mixed culture and that it was a factor in promoting both growth and nitrogen fixation.

We have also found that treatment with sodium dodecyl sulphate[3] to extract extracellular deoxyribonucleic acid (DNA) resulted in the appearance of DNA in the slime substances. Further experiments to clarify the nature of these phenomena are being performed.

Azuma Okuda
Michiharu Kobayashi

Department of Agricultural Chemistry,
University of Kyoto, Japan.

[1] Okuda, A., Yamaguchi, M., and Kobayashi, M., *Soil and Plant Food (Tokyo)*, **6**, 35 (1960).
[2] Okuda, A., and Kobayashi, M. (unpublished data).
[3] Catlin, B. W., and Cunningham, L. S., *J. Gen. Microbiol.*, **19**, 522 (1958).

Seasonal Variation in Alginic Acid, Mannitol, Laminarin and Fucoidin in the Brown Alga, *Ecklonia radiata*

The brown alga *Ecklonia radiata* (Ag.) J. Ag. which occurs abundantly in the sub-littoral zone of the southern coasts of Australia, has been found to contain alginic acid, mannitol, laminarin and fucoidin, in conformity with observations on other species of the Laminariales from South Africa and the northern hemisphere. The above constituents were isolated from the seaweed and characterized by physical constants, chromatography and infra-red spectra[1]. An examination has now been made of the seasonal variation in the content of these carbohydrates, which is of interest in connexion with their biochemical function and possible utilization.

Samples were collected at Point Lonsdale, Victoria, each month during December, 1959–January, 1961. Each sample consisted of about twelve plants, which were dissected into laminæ, midrib and stipe. The 'midrib' was taken as that portion of the frond, comprising the elongation of the stipe, from which the 'laminæ' had been removed. The separate portions of the plant were milled through breaker plates in a Bauer defibrator and dried by azeotropic distillation with benzene. They were then ground in a Wiley mill to pass through a 100 mesh/in. sieve, and analysed according to the methods of Camèron, Ross and Percival[2]. In the case of the alginic acid determination, however, much more extensive acid washing was required than suggested by these workers in order to remove calcium ions from the alginate.

The maximum and minimum contents of the various components are shown in Table 1, with their time of occurrence. Marked variations were observed in the contents of laminarin, mannitol and alginic acid, the differences between the maximum and minimum contents decreasing in that order; however, the variations are less than those observed by Black and Dewar[3] for British *Laminaria* species. The fucoidin content is low and less variable relative to the total dry matter. It will be observed also that the contents of laminarin, and to a lesser extent mannitol, decrease from lamina to stipe, whereas the alginic acid content increases.

Laminarin is regarded by some investigators as a reserve carbohydrate. It is certainly stored in the frond, its content increasing to a maximum in summer and autumn, and decreasing rapidly to zero in mid-winter. The rapid decrease may be associated partly with the shedding of the lamina as well as utilization of reserve carbohydrate. The laminarin

Table 1. Seasonal Variation in Composition of *E. radiata*

	Maximum			Minimum		
	Lamina	Mid-rib	Stipe	Lamina	Midrib	Stipe
Alginic acid (per cent)*	24·5 April	28·4 April	30·2 April	17·0 September	19·0 September	19·8 September
Mannitol (per cent)*	16·6 February	16·7 April	13·6 June	8·5 July	7·4 August	6·7 October
Laminarin (per cent)*	9·8 May	7·0 May	1·1 May	1·0 August	0·0 August	0·0 August
Fucoidin (per cent)*	1·3 July	1·4 June	1·1 April	0·4 —	0·8 —	0·7 —
Dry matter (per cent)†	22 January	24 June	41 June	17 August	15 August	13 September

* Based on total dry material.
† Based on original wet weight.

content may vary more widely in British species because of a slightly greater range in sea temperatures (45°–57° F. as against 54°–65° F.) and the considerably lower minimum temperature. In the case of laminarin and of alginic acid the seasonal fluctuations are similar for all parts of the plant. However, for mannitol the maximum and minimum contents are reached earlier in the laminæ than in the stipes, which seems to be more in accordance with the behaviour of a reserve carbohydrate than the variations observed for laminarin. The alginic acid content of *E. radiata* appears to be at a minimum in spring, at which time a maximum is reached in the British species.

From the point of view of possible utilization, *E. radiata* should be a useful source of alginic acid and mannitol and may yield appreciable quantities of laminarin, provided that due attention is paid to the seasonal variation.

We wish to thank Mr. K. J. Harrington for helping with the collection and preparation of samples, and Miss Glenys Chong for assistance in their examination.

C. M. Stewart
H. G. Higgins
Sue Austin

Division of Forest Products,
Commonwealth Scientific
and Industrial Research Organization,
South Melbourne.

[1] Stewart, C. M., and Higgins, H. G., *Nature*, **187**, 511 (1960).
[2] Cameron, M. C., Ross, A. G., and Percival, E. G. V., *J. Soc. Chem. Indust.*, **67**, 161 (1948).
[3] Black, W. A. P., and Dewar, E. T., *J. Mar. Biol. Assoc. U.K.*, **28**, 673 (1949).

Occurrence of *Phyllochaetopterus claparedii* McIntosh in the North-east Pacific

The waters near the Friday Harbor Laboratories of the University of Washington have been extensively dredged in recent years. It was of some interest, therefore, that a solitary *Phyllochaetopterus* of relatively large size was brought up from 22 fathoms over a muddy bottom just south of Orcas Island on August 26, 1960, with Forster's anchor dredge[1]. The specimen proved to be identical with the description of *Phyllochaetopterus claparedii* by McIntosh[2] found off Kobe, Japan. It has been recorded since only by Fauvel[3] from Cam Ranh and Tourane Annam (Vietnam). Treadwell's[4] specimens from Porto Rico are only doubtfully attributed to this species. The specimen from Friday Harbor had a pale yellow colour when alive apart from the grey-green gut, and was found in a transparent horny tube about 1 m. in length which was only faintly ringed (not jointed) distally and about 4 mm. across, comparable in size