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The Buoyant Properties of *Codium*

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Abstract

Factors contributing to the buoyant properties of *Codium fragile* subspecies *tomentosoides* were examined. The intracellular fluid has a low K/Na ratio and low SO_4^{2-} content and the density of the intact plant is less than a *Codium* species of comparable structure with a high K/Na ratio and higher SO_4^{2-} content. However, the thallus is denser than seawater except where gas bubbles form on or within the thallus as a result of photosynthetic production of oxygen. Active photosynthesis can lead to more or less permanent accumulation of gas in the medullary region, the hollow thallus segments developing a characteristic reflectance. The static lift of these segments may be as much as 40 mg ml^{-1} but in itself is insufficient to account for the substrate/plant weight ratios of most drift material. Thus it appears that the ability of the plant to transport molluscs and rocks is primarily due to the form of the plants imparting an additional hydrodynamic drag on the substrate. Calculations of drag forces for a range of plant sizes and velocity regimes support this conclusion.

Introduction

Many of the larger benthic marine algae are highly buoyant due to the presence of special gas-filled structures or pneumatocysts (Dromgoole 1981b) and others can achieve flotation as a result of the accumulation of gases within the tissues (Müller-Stoll 1954). The possibility that buoyancy in some species may also be dependent on active selective ion accumulation or exclusion is suggested by the fact that *Valonia macrophysa* Kützing with a K/Na ratio of 5.7 sinks whereas *Halicystis osterhoutii* Blinks and Blinks with a ratio of 0.03 floats (Gross and Zeuthen 1948).

Flotation in the larger algae may have ecologically significant consequences. For example, in *Codium fragile* (Sur.) Hariot subsp. *tomentosoides* (Van Goor) Silva, mature plants are apparently buoyant enough to "float" molluscs from shellfish beds (Loosanoff 1975). The lifting power of the same species of *Codium* can also lead to the drift accumulation of rock fragments on beaches with a consequent change from a sandy to a stony substrate (Ben-Avraham 1971).

Surprisingly the buoyancy or lifting power of *Codium fragile* subsp. *tomentosoides* does not seem to have been studied in detail. Ramus (1978) noted that the segment tips of the plant are often filled with air but the processess which lead to such gas accumulation are not known. Distinct differences in the cation composition of intracellular fluid of *Codium* species have been recorded with K/Na ratios varying from 0.02 to 1.10 (Kesseler 1965, Bisson and Gutknecht 1975). The extent to which these and other factors contribute to the buoyancy or lifting power of *Codium fragile* subsp. *tomentosoides* is briefly considered in this communication.

Materials and Methods

Plant Material

All measurements of density or ionic composition were made on freshly collected material which had been stored in large volumes of natural seawater for less than 6 h at laboratory temperatures (18–20 °C). Care was taken to avoid using plants which may have experienced a previous severe desiccation in the field.

Drift material of *C. fragile* subsp. *tomentosoides* was collected at two localities immediately following strong onshore winds and taken to the laboratory where plants were stored in seawater and allowed to regain any water lost by dehydration. After 6 h the fresh weight, thallus length, and clump diameter of the plants was recorded together with the weight and nature of the attached substrate.

Density

The density of plant segments was determined after weighing in air and in seawater of known density with

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