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An Investigation of Drought Avoidance in Intertidal Fucoid Algae

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Abstract

The possibility that fucoid algae inhabiting the upper shore might possess physiological or morphological mechanisms for avoiding drought, was investigated experimentally. The four species chiefly investigated characteristically occupy different levels on the shore with *Pelvetia canaliculata* (L.) Dcne. et Thur. the highest, followed by *Fucus spiralis* L., *Ascophyllum nodosum* (L.) Le Jol. and finally *Fucus serratus* L.

Under controlled conditions dehydration proceeded as a roughly logarithmic function with time in all species. *Pelvetia* lost water at a slightly higher flux than the *Fucus* species, but this did not reflect a difference in epidermal resistance to water loss, for rates of water loss from surfaces composed either of *Pelvetia* or of *F. spiralis* plants were identical and about 84% as fast as that from a free water surface of the same area.

When dried at water potentials between - 395 and - 150 bars *F. spiralis* retained significantly more water per 100 g dry matter than either *Pelvetia* or *F. serratus*, but in drier conditions, all three species retained similar amounts. There was a close correlation between percentage dry matter of the thallus and the amount of bound water retained. *Pelvetia* consistently had the highest dry matter content, and also the most bound water, but it did not have the greatest hygroscopic capacity at any of the water potentials tested. The five intertidal species investigated had very similar hygroscopic capacities, but two species inhabiting the lowest levels on the shore had lower capacities.

Many terrestrial plants avoid drought by adopting a low surface area to mass ratio. In young fucoid algae there is a progressive decrease in the ratio of surface area to mass from lower shore species to upper shore species, but this trend was reversed in the adult plants.

The effects of thallus shape were also investigated. The flux of water vapour from the more or less cylindrical stipes of *Fucus* and axes of *Ascophyllum* was estimated to be almost three times that from the flattened laminae of *Fucus*. In spite of its channelled thallus, *Pelvetia* also lost water faster than *Fucus* laminae of similar surface to mass ratio.

Branch overlap in natural stands was estimated to reduce the area of thalli exposed to the air to only about 20% of that exposed by isolated plants. However, *F. spiralis* receives at least as much protection from aggregation as does *Pelvetia* and since it grows much more rapidly, it attains this protection earlier in its life.

It is concluded that drought avoidance is not the primary adaptive mechanism in intertidal fucoids. The tissues of upper shore species can apparently tolerate periodic dehydration to air dryness. In nature both *Pelvetia* and *F. spiralis* survived after losing almost 96% of their water content.

Introduction

On northern European shores, five common species of intertidal fucoid algae demonstrate the role of a physical environmental gradient in determining species distribution. These normally appear in a well-defined sequence of zones with *Pelvetia canaliculata* highest on the shore, followed by *Fucus spiralis*, then a mixed zone of *Ascophyllum nodosum* and *F. vesiculosus* and finally a low-shore zone of *F. serratus*. It has been shown that the upper limits of at least the first three species are determined largely by their resistances to desiccation (Schonbeck and Norton 1978). The upshore species, particularly *Pelvetia canaliculata*, apparently survive prolonged exposure either by avoiding or by tolerating tissue dehydration. True drought avoidance consists of the ability to maintain a tissue water potential far higher than that of the environment, and this ability is rarely found in lower plants (Levitt 1972). However, since the intertidal environment is characterised by predictable periodic resubmersion, an alga which loses water *slowly* might

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