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TITLE: AN INVESTIGATION OF PHOTOSYNTHETIC RATES IN A FAST GROWING STRAIN OF THE RED ALGA GIGARTINA EXASPERATA

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ABSTRACT: The marine red alga Gigartina exasperata Harvey and Bailey is of potential economic value as a source of the polysaccharide extract carrageenan. This extact is a structural component of the cell wall and has been traditionally obtained from Gigartina stellata and Chondrus crispus in the North Atlantic and several species in the genus Eucheuma in the tropics. Carrageenan is used as a stabilizer, viscosity controller, and gelling agent in various foods, cosmetics, and many industrial and medical preparations (Chapman, 1970).

Most of the carrageenan-producing seaweed now being used is obtained from wild stands which are being harvested at or near their maximum sustainable yield. It has become apparent that to meet increasing demands for the product the industry must find a new source, and the most promising one appears to be seaweed aquaculture. The first encouraging development of algal aquaculture for carrageenan extraction has been in the Phillipine Islands where a successful method of cultivating Eucheuma has been devised and implemented (Doty, 1973).

The Puget Sound region provides an excellent setting for the development of seaweed farms due to its many miles of shoreline, high water quality and suitable climatic characters (Jameson and Beswick, 1972). Several methods of cultivation are currently being evaluated here including: 1) tank culture in which many enviromental factors (light intensity, temperature, nutrient levels, seawater flow, etc.) can be manipulated to obtain optimal growth rates (Waaland, 1976), and 2) artificial substrates which are inoculated with spores ("seeded") and then placed in the wild where the plants will grow to maturity before harvest (Waaland, in press). Initial investigations indicate that Gigartina exasperata is one of the most promising Puget Sound species for use in aquaculture because of its fast growth rates, its high carrageenan

quality and its relative ease of vegetative propagation (Waaland, 1974).

A common practice in terrestrial agriculture is the development of better strains of plants through selection of only the fastest growing or best producing specimens to be propagated for subsequent crops. This principle has been applied to seaweeds grown in tank cultures by J.R. Waaland who tagged and monitored the growth of a number of specimens of G. exasperata collected in the wild and subsequently grown in tanks. A single plant from this experiment increased its weight at a rate approximately twice as fast as the rest of the specimens. This plant, given the experimental designation "M-11", has been maintained in culture and propagated through fragmention to produce a large number of individuals (Waaland, Pers. Comm.). Because of its faster growth rate and the consequent more frequent availability of harvestable crops the culture of this highly productive algal strain could offer a significant advantage over wild plants in the development of an algal aquaculture industry.

The mechanism by which the "M-11" strain achieves a rapid growth rate has become an important question. What modifications have occurred in this plant's metabolic activities to facilitate such variations of growth rate? The answer to this question might help in efforts to find or create similar modifications in this as well as in other species and the experiments presented here were undertaken to provide this answer. The first and seemingly most obvious part of the plant's metabolism which we believed might exhibit the variation in question was the photosynthetic process. Since any growth would ultimately, if not directly, be a result of this energy trapping process it was a logical place to begin the investigation. We therefore began this study with a comparison of the photosynthetic performance between M-11 and wild-type plants at a range of temperatures and light intensities encompassing the variation expected in natural or artificial culture. It was hoped that these data might also afford empirical information concerning optimal aquaculture conditions and the effects of varied light and temperature on the growth rate.

Various methods have been used to measure photosynthetic rates in marine alage, including measurements of uptake of radioactively labeled CO_2, manometric determinations, Winkler oxygen titrations, and pH change (Ryther, 1956). The method found to be most practical for our purposes is the oxygen electrode (Kanwisher, 1959). This method has been widely applied in diverse studies and its accuracy matches or exceeds

that of the otherwise preferred Winkler titration method (Czaplewski and Parker, 1973; Kanwisher, 1959, 1962; Strickland and Parsons, 1968; Wethey and Porter, 1976; Littler, 1973).

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