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MARINE SPONGE- GENUS SPIRASTRELLA- A REVIEW

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ABSTRACT

Marine sponges are potential sources of many unique metabolites, which includes antiangiogeneic, cytotoxic, antimicrobial and anticancer compounds. The purpose of this article is to present structurally reviewed pharmacological activities in the different species of *Spirastrella*, isolation of active constituents from various species of *Spirastrella* and its contribution as bioactive compounds. It also discussesthe destructive role of the boring sponge *Spirastrella* on the reef.

KEYWORDS: *Spirastrella*, antiangiogeneic, cytotoxic, antimicrobial.

INTRODUCTION

The marine environment is an excellent storehouse of bioactive compounds, with unique biological properties, which may not be found in terrestrial natural products. The ocean environment is massively complex, consisting of extreme variations in pressure, salinity, temperature, and biological habitats. Among the groups of marine organisms, sponges are the most diverse and abundant in nature, due to their soft bodies and sedentary life styles.

Marine sponges are sessile invertebrates which often lack of physical defense, instead they have evolved to develop chemical defense against predators and larval settlement of other sessile organism. In fact marine sponges are one of the richest sources of interesting chemicals among marine organism.

The history of sponge study of the Indian Ocean starts from 1765 onwards. A perusal of literature reveals that 451 species of marine sponges are known to occur in India (Pattanayak, 1999) through the works of Sollas (1884), Dendy (1887-1989), Annandale (1914-1915), Burton (1930) and Ali (1954-56). An exhaustive survey of the marine sponges with special reference to the Gulf of Mannar and Palk Bay has been studied during the years 1964-67 by

Thomas (1968-2006). Coral boring sponges of the Gulf of Mannar and Palk Bay were studied by Thomas (1969). The 98 fauna of West coast of India is partly worked out when compared to that of the east coast.

Classification and Species

Sponges in the mid 1700 were thought to be plants, however zoologists then classified them as Porifera which mean bearing openings. The general classification of *Spirastrella* is as follows.

Kingdom: Animalia
Phylum: Porifera
Class: Demospongiae
Order: Hadromerida
Family: *Spirastrellidae*
Genus: *Spirastrella*

The different species of Spirastrella are as follows

Spirastrella abata(Tanita 1961), *Spirastrella andamanensis* (Pattanayak, 2006), *Spirastrella coccinea* (Duchassaing & Michelotti, 1864), *Spirastrella coccinopsis* (Laubenfels, 1953), *Spirastrella cunctatrix* (Schmidt 1868), *Spirastrella decumbens* (Ridley, 1884), *Spirastrella hartmani* (Boury-Esnault, 1999), *Spirastrella insignis* (Thiele, 1898), *Spirastrella keaukaha* (Laubenfels, 1951), *Spirastrella mollis* (Verrill, 1907), *Spirastrella pachyspira* (Lévi, 1958), *Spirastrell apunctulata* (Ridley, 1884), *Spirastrella sabogae* (Boury-Esnault, 1999), *Spirastrellatristellata* (Topsent, 1897*), Spirastrell aphyllodes* (Schmidt, 1870) *Spirastrella aculeate* (Topsent, 1890), *Spirastrella alcyonoides* (Hallmann,1912) *Spirastrella andrewsi* (George & Wilson, 1919) *Spirastrella angulata* (Bowerbank, 1872), *Spirastrella areolata* (Dendy, 1897) *Spirastrella aurivillii* (Lindgren, 1897), *Spirastrella australis* (Lendenfeld, 1888), *Spirastrella bistellata* (Schmidt, 1862), *Spirastrella bonneti* (Topsent, 1906), *Spirastrella carnosa* (Topsent, 1897), *Spirastrella congenera* (Ridley, 1884), *Spirastrella cunctatrix* (Schmidt 1868), *Spirastrella cuspidifera* (Lamarck, 1815) *Spirastrella cylindrical* (Kieschnick, 1896), *Spirastrella digitata* (Hentschel, 1909), *Spirastrella dilatata* (Kieschnick, 1896), *Spirastrella dioryssa* (Laubenfels, 1950), *Spirastrella excentrica* (Burton, 1931), *Spirastrella fibrosa*, (Dendy, 1897) *Spirastrella globularis* (Dendy, 1897), *Spirastrella inconstans* (Dendy, 1887), *Spirastrellala cunosa* (Kieschnick, 1898), Spirastrella massa (Ridley & Dendy, 1886) *Spirastrella minax* (Topsent, 1888), *Spirastrella montiformis*

