where σ_1^2 stands for the ratio of the mean square amplitudes corresponding to the centric group to that of the entire structure. A comparison of (8) with (9) shows that the final distributions are identical in form except for the appearance of D in (8) in place of σ_t in (9). The parallel roles of σ_1 and D are now obvious. Thus the two limits $D=0$ (or $\sigma_1=0$) and $D=1$ (or $\sigma_1=1$) correspond to acentric and centric distributions. Intermediate values of D (or σ_1) correspond to different degrees of centrosymmetry. Thus D (or σ_1) may be taken as a quantitative measure of the degree of centrosymmetry of the structure. In fact it may be pointed out that Srinivasan *et al.* (1972) suggested earlier the use of D for this purpose and the present results only supply a sound theoretical justification for the same. The curves of $P(y_N)$ given as a function of σ_1^2 in the earlier paper (Srinivasan, 1965 *a, b*) are applicable here.

It may be mentioned that D can be estimated in practice by working out some of the statistical parameters connected with y_N. For instance, the moments or variance of y_N can be worked out which turn out to be functions of D. However, these may not be very sensitive especially when $\triangle r_{Nj}$ are small. It seems preferable to turn to other statistical parameters involving quantities y_N and y_N^c such as say the difference $y_d = y_N - y_N^c$. Since it measures the deviation of y_N from that of the assumed model, this and other related parameters such as reliability indices based on it may be expected to be more sensitive.

We may also mention here that since y_N and y_N^c now involve non-centrosymmetric and centrosymmetric combination, distributions connected with pair such as say the quotients y_N/y_N^c, y_N^c/y_N need not show symmetry properties such as were associated with these variables for cases I and II. These aspects as well as statistics for case IV are under detailed investigation and will be reported later.

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UPTAKE AND METABOLISM OF ^{14}C-LABELLED GLUCOSE IN *SARGASSUM ILICIFOLIUM*

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ABSTRACT

Sargassum ilicifolium, a common marine brown alga, shows the ability to take up glucose and metabolise it. Metabolism is greater in light than in darkness. The main products of metabolism are sugar phosphates, glutamate, aspartate and alanine and to some extent citrate, fucose, mannose, fucoidin, laminarin and alginate. Alginic acid biosynthesis starts later and is not possibly from mannitol. The alga probably belongs to a group of C_4 plants of aspartate formers.

MARINE algae are well known for synthesising a wide range of complex organic compounds. In order to study metabolic pathways of these organic compounds, several attempts[1-8] have been made to feed marine algae with labelled compounds which are suspected to be the precursors. In the light of these observations, it was thought that an experiment of feeding uniformly labelled glucose-^{14}C to *Sargassum ilicifolium* could be designed.

MATERIALS AND METHODS

S. ilicifolium was collected at low tides from sea-shores of Ratnagiri and placed in sea water.

TABLE I

Distribution of total radioactivity in various compounds formed after supplying uniformly labelled ^{14}C*-glucose*

(The activity represents c.p.m. in 4 g of fresh tissue Activity in glucose spot is not considered even though counted)

Name of compound	30 Minutes		2 Hours		6 Hours	
	Light	Dark	Light	Dark	Light	Dark
Sugar phosphates ..	2950	2100	4700	3550	5350	4150
Aspartate ..	2500	1800	4000	3700	4700	3900
Glutamate ..	7350	6350	5900	5150	6400	5150
Glutamine ..	1843	1254	2630	2718	3058	3128
Alanine ..	550	400	3300	3400	3250	4100
Fucose ..	650	325	872	764	976	816
Mannose ..	450	350	750	700	825	800
Citrate ..	1700	1850	2900	2400	3650	3100
Fucoidin + Laminarian* ..	250	325	450	462	750	673
Alginic acid* ..	—	—	—	—	460	390
Other compounds* ..	—	—	—	—	265	262
Other insoluble fractions* ..	—	—	—	—	248	194

* Ethanol insoluble fractions.
— Activity not recorded.

The plants were washed first in filtered sea water and then in synthetic sea water[4]. The experiments of 30 minutes, 2 hours and 6 hours were carried out in two sets either in light or in darkness. The samples weighing 4 g were cut into small squares. The algal material was taken in an Erlenmeyer flask and floated in 60 ml of 0·025 M glucose solution (pH 8·0) prepared in synthetic sea water. The reaction was initiated by adding 0·02 mc of glucose-U-^{14}C (specific activity 280 mc/mM). Experiments under light were performed by supplying illumination of about 4000 ftc near the algal material. Temperature was maintained between 15° C and 20° C. The flask was continuously shaken. The reaction was terminated by the addition of boiling 80% ethanol.

The material was homogenised and the extract filtered. The residual solids were analysed according to the method described by Bidwell[5]. The radioactivity of individual insoluble fractions was determined.

