Toth, Gunilla B. 2002. Inducible chemical responses and herbivore resistance in seaweeds.
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Abstract: Interactions between living organisms are to a large extent influenced and controlled by chemical substances. For example, motile organisms exploit chemical compounds in order to find partners or food, and the tissues of sessile organisms commonly contain secondary metabolites that function as chemical defenses against consumers. The production of defense chemicals often involves a cost in terms of fitness, and selection should favor organisms that are able to recognize and respond to environmental cues that carry reliable information of future attack risk (i.e. inducing defenses only when consumers are, or will be, present and active). It is well known that many terrestrial plant species can induce a wide variety of responses that result in an increased resistance to different threats, but few studies have found such responses in seaweeds.

The ability of seaweeds to sense and respond to different abiotic (dissolved copper and artificial damage) and biotic (direct herbivory and waterborne signals) environmental cues was evaluated in manipulative induction experiments. Induced seaweed responses were quantified both as tissue concentrations of defense metabolites (phlorotannins) and as increased herbivore resistance (negative effects on herbivore feeding preference or performance). The studied seaweed species responded differently when exposed to cues associated with different environmental threats. Production of phlorotannins was not induced by increased concentrations of dissolved copper or artificial tissue damage. However, direct grazing by the gastropod *Littorina obtusata*, but not by the crustacean *Idotea granulosa*, induced the production of phlorotannins in both apical and basal parts of *Ascophyllum nodosum*, while grazing by the gastropod herbivores *Ansates pellucida* and *Lacuna vincta* resulted in decreased tissue phlorotannin content in all tested thallus parts of *Laminaria hyperborea*. *Littorina obtusata*, but not *I. granulosa*, was sensitive to high phlorotannin concentrations in the food. Furthermore, direct grazing by *I. granulosa* induced a chemically based resistance to further herbivory in five seaweed species (*Ahnfeltia plicata, Chordaria flagelliformis, Furcellaria lumbricalis, Sargassum muticum*, and *Ulva lactuca)*, although the metabolites responsible for the increased resistance were not determined. Moreover, herbivore-derived waterborne signals induced phlorotannin production in one seaweed species (*A. nodosum*), and resistance in five species (*A. nodosum, Cladophora rupestris, Halidrys siliquosa, Polyides rotundus, and U. lactuca*), ensuring that seaweeds can anticipate future herbivore attack without receiving direct tissue damage.

The results indicate that inducible responses that lead to increased herbivore resistance are common in seaweeds, in contrast to what has previously been assumed, and that both the eliciting cues and the induced responses can be highly specific.

Keywords: bioassay, communication, copper, crustacean, cue, defense, direct herbivory, feeding preference, Folin-Ciocalteus, gastropod, herbivore resistance, inducible response, intra-plant signal transfer, optimal defense model, phlorotannin, plant-herbivore interaction, polyphenolic, PVPP, resistance, seaweed, tannin, waterborne chemical signal.

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