(Hallmann, 1912), *Spirastrellapanis* (Thiele, 1898) (Ridley & Dendy, 1886), *Spirastrellapoculoides* (Hallmann, 1912), *Spirastrellapotamophera Spirastrella papillosa* (Laubenfels, 1954), *Spirastrella poterionides* (Vacelet & Vasseur, 1971), *Spirastrella pulvinata* (Bowerbank, 1872) *Spirastrella purpurea* (Lamarck, 1815), *Spirastrella rotunda* (Tanita & Hoshino), *Spirastrella semilunaris* (Lindgren, 1897), *Spirastrellasolida* (Ridley & Dendy, 1886), *Spirastrella spiculifera* (Kieschnick, 1900), *Spirastrella spinispiraefera* (Brøndsted, 1924) *Spirastrella spinispirulifera* (Carter, 1879) *Spirastrella tentorioides* (Dendy, 1905) *Spirastrella transitoria* (Ridley, 1884), *Spirastrella vagabunda* (Ridley, 1884), *Spirastrella vidua* (Schmidt, 1875).

Boring Sponges

Boring into objects like rock, shell, wood or coral for food or protection is a marked activity among marine organism. Boring sponges are a major group among the marine organism which causes significant destruction to the reef system. Among twelve different taxa of marine plants And animals, sponges form a major group which cause a great amount of damage and ecological disturbance to the marine ecosystem. In the Gulf of Mannar and Palk Bay, the boring sponges play a major role in causing destruction to the dead and living corals. The sponges by the etching of hard calcium carbonate in the form of microchips bore into the hard calcareous substrata and so the interior of these cavities when viewed under high magnification have a eroded appearance. The outer layer of coral appears normal but a slightest pressure would make the entire outer layer cave in as the interior is hollow. There are 20 species of boring sponges now known from the Gulf of Mannar and Palk Bay falling into 9 genera. The most conspicuous genus is Cliona both in number of species and in distribution (Thomas, 1969). The number of species and the various genus of boring sponge are as follows Genus *Rhabdermia* (1), *Spirastrella* (4), *Amorphenosis* (1), *Aka* (2), *Cliona* (6), Thoosa (1), Jaspis (1), Halina (11), Samus (1).

In the genus *Spirastrella* the four species of boring sponges are *Spirastrella cuspidifera Spirastrella. inconstans, Spirastrella. pachispyra*, *Spirastrella aurivilli*.

Microscopic Characters

Spirastrella cuspidifera

The dry type of *Spirastrellacuspidifera* is a clusterwhich is about, 44 cm tall, 20–25 mm in diameter at about midway to the top. The tylostrongyles is a modified version of tylostyles,

has a size of 330–400 X 8–11µm.The spirasters are small (4–13m long) and many smaller ones (4–6m) are known as amphiasters.

The tylostyles are straight or slightly curved and the head oval or irregular and the size is0.511 mm x 0.012 mm. There are two types of spirasters. They are slender forms with spines or tubercles arranged spirally or even straight and the size is 0.008-0.068 x 0.001-0.002 mm. The second one is robust forms with two bends, spines long and spirally arranged or rarely smooth and the size up to 0.038 x 0.006 mm. The sponge is widely distributed in the Red Sea, Indian Ocean, Australian Region and Pacific Ocean.

