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Review

Chemical and biological aspects of octocorals from the Brazilian coast

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ABSTRACT

This review explores the chemical and biological aspects/results reported in the literature of the octocoral species collected at the Brazilian Coast. This article summarizes the biological activities (including pharmacological, antifouling and others related to chemical ecology) for the compounds and/or extracts described elsewhere. Data and references of compounds isolated from species belonging to the same genus, which have not been investigated in Brazil yet, are presented, emphasizing the importance for research in this area.

Introduction

Octocorals or soft-corals (phylum Cnidaria, class Anthozoa, subclass Octocorallia = Alcyonaria) are soft-bodied invertebrates found throughout the world's oceans. The phylum Cnidaria, which includes mostly marine invertebrates with specialized cells called nematocysts, is divided into five classes: Anthozoa, Hydrozoa, Cubozoa, Staurozoa and Scyphozoa (Daly et al., 2007). From Class Anthozoa, we found colonial or solitary clonal animals, exclusively polypoid, separated into the Subclasses Hexacorallia (= Zoantharia) and Octocorallia (= Alcyonaria), each one further divided into multiples orders (Daly et al., 2007). Hexacorallia polyps have six tentacles and mesenteries or multiples thereof, and include black corals, sea anemones, tube anemones and stony corals, which comprise the main reef-building species (Daly et al., 2007). Octocorals are comprised by soft corals, sea pens and gorgonians, with eight tentacles and eight internal mesenteries that exhibit less variation in polyp morphology than hexacorals (Daly et al., 2007; McFadden et al., 2010).

Both groups can have endosymbiotic associations with dinoflagellates called zooxanthellae (*Symbiodinium* sp.). The host provides nitrogenous waste and receives photosynthetic products from the symbiont in return. Most zooxanthellate corals with obligate associates

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are restricted to shallow waters, such as some tropical scleractinians, and are the main reef-builders (Wells, 1956). Others can maintain facultative symbioses or survive without symbionts, being able to live in Polar Regions and deep-sea environments (Wells, 1956; Cairns, 1982; Huston, 1985; Cairns and Kitahara, 2012). Unlike stony corals (Hexacorallia, Scleractinia), most soft corals thrive in nutrient-rich waters with a less intense illumination. Almost all utilize symbiotic photosynthetic zooxanthella as a major energy source. However, most will readily eat, as passive suspensivorous feeders, any free-floating food, such as phytoplankton and zooplankton out of the water column (Lira et al., 2009; Gomes et al., 2012). They are integral members of the reef ecosystem and provide a habitat for fish, snails, algae and other marine species.

Octocorallia comprises approximately 3200 species of soft corals found in all marine environments. These are diverse on shallow tropical reefs and in deep-sea habitats, where they are often dominant space-occupiers and important structural components of the community (McFadden et al., 2010).

The Brazilian octocoral fauna, particularly deep-sea species, is still poorly known compared to the Caribbean fauna (Arantes et al., 2009; Castro et al., 2010). Around 107 species and/or morphotypes have been reported in Brazilian waters, some only recently. Fourteen of these species are endemic to the Brazilian coast (Arantes et al., 2006; Castro et al., 2010; Neves, 2010; Ofwegen and Haddad, 2011; Pérez et al., 2011; Neves and Pérez, 2012). Investigating the diversity and distribution of the Brazilian octocoral fauna is a complicated task, as the available literature is sparse and mainly found in gray literature, such as theses and dissertations (Castro et al., 2010). In contrast to deep-water species, shallow-water Octocorallia are well known on the Brazilian coast. According to a review published in early 2010 (Castro et al., 2010), seventeen reef species have been registered in Brazilian shallow waters, distributed from Amapá to Santa Catarina (Castro et al., 2010). The distribution of octocorals over large spatial areas is mainly regulated by substrate, temperature and salinity, while on smaller areas, food supply is one of the most important factors that control species distribution (Mortensen and Buhl-Mortensen, 2004; Arantes et al., 2006; 2009; Castro et al., 2010; Neves, 2010; Ofwegen and Haddad, 2011; Pérez et al., 2011; Neves and Pérez, 2012). The species distribution in deeper water may be related to water masses, as these influence food availability patterns (Clark et al., 2006).

Shallow-water samples from coral reefs are the usual targets of natural product chemists, mainly due to their abundance and easy collection. Nevertheless, in the past few years, deep-water species from less diverse environments, such as temperate and Antarctic seas, have also led to the discovery of some interesting compounds (Rodríguez Brasco et al., 2007). Octocorals from tropical and temperate waters have been a prolific source of novel secondary metabolites, most of them derived from the mevalonate pathway, such as terpenoid and steroidal derivatives (Blunt et al., 2005; Rocha et al., 2011; Leal et al., 2012). Notably, the families Gorgoniidae and Plexauridae, the most abundant in Brazil, have been demonstrated to contain a wide variety of compounds including steroids, acetogenins, sesquiterpenes and diterpenes. This group of marine invertebrates is recognized as an extremely rich source of bioactive secondary metabolites: and since these animals lack physical defenses, these compounds are generally believed to function as chemical defenses. It has been reported that 50% of soft coral extracts exhibited ichthyotoxic activities (Sammarco and Coll, 1998). An encyclopedic review of the octocoral chemistry published by Coll (1992) reviews the natural products, chemotaxonomy, chemical ecology and biosynthetic derivation of octocoral metabolites. Many of cembranoid diterpenes, secondary metabolites from soft corals, may be involved in ecological interactions (Coll, 1992), while other metabolites have antimicrobial (Correa et al., 2011), cytotoxic (Wang and Duh, 2012), antiviral (Yeh et al., 2012) and anti-inflammatory activities (Reina et al., 2011). In a recent review, the order Alcyonacea was proven to be the most promising source of compounds for therapeutic use. In the case of isolated compounds, terpenoids proved to be the most auspicious. The greatest interest, for which the most studies have been carried out, is antitumor activity (Rocha et al., 2011).

Marine organisms are an important source of new bioactive molecules; thus the scientific community worldwide is focusing its efforts on the isolation and characterization of biologically active natural products. A relatively small number of marine organisms studied have already yielded thousands of new chemical compounds; Porifera (class Demospongiae) and Cnidaria (class Anthozoa) being two main sources of new molecules (Blunt et al., 2014). Moreover, research of species from unexplored geographical sites with a high biological diversity and endemisms, such as species found in tropical regions, can provide novel marine bioactive compounds (Leal et al., 2012).

Despite the great biodiversity present along the Brazilian coastline, an important source of potential biologically active compounds, chemical analysis of Brazilian marine organisms is still incipient. So far, the chemistry of marine natural products in Brazil has focused on sponges, tunicates and brown algae (Berlinck et al., 2004). Regarding the chemical studies on octocorals, of the approximately 107 species reported in Brazil, to date only twenty have been studied, from which thirteen have been studied by Brazilian research groups (Chart 1).

In this review we report the secondary metabolites isolated from octocorals present or collected in Brazil, specifically focusing on their structures and biological activities, as well as their importance in chemical ecology.

The reported results are organized and discussed in light of the currently accepted taxonomical classification, and the compounds found in each family are exemplified. The results obtained from species collected in Brazil are shown, highlighting the most representative compounds present. Also, the results obtained from species present in Brazil, but collected worldwide, are further discussed. In conclusion, octocorals represent a potential source of new bioactive molecules that could be exploited more productively in this country.