

***SCHIZAMMINA ANDAMANA* N. SP., A LARGE FORAMINIFERAN
(PROTOZOA, GRANULORETICULOSA) FROM THE SHELF
WEST OF THAILAND**

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ABSTRACT: A new species of *Schizammina* is described from the mid-shelf of the Andaman Sea at depths between 60 and 85 m. The test is agglutinating, up to about 30 mm high, and consists of dichotomously branching tubes. Tube diameter varies between 0.8 and 1.2 mm. The most closely related species are *S. atlantideae*, *S. furcata*, and *S. galathea*. *Schizammina andamana* n. sp. was the dominant macrofauna organism at some stations and its cytoplasm contained centric diatoms, indicating that it is a filter feeder on sedimenting primary production.

INTRODUCTION

The Thai-Danish BIOSHELF project 1996–2000 in the Thai Economic Exclusive Zone of the Andaman Sea comprised 12 transects perpendicular to the coast. Sampling in these was carried out during a number of cruises with the ‘R/V Chakratong Tongyai’, using different kinds of gear at depths from 40 to 900 m (Aungtonya *et al.* 2000, Tendal *et al.* unpubl.).

During the last two cruises in 2000 it was noticed, when sorting some of the samples on deck, that a schizaminid foraminiferan lives in the mid-