Spirastrella pachyspira

Spirastrella pachyspira, an encrusting sponge is violet in colour when alive. The surface is irregularly connulose or rigid. Tylostyles form brushes in the surface and spirasters, a plate by the interlocking of their spines. Thickness of this plate may comeupto 0.36mm. In thicker parts, the tylostyles may be present in plumose columns with their heads buried deep in the spiraster plate. The tylostyles size is 0.315-0.959 X 0.012-0.021mm. The arefour types of spirasters. They are (a) small with curved shaft; size0.016mm average (b) typical slender spirasters size 0.042X0.004mm (c) robustspirasters with blunt spines size0.050X0.016mm and (d) branched spirasters plate like size 0.105X0.063mm. *Spirastrellapachyspira* is distributed in the Red sea, Aldabra, Madagascar, Gulf of Mannar and Palk Bay.

Spirastrella inconstans

The sponge is pale yellow in colour internally and light brown externally in living condition. The tylostyles are straight or slightly curved; smaller forms located in the surface and the size is 0.525 mm x 0.019 mm. The spirasters. are rarely represented with 2-5 bends and the size is, 0.008-0:035 x 0.002 mm. It is also distributed in the Red Sea, Indian Ocean, Australian Region and Pacific Ocean.

Spirasterella aurivilli

The colour of the sponge when alive is pinkish red. There are two types of tylostyles. (a) They are straight or slightly curved with the head spherical, irregular or trilobed and the diameter, 0.002 mm. (b) They are the smaller forms of the dermal region and the size, is0.321 mm x 0.012 mm. The spirasters are slender, with long and sometimes bifid spinesand the size, when well formed, 0.061 X 0.003 mm. This species is quite abundant in the Gulf of

Mannar and Palk Bay. It is also Distributed in theIndian Ocean, Australian region and Pacific Ocean.

Bio- active Compounds from genus *Spirastrella*

This study emphasizes on the work carried out on this genus George R. Pettit (1993) isolated two extraordinarily potent (Gl_{50}*ca.* 10^{-8}µg ml^{-1}) human cancer cell line inhibitors designated as spongistatins 4 and 5 from the marine sponge *Spirastrella spinispirulifera*.

Naseer Alam et al (2001) isolated a known and four new lyso-PAF (Platelet activating factor) derivatives from the sponge *Spirastrellaabata*. Two of them are unprecedented in having the methoxy groups at C-2. The structure have been determined by combined spectroscopic methods.

David E Williams et al (2003) isolated a novel antimitotic macrolide Spirastrelloide A from the carribean marine sponge *Spirastrella coccinea*. It is a 47 carbon linear polyketide containing a tetrahydropyran and two spirobispyran substructures embedded in the macrocyclic and aside chain terminating in a carboxylic acid. The Spirastrelloide A methyl ester showed potent activity in a cell based assay which detected mitotic arrest and it did not affect tubulin polymerization *in vitro* which is a rare biologic property of accelerating the entry of cells into mitosis from other cell cycle stage, before arresting them in mitosis.

Maria Jesus Martin et al (2005) isolated two new halogenated derivatives i.e chlorine and bromine of helinane from 2-propanol extract of the sponge *Spirastrella hartmani*. The chlorine substituted helinane showed in-*vitro* cytotoxicity against the human tumor cell lines A549, HT29 and MDA-MB231

Brandon I. Morinakaetal (2011) isolated brominated lipids mollenyne A from the sponge *Spirastrella mollis* collected from the Bahamas. Mollenyne A is a chiral tri-halogenated cytotoxic C_{20}carboxamide, embodying three units: a triyne-ene terminus, an allylic alcohol flanked by halogenated carbons and homoagmatine (decarboxyhomoarginine). The extracts from a collection of Bahamian sponges and tunicates were screened for in vitro cytotoxic activity against human colon tumor, HCT-116.A highly cytotoxic extract from the red encrusting sponge *Spirastrellamollis* (IC50 $\leq$ 0.1µg/mL) was identified. a new halogenated lipid, mollenyne A was isolated from the dichloromethane extract of *S. mollis* by C_{18} flash chromatography and reversed phase HPLC.

