Introduction

Marine sponges were once thought to be some of the simplest multicellular organisms in the animal kingdom. In reality, these organisms are relatively complex life forms that are important members of reef ecosystems. It has been highlighted (Diaz and Rützler, 2001) that on coral reefs sponges play a variety of important roles: primary production and nitrification through complex symbiosis; chemical and physical adaptation for successful space competition; capability to impact the carbonate framework through calcification, cementation and bio-erosion; and the potential to alter the water column and its processes through their ability to filter large volumes of water. The majority of marine sponges are sessile filter feeders. Consequently, most marine sponges need to reside where there is strong water movement and surge in order to survive; the water movement provides oxygen and nutritional intake that sponges need. This water is actively pumped through hundreds of pores found on a sponge’s surface (Riisgård et al., 1993). Furthermore, they lack a “conventional” organ system for digestion (Hentschel et al., 2002) that is present in higher animals. This results in an unconventional distribution of microbes within sponge tissue, regardless of the nature of the transient association between microbe and sponge, whether for nutritional or alternative benefit. It is known, however, that marine sponges utilize their ability to filter large amounts of sea water to trap microbes for food and also to benefit the sponge in other ways (Radjasa and Sabdono, 2009).
Sponge metabolites

In the search for novel bioactive compounds for the development of pharmaceuticals many species of marine sponges have been collected (El Sayed et al., 2000; Baker et al., 2007; Zhu et al., 2008; MarinLit 2013). Typically, sponges produce secondary metabolites as do their associates, including bacteria and fungi. These secondary metabolites often play an important role in the life cycle of a given marine sponge where they serve ecological functions such as competition for space, protection from predation, prevention of fouling, and from ultraviolet light (Rohwer et al., 2002). The microbes in turn use their secondary metabolites to protect themselves from the sponge and other organisms and conditions within the sponge’s tissue. In doing so, they often also impart positive protective properties to the sponge, for example, against predators, parasites, pathogenic bacteria, reactive oxygen species and ultraviolet light.

Bergmann and Feeny (1950) in one of the earliest reported marine natural products research efforts discovered two novel nucleosides, spongothymidine and spongouridine, in the marine sponge Cryptothelitia crypta. This discovery led to the synthesis of two compounds known as ara-A and ara-C that were the first marine natural-product inspired pharmaceuticals. Today, ara-A is employed as both an anticancer and an antiviral agent (Field et al., 2004) while ara-C is used in the treatment of leukemia and lymphoma (Wang et al., 1997; Sipkema et al., 2005). Since that early finding, many thousands of natural products have been discovered from the marine environment (MarinLit, 2013). Of the compounds discovered, many have been shown to have potent pharmacological activities, including anti-tumor (Erba et al., 2001), antifungal (Lee et al., 2007), anti-viral (Field et al., 2004), antimalarial (Wright et al., 1996), antitubercular (König et al., 2000), anti-HIV (Matthée et al., 1999), anti-inflammatory (De Silva and Scheuer, 1980), as well as anti-bacterial (McCarthur, et al., 2008).

Hawaiian sponge biological activity

The current study investigated the biological activity of organic solvent extracts derived from shallow water marine sponges collected along the eastern coastline of Hilo, Hawaii and from mesophotic sponges collected from the Au’au channel, Maui. Three shallow-water sites were surveyed during this project at which 13 sponges were observed and collected in situ using either scuba or snorkel diving. Five mesophotic sponges collected from the Au’au Channel off Maui using the NOAA HURL PISCES IV and PISCES V submersibles from February 26 - March 10, 2011 were also analyzed. Samples averaging 1-6 cm³ in size were taken from each sponge in order to perform tissue and spicule analysis for preliminary taxonomic identification. Of the 13 shallow-water sponges, six were identified to genus level based on scanning electron microscope (SEM) images of their spicules. Organic extracts from each sponge were tested for their antioxidant and antibacterial properties. Total antioxidant activities of individual organic solvent extracts of all 18 sponge samples were determined employing the ferric reducing antioxidant power (FRAP) assay (Benzie and Strain, 1996, 1999). Of the sponges tested, extracts of the mesophotic sponges showed the highest total antioxidant activity. Mesophotic sponge D0016 showed the highest antioxidant activity with a FRAP value of 1780 ± 239 μM/µg extract. Antimicrobial properties of the extracts were determined using the Kirby-Bauer antibiotic sensitivity test (Schultz et al., 1995). Again, extracts of the mesophotic sponges showed the highest levels of inhibition against the panel of Gram-positive bacteria: Staphylococcus aureus, Bacillus cereus, and Enterococcus faecalis, with sponge D0015 demonstrating the highest activity.

Conclusion

These results show that numerous Hawaiian sponges, from both shallow and deep waters, exhibit significant antioxidant and antibiotic activities that may lead to discovery of novel compounds for potential use by the pharmaceutical and related industries.


