Siliceous Sponge Reefs

Living “Dinosaurs” in Peril

Siliceous sponge reefs occur several times in Earth history. In the late Jurassic this facies was widespread mainly on the northern shelf of the Tethys. After this time there was a drastic reduction in the occurrence of these reefs and it was presumed that this reef type died out in the Tertiary. The discovery of globally unique hexactinellid sponge reefs on the continental shelf off British Columbia (Canada) has changed this perception. Recent investigations by manned submersible, ROV and high resolution geophysical surveying, reveal that 50% of these reefs are being destroyed by the mobile fishing gear.

Introduction

Known since the Late Proterozoic, hexactinellid sponges are the first metazoans which can be related to an extant animal group [1]. In the Mesozoic, they became important reef builders in deeper water. During the Jurassic the siliceous sponge reefs had a widespread distribution mainly on the northern shelf of the Tethys realm, and achieved an acme in the Late Jurassic where they formed a reef belt extending over more than 7,000 km [5]. This sponge reef was the largest bioconstruction ever existed on earth. After Cretaceous times these reefs have completely disappeared and it was thought that they died out during the Early Tertiary.

The discovery of recent siliceous sponge reefs off the coast of British Columbia (Canada) in the nineties was largely unnoticed although the finding published in scientific journals [2]. Since 1999 the sponge reefs are object of continuous scientific investigations.

Sponge Reef Locations and Reef Shape

The sponge reefs discontinuously cover about 1,000 km$^2$ of seafloor in Queen Charlotte Sound and Hecate Strait at depths between 140 and 240 m. Four main
reef complexes are situated on the narrow continental shelf about 70-80 km off the Canadian mainland in deep troughs which cross the western Canadian continental shelf, often settling on relict iceberg scours. Much smaller isolated reefs have been found on the inner shelf between Vancouver Island and the mainland in water depths as shallow as 90 m [6].

The four main reefs complexes are variable in size and structure.

The reefs forming the complex are up to 25 m high, frequently with vertical flanks and can cover hundreds of square kilometres. They display a variable morphology on several scales, forming mounds (bioherms) and biostromes (sheets or meadows) of diverse size and shape in different areas.

The growth form of individual mounds is characterized by an initial growth phase as a discrete, symmetrical circular form, usually found on an iceberg scour berm. These small mounds grow over time and coalesce to form larger irregular structures [3].

Dead sponges do not lose the structure of the living organism and their durable skeletons projecting out of the seabed, provides a firm substrate which allows sponge larvae to become anchored. An average growth rate of the hexactinosidan sponges is estimated to be 0-7 cm per year whereas the average vertical growth rate of the reefs is about 2 mm. Radiocarbon data provide an age of 9,000 years [2]. Very low sedimentation rates and long-term environmental stability characterize the oceanographic conditions, which clearly mirror deep-sea conditions.

**Sponge Fauna**

The sponge fauna of the reefs is low diverse and consist of only seven hexactinellid species. Three hexactinosidan taxa (Heterochone calyx (fig. 1), Aphrocallistidae vastus
(fig. 2), Farrea occa (fig. 3)) act as framebuilders, whereas the other four hexactinellid lyssacinosidan (rossellid) taxa (Rhabdocalyptus dawsoni; Acanthascus platei, A. cactus, Staurocalyptus dowlingi) occur randomly within and outside the sponge reefs. The sponge reefs provide a seafloor habitat of great complexity and are host to a large number of fish and a diverse invertebrate fauna.

Human Impact

The sponge reefs face human threats to their continued existence as continental shelf fisheries resources are exploited. A particularly harmful, non-selective and wasteful type of fishing is known as bottom trawling. Mobile fishing gear is a widespread cause of physical disturbance and destruction of shelf benthos. A typical trawling configuration is a large, weighted net with a broad mouth held open by heavy (2,000 kg) doors or heavy boards at each side. This mobile fishing equipment has impacted all sponge reefs. Large areas are abraded, fragmented and ploughed as trawling doors and weighted nets impact the seafloor. The brittle sponge skeletons cannot withstand this mechanical stress and break and crumble. This ultimately leads to the death of sponge individuals and to the reduced opportunity for recolonization of the affected area of the reef surface by a new generation of sponges as the substrate, which the young sponges require, is lost. Sidescan sonar data indicate the heavy impact of bottom trawling as well. Trawl marks identified with this acoustic method record the passage of trawl doors scraping across all sponge reef complexes [5].

Seafloor observations using a manned submersible clearly proved that siliceous sponges suffer heavy damage during fishing, by mobile fishing gear, in a variety of ways. These include breakage and removal of the sponge at the seafloor, abrasion or fragmentation of distal portions of sponges, and direct ploughing and remobilization of the seafloor into linear piles of sponge skeletal debris. In situ, seafloor observations indicate that living hexactinosidan sponges as well as dead hexactinosidan skeletons offer very little resistance to shearing or compressional forces applied by objects at the seafloor and fragment readily due to the brittle nature of the hexactinosidan skeletal structure [5].

Conclusion and Outlook

The ecological niche of the modern hexactinellid sponge reefs off British Columbia can be characterized to be ultra-conservative as it has not changed substantially since early Jurassic times. The reefs represent a long time stable community that develops slowly over centuries or even millennia as individual sponges can live to be several hundred years old. They have formed in a deeper water environment
characterized by low levels of natural disturbance with stable temperatures, moderate water current velocity and low sedimentation rate.

50% of the sponge reefs have already been destroyed by mobile fishing gear. If we fail to protect these reefs from bottom trawling and other human impacts, we will lose this singular opportunity to study this ultra-conservative, but efficient, reef type, which existed for hundreds of millions of years and was, at one time, as widespread on Earth as the coral reefs of today.

References

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