# ALGAL SECONDARY METABOLITES AND DIGESTION

# IN MARINE HERBIVOROUS FISHES

Nancy M. Targett
University of Delaware
Graduate College of Marine Studies
700 Pilottown Rd, Lewes, DE USA
302-645-4262/302-645-4213/ntargett@udel.edu

**EXTENDED ABSTRACT ONLY – DO NOT CITE**

Much of the work on secondary metabolites has defined organismal responses to compounds through behavioral assays. However, more recent studies have begun to address the physiological and biochemical mechanisms underlying these responses. Given the number and diversity of algal secondary metabolites, and their broad range of pre-ingestive bioactivities, it is not surprising that most of the work examining the interaction of secondary metabolites and digestion has occurred in algal-herbivore systems. The gut environment determines how efficiently an herbivore digests the suite of primary and secondary metabolites present in algae, for it is in the gut that biochemical interactions are mediated by gut histology, chemistry, and microorganisms. Specialization upon given food types requires particular sets of morphological and physiological adaptations for ingestion, digestion, and absorption of nutrients. I will review the status of our knowledge of the effects of secondary metabolites on herbivore digestion in general, and then focus specifically on the well-studied interaction of brown algal phlorotannins and herbivorous fishes.

Because secondary metabolites can be quite reactive, and because they can comprise up to 20% of the dry mass of some species of algae, their effect on digestive processes and of the digestive processes on the metabolites is of particular interest. Herbivorous fishes consume food of lesser quality (more structural material, less protein) and must access the nutrients stored inside algal cell walls. To gain access to these nutrients, herbivorous fishes employ several distinct digestive processes.

The effect of plant secondary metabolites on herbivore digestion and nutrition is dependent not only on the characteristics of the metabolites but also on subtle interactions between the metabolite(s), gut environment, and plant nutritive qualities. In the marine environment, such interactions are complex. This is due, in part, to the diversity of marine plants, the diverse array of secondary metabolites that may be encountered by grazers, and the diversity of herbivore gut environments.

To date, most studies describing the effect of plant secondary metabolites on herbivore digestion in marine systems have focused upon the macromolecular-complexing activity of algal phlorotannins. While these compounds have demonstrated negative effects on marine herbivore food preference and digestion efficiency in some circumstances, it is clear that they can no longer be considered as broad–scope plant defenses. Rather, their anti-digestive activity can be counteracted in marine herbivores possessing guts with certain chemical (pH, redox condition, cation concentration, surfactants etc) and biological (microbes) characteristics. As a result of numerous *in vivo*, *ex vivo*, and *in vitro* studies, a framework linking the bioactivity of dietary phlorotannins with general herbivore gut features has emerged. Additional studies are required to test this framework and to further enhance it by considering other variables such as plant nutritional quality, degree of plant calcification, presence of antioxidants, and the ramifications of multiple defenses. No such framework yet exists for algal derived non-phlorotannin secondary metabolites. Modifications of diet-derived non-phlorotannin secondary metabolites have been identified in some herbivores and this represents a first step toward understanding how herbivore digestive processes effect metabolite changes.