

Seaweeds preferred by herbivorous fishes

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Abstract Marine macrobenthic algae (or seaweeds), epiphytic microalgae, and other aquatic plants constitute the main food items of marine herbivorous fishes. About 5% of all fish species are herbivorous; only 30% of these are marine, most of them living in coral reefs. An analysis was performed on all the seaweeds that formed part of the natural diet of these fishes, based on information contained in FishBase (<http://www.fishbase.org>). The results showed that many coral-reef-associated marine herbivorous fishes, such as the families Blennidae, Kyphosidae and Siganidae, fed selectively on filamentous and turf fleshy seaweeds, which they prefer over calcareous coralline and encrusting species. In particular, Chlorophyceae of the genera *Cladophora*, *Enteromorpha* and *Ulva* were preferred by *Scartichthys viridis* (Blennidae), *Girella* spp. (Kyphosidae), *Sarpa salpa* (Sparidae), and Phaeophyceae in the genera *Sargassum* and *Dictyota* were preferred by *Kyphosus* spp. (Kyphosidae) and *Siganus* spp. (Siganidae). A web-based tool was developed to provide information on plants (algae, seagrasses, terrestrial plants and fruits) preferred as food by herbivorous fishes

(<http://www.incofish.org/herbitool.php>). The tool is intended to assist aquaculturists, conservationists and ecosystem-based fisheries managers.

Keywords Aquaculture · Diet composition · FishBase · Food items · Herbivores tool

Introduction

Filamentous and turf seaweeds, Bacillariophyta, Dinophyceae, Cyanobacteria, associated meiofauna and detritus are food resources for grazing herbivorous fishes (Ojeda and Muñoz 1999; Crossman et al. 2001; Choat et al. 2002) and form a complex assemblage called the epilithic algal matrix (EAM) (Wilson et al. 2003). The bulk of the diet consists mainly of turf and filamentous algae, and macrophytes, but a small amount of animal materials may be ingested (Horn et al. 1982); other food items ingested are detritus or “unidentified organic matter”. Wilson et al. (2003) have even suggested that fishes assimilate more detritus than algae and should be considered as detritivores.

The susceptibility of algae to grazing by herbivorous fishes depends on algal morphology (Hay 1984; Lewis 1985; Hay 1997). Most herbivorous fishes prefer fleshy seaweeds over calcareous coralline and encrusting seaweeds (Montgomery and Gerking 1980; Horn et al. 1982; Ojeda and Muñoz 1999). This preference appears to have developed from the temporal and spatial variation in food availability (Horn et al. 1982, 1986; Andrew and Jones 1990; Jones and Andrew 1990); the presence or absence of secondary metabolites produced as chemical defenses against herbivory (Lewis 1985; Steinberg 1986; Duffy and Paul 1992; Cronin and Hay 1996; Cronin et al. 1997; Hay 1997; Cetrulo and Hay 2000; Erickson et al. 2006); and by

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nutritional qualities in terms of energy, micro-nutrient, calorie and protein content (Montgomery and Gerking 1980; Edwards and Horn 1982; Neighbors and Horn 1991; Pillans et al. 2004).

The objectives of this paper are (1) to identify the dominant seaweed groups among the Florideophyceae, Chlorophyceae and Phaeophyceae that are ingested by herbivorous fish, and (2) to develop a web-based tool for identifying the food preferences of herbivorous fishes by country, FAO area or ecosystem. This would also provide knowledge on the distribution and diversity of herbivorous fishes in different localities and ecosystems around the world. The eventual goal is to provide a tool for natural resource managers involved in aquaculture, fisheries, and conservation of marine herbivorous fishes.

Materials and methods

Seaweeds as food

The name “fish” refers to non-Tetrapoda Vertebrata species. Larvae were not included in the study. “Herbivorous fishes” or “herbivores” refer to adults and juveniles of fish species with trophic levels between 2.0 to 2.2. Trophic levels were estimated (1) from diet composition data, covering the whole range of food items consumed by a given species at a given locality and season, and (2) from food items studies, if no information on diet was available (Pauly and Sa-a 2000).

In FishBase, food items of fishes were classified into 58 categories, defined as functional groups of taxa that shared the same consumers and resources within a food web (Sa-a et al.

2000). The food items and diet data were drawn from peer-reviewed publications, theses and dissertations that contained lists of seaweed species that have been found in the stomach or otherwise known to be ingested by a given fish.

An analysis was performed on the seaweeds that formed part of the natural diet and stomach contents of herbivorous fishes, based on information contained in FishBase. Seaweeds consumed by a given species were grouped by phylum and by family; the taxonomy and validity of algal names were verified using AlgaeBase (Guiry and Guiry 2007; <http://www.algaebase.org>).

Herbivorous fish tool

The web-based tool available in the Incofish website was developed to retrieve information on herbivorous fishes from FishBase (Fig. 1). The tool was developed using open source resources such as PHP Hypertext Preprocessor (PHP), Hypertext Markup Language (HTML), Cascading Style Sheet (CSS) and MySQL for the backend database.

Results

Seaweeds as food

Herbivorous fishes accounted for only 5% (1,660/29,500) of the total number of fish species known globally. Of this quantity, 89% are from tropical waters (1,441/1,660) while 3% are temperate species (49/1,660).

Seventy percent, 28% and 2% are freshwater, marine, and brackishwater species, respectively (Froese and Pauly 2007).

Fig. 1 The search page of the herbivorous fish tool, <http://www.incofish.org/herbitool.php>