The combined filtrate was evaporated under reduced pressure to 5 ml and electrolytically desalted. The extract was analysed for ethanol soluble fractions by two-dimensional paper chromatography employing phenol : water (80 : 20 v/v) and butanol : acetic acid : water (80 : 22 : 50 v/v/v) as solvents. The radioactive compounds were detected by exposing the chromatograms to X-ray films. The activity incorporated in individual compounds was counted with a transistorised proportional counting system and confirmed with a liquid scintillation system.

RESULTS AND DISCUSSION

Table I represents soluble as well as insoluble fractions and their radioactivity as counts per minute in 4 g of fresh tissue. A close scrutiny of autoradiograms revealed that glucose was gradually utilized. The utilization of glucose was more in light than in darkness. As a result of the utilization of glucose, sugar phosphates, amino acids and organic acids could be detected in the soluble fraction. In the soluble fraction, besides glucose, two spots in the sugar area had also shown incorporation of radioactivity. In the soluble fraction, incorporation was slow and alginic acid had little incorporation and that too only after 6 hours, while fucoidin and laminarian incorporated ^{14}C from 30 minutes onwards. The results can be favourably compared with those of Lin and Hassid[3].

The results are on similar lines and indicate that in *S. ilicifolium* sugar phosphates are formed by glucose utilization. This will obviously require phosphorylation and it appears enzymes similar to those present in *F. gardneri* may also be operating in *S. ilicifolium*. No label could be detected in mannitol, which possibly indicates that glucose is not the precursor of this important sugar alcohol in the brown alga. This observation is similar to that of Lin and Hassid[3].

The incorporation of radioactivity into glutamate, aspartate and alanine clearly indicates that these were the major amino acids formed. This is similar to the result obtained by Bidwell and Ghosh[2]. From the recent unpublished work on photosynthesis of *Sargassum*, a good amount of radioactivity

was located in these amino compounds. Bidwell and coworkers[6] found out that in wheat leaves, when radioactive glucose was supplied, alanine became much more radioactive in light than in darkness. This was attributed to blockage of the carbohydrate respiration. It was possible for them to reverse blockage by the application of amino acids intrusion. The observation of more radioactivity in darkness is similar to that of Bidwell *et al.*[6]. However, whether it is respiration blockade cannot be ascertained with the present data.

Bidwell and Ghosh[2] have found that uniformly labelled glucose ^{14}C is utilized by *F. vesiculosus*. They have indicated several pathways of glucose utilization involving carboxylation and decarboxylation reaction. They notice that organic acids are better substrates for alginic acid than glucose. These authors also did not record any activity in mannitol but recorded it in fucose. From Table I, it is clear that activity in fucose fraction is higher at 6 hours than at half an hour. It is of interest to record the highest activity in citrate as noted by Bidwell and Ghosh[2]. However no explanation for this can be given with the present data. From Table I, it is also clear that alginic acid synthesis starts much later. This observation indicates that in *Sargassum* alginic acid biosynthesis starts later and it is possibly from sugar phosphates as proposed by Lin and Hassid[3].

In the present investigation, it is of interest to record an appreciably high label in aspartate and no label in malate. This, in the light of recent work of Karekar and Joshi[7], indicates that *S. ilicifolium* belongs to a group of C_4 plants of aspartate formers and possibly aspartate is a key compound from which many other metabolic products are formed.

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PRELIMINARY OBSERVATIONS ON THE USE OF MARINE CATFISH PITUITARY GLANDS FOR INDUCED SPAWNING OF THE INDIAN MAJOR CARPS

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ABSTRACT

Major carps are not available in adequate numbers, especially along the coastal regions of the country, for collection of pituitary glands for large scale induced spawning of these species. Therefore, attempts were made to utilise the pituitary of marine catfish, which are landed in good numbers along the coastal areas, for induced spawning of the major carps. Two species of the major carps, namely, *Labeo rohita* and *Cirrhina mrigala*, were successfully spawned during July, 1973 by administering intramuscular injections of pituitary extract of two species of marine catfish, *Tachysurus thalassinus* and *T. jella*. Sixtyfour per cent of the treated carps spawned successfully when injected with 30 mg and 20 mg of marine catfish pituitary per kg body weight of female and male fish respectively.

INTRODUCTION

THE Indian major carps were successfully induced to breed by the administration of fish pituitary hormones in 1957 (Chaudhuri and Alikunhi, 1957; Alikunhi *et al.*, 1960; Chaudhuri, 1960). Since then, the induced breeding technique has been vastly improved and its use as a dependable method of pure fish seed production has spread widely to all States of India. However, the quantity of fish seed produced in the country through this method in 1964–65 was only 1·57% of the total annual production (Anon., 1966). One of the reasons for this low percentage of fish seed produced through hypophysation technique is the shortage of carp pituitary glands, especially along the coastal areas. With a view to overcome this limitation, studies on the use of marine catfish pituitary glands for induced breeding of freshwater fishes were initiated at the College of Fisheries, Mangalore, in

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