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A Review of Some Aspects of Form and Function in Seaweeds

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Introduction

The relationship between form and function in seaweeds is emphasized by the similarity of form in unrelated species. Morphologically similar types such as thin blades, branched tufts, and crusts are found in several algal groups. The functional significance of a particular form is suggested when unrelated plants exhibit a similar appearance in the same habitat. For example, Norton (1970) reported algal meadows dominated by two strikingly similar plants, *Cladostephus verticillatus* (a brown alga) and *Halurus equisetifolius* (a red alga). Similarly, the subtidal surge zone in which regular back and forth water motion prevails (Neushul 1972) is usually dominated by laminarian algae. Representatives of other groups of seaweeds may occupy this zone, but they often bear a striking resemblance to laminarian algae – e. g. *Durvillea* spp. and *Marginariella* (Fucales) or *Desmarestia ligulata* var. *firma* and *Phyllogigas* (Desmarestiales). In deep waters, stalked, peltate thalli, which may have extensive starch reserves, occur in several species – e. g. *Caulerpa* spp. (Chlorophyta), *Fauchea peltata, Maripelta rotata, Humbrella hydra, Constantinea simplex,* and *Sciadophycus stellata* (Rhodophyta). With the first three species the deep-water, peltate plants contrast with non-peltate thalli of other shallow-water members of these genera. Presumably this attests to the light-gathering efficiency of such a morphology and its functional suitability for species growing in dimly lit deep water. The same generalizations may also apply to the crustose seaweed architecture, which is a characteristic and common morphology in deep water habitats (Cheney and Dyer 1974, Sears and Wilce 1975).

Seaweeds, unlike most land plants, exhibit little division of labor, for all parts of their thalli are involved in assimilation, absorption, and secretion. Hence, any alteration in thallus shape or size will affect all of these functions. However, it is unlikely that all parts of the plant are equally adept at each of these functions (Fagerberg *et al.* 1979). Even if they were, different parts of the plant may be subjected to different conditions and this must affect their efficiency for various tasks. Clearly the nutrient and light regimes experienced by the holdfast and the terminal laminae of a huge *Macrocystis* plant must be quite different. Environmental differences of similar magnitude may occur around very tiny plants, because of the steep concentration gradients of nutrients and gases near rock surfaces.

Nutrients and Hydrodynamic Relationships

Since seaweeds lack absorptive roots, nutrients are taken in over their entire surface. Thus, the surface area to mass ratio of the thallus is very important. The ratio is probably most favorable for absorption in spores or zygotes, but little is known of nutrient uptake by these bodies. However, in unicellular phytoplankton, nutrient uptake is extremely rapid and efficient (Pasciah and Gavis 1974). Gerard and Mann (1979) describe higher (3×) surface area/mass ratios for sheltered than exposed open coastal populations of *Laminaria longicruris,* which allows enhanced nutrient uptake in the winter and a more sustained summer growth.

As a plant like *Fucus vesiculosus* matures, its shape changes and the ratio of surface area to mass almost invariably declines (Khailov *et al.* 1978), even though this may be retarded by the production of broad, thin laminae and long, thin projections, such as hairs. Although hairs are often thought to enhance nutrient uptake (Schonbeck and Norton 1979c), they may be shed before adulthood, as in *Fucus* spp. and various red algae (Fritsch 1945, West 1978). Juvenile seaweeds may require a surface area enhancement because of the nutrient deficiences engendered by low water velocities in the boundary layer they inhabit. Branching also increases the surface area to mass ratio, and Odum *et al.* (1958) have shown that a branched, filamentous plant such as *Cladophora* absorbs 25 times more phosphorus in a given time than a plant like *Fucus* with a more massive thallus.

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