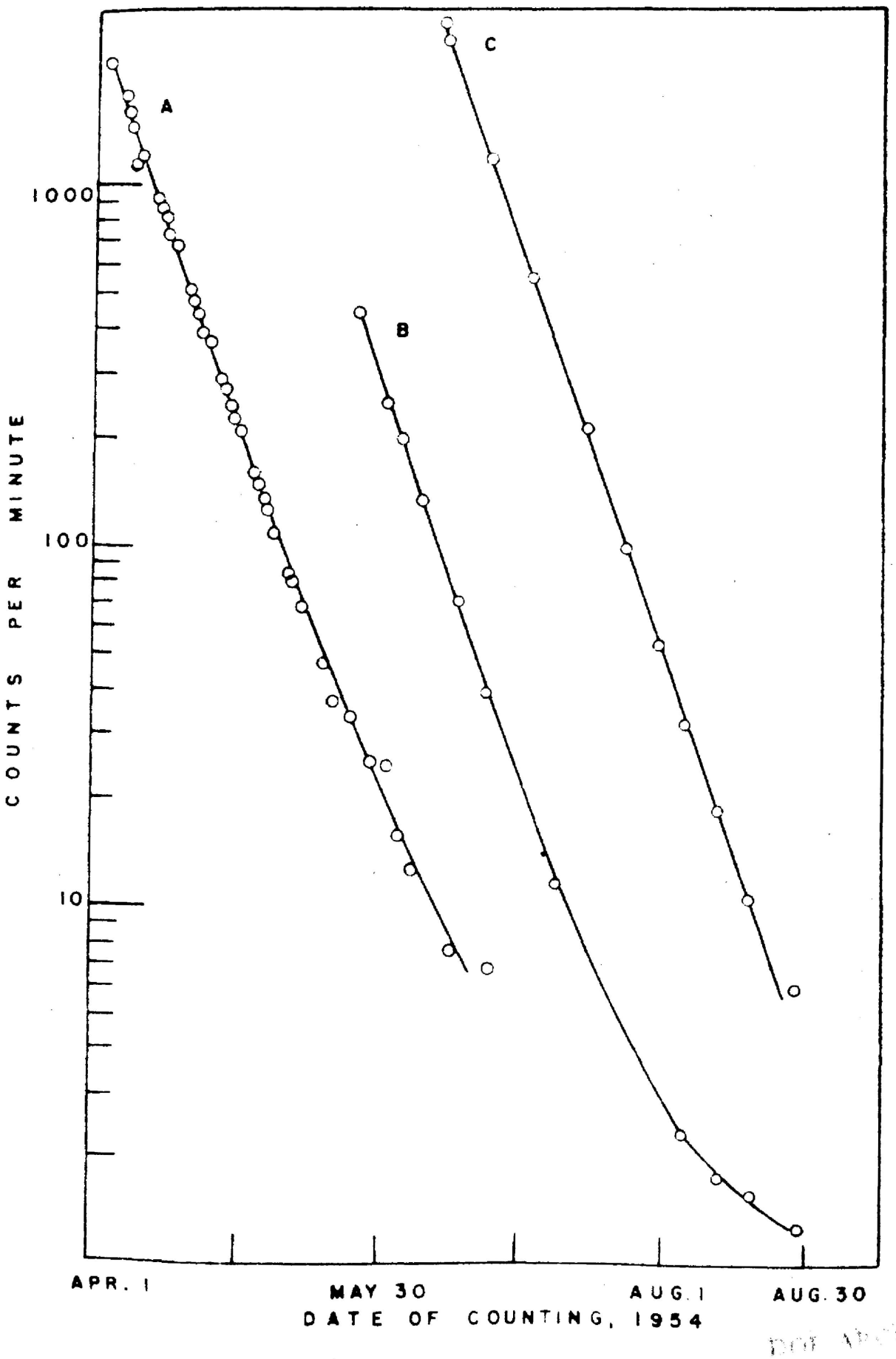
**Leaves.

in Asparagopsis was due to I^{131}. The half life of the isotope contributing 90 per cent of the radioactivity in Asparagopsis was found to be 7.6 to 8.5 days. This compares well with the accepted value for I^{131}, which is given as 8.14 days (5). The lowest values obtained at Eniwetok may have been due to the presence of I^{132}, I^{133}, and I^{135}, isotopes whose faster decay rates would tend to lower the value.

It was evident from the short half life and high level of radioactivity of two samples of Asparagopsis collected on April 3, 1954 at Parry Island that these algae were concentrating a recently formed isotope. The values for the counts of these samples were 12,400 and 11,400 d/m/g as opposed to an average value of 260 d/m/g based on radioactive decay of samples collected in the same locality on March 6, 1954. The increase in specific activity might have been due to material resulting from the March 27 test at Bikini Atoll, since it was observed that the background count at Parry Island increased a few days after this date. Changes in the activity levels in the algae would be expected to follow closely those of the environment, for it has been shown in laboratory tests that I^{131} uptake reaches equilibrium after the first hour in Ascophyllum (4) and after three hours in Laminaria (7). As laboratory tests have not been conducted with Asparagopsis to determine this factor, it cannot be stated with certainty that it would behave similarly.

It has been known for many years that iodine is present in the sea and in a majority of the algae (8); in Asparagopsis iodine constitutes 0.092 per cent of the dry matter (2). Laboratory experiments have indicated that certain algae will concentrate I^{131} from sea water (3, 4, 7). The observations made at Eniwetok during the present investigations support these findings since the I^{131} concentration in Asparagopsis was approximately 18,000 times that of the surrounding water. (the total activity of the water was 24,700 d/m/g and the activity due to I^{131} in the algae was 30,000,000 d/m/g. The contribution of I^{131} to the total activity of a fission products mixture at 10 days is 6.8 per cent; therefore, assuming the ratio to be the same, the activity in the water due to I^{131} was 1,680 d/m/g. Thus the concentration factor for I^{131} by the algae was 17,900). If other iodine isotopes are considered, this figure would probably be higher.

The role of iodine in the physiology of the algae is uncertain, but it has been detected as mineral iodide (5, 6) as well as the iodo-amino acid, iodotryosine (3, 6). It is now generally accepted that iodine occurs in both forms and that the ratio of the two varies in the different species of algae (3). The absorption of I^{131} has been shown to be associated with respiration (4), since its uptake in Ascophyllum, a brown alga, decreases when nitrogen is used in place of oxygen. The specimens of


A
B
C
1000
100
10
COUNTS PER MINUTE
APR. 1
MAY 30
AUG. 1
AUG. 30
DATE OF COUNTING, 1954

Asparagopsis from Eniwetok were collected in a region of pounding surf and active water movement, conditions favoring maximum aeration and maximum uptake of I^{131}.

CONCLUSIONS

It has been observed from the investigations following the weapons tests at the Pacific Proving Ground that a red alga, Asparagopsis taxiformis, has a remarkable affinity for I^{131}, an isotope with a half life of 8.14 days. It is believed that the alga may prove useful as an indicator of radioactive fallout from nuclear detonations.

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