Kyoung Hwa Jang et al (2012) isolated three sphingosine-4-sulphates and lysophosphatidy lglycerol from the Korean sponge *Spirastrella abata*. The compounds showed good cytotoxic effect against the K562 cell line. The antimicrobial properties of the compounds were much weaker and only exhibited marked inhibition against diverse bacterial and fungal strains. These compounds also showed weak to moderate inhibition against isocitratelyase (ICL) and Na^+/K^+-ATPase. The compound lysophosphatidyl glycerol showed significant cytotoxicity and Na^+/K^+-ATPase inhibition than the sphingosine sulfates.

A. Mohan Kumar et al (2012) studied the antimicrobial effect on extracts of increasing polarity from *Spirastrellainconstans* against Methicillin resistant Staphylococcus aureus. The chloroform extract when compared to other solvent extracts showed a maximum of 30 mm diameter of zone inhibition. The protein content in the crude extract was estimated by Lowrys method. The protein was precipitated using ammonium sulphate precipitation method and purified using dialysis. The molecular weight of the purified protein was found to be 3,000 Da.

K. Chairman etal (2012) screened 12 species of marine sponges against some selected human pathogenic bacteria and fungi. The present study showed that the ethyl acetate extracts of marine sponges exhibited good antimicrobial activity. But the ethyl acetate extract of *Aurora globostellate* and *Spirastrellainconstans* possessed highest antibacterial activity than methanol extracts and so it could be useful in seeking active principle against human pathogenic bacteria.

S. Sudharsan et al (2013) isolated and characterized collagen from the marine sponge, *Spirastrellainconstans*. The amount of collagen a protein content was fond to be 32%. The molecular weight of crude and purified collagen was determined using sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE), the crude collagen showed three bands (80, 60 and 59 kDa molecular weight) and purified showed only a single band (58 kDa). The structural properties and the stability of collagen were analyzed by using (FT-IR) spectrum and differential scanning calorimetry (DSC). The scanning electron microscopic (SEM) analysis revealed that the s\microstructure of sponge collagen is highly porous and has interconnected scaffolds.

Maushmi Kumar et al (2014) isolated four strains of microorganisms from three different varieties of marine sponge i.e *Halichondriaglabrata,* Cliona lobata and

Spirastrellapachyspira. They showed broad spectrum antimicrobial activity against both gram positive and gram negative indicator organism.

Schyschka*et al* (2008) studiedthat macrocyclic lactone isolated from the marine sponge *SpirastrellaSpinispirulifera* induces apoptosisby interacting with caspasedependant pathway by the release of cytochrome c, SMAC/DIABLO and Omi/HtA_2 from the mitochondria to the cytosol leading to apoptosis in Jurkat cells.

Maushmi Shailesh Kumar et al studied the effect of the enzyme activity i.e presence of the acetylcholinesterase in both young and developed marine sponges of *Halichondria glabrata Spirastrella pachyspira* and *Cliona lobata* from western coastal area of India. The *Spirastrella pachyspira* showed maximum enzyme activity when compared to the other two types of sponges. The methanolic extract of *Spirastrella pachyspira* was studied for its anti/pro angiogenic activity. The extract obtained from *S. pachyspira* was found to be a potent angiogenesis inhibitor.

Kun Lin et al (2015) isolated four known and two new lysophospholipids from the sponge *Spirastrellapurpurea* from Weizhou island Guangxi Autonomous region, China. The structures of the new compounds were elucidated by detailed spectroscopic techniques including 1D and 2D NMR, mass spectroscopy and optical rotation experiments. The isolated compounds displayed various moderate *in-vitro* fungal activities against four fungi (Cryptococcus neoformans, Candida glabrata, Trichophytarubrum and Aspergillusfumigatus) whereas they displayed no neuroprotective activity against $\alpha\beta_{25\text{-}35}$ induced SH-SY_5Y cell damage.

CONCLUSION

In this review article different species of *Spirastrella* have been listed. The destruction caused by the boring marine spongeare discussed. Spirastrella species were found to contain several halogenated helinane compounds, sphingosine, spirastrelloide, bioactive lipids and macrocyclic lactones. These compounds exhibited good antibacterial activity against gram+ve and gram-ve microorganisms, antifungaland were found to be potent antiangiogenic, anticancer agents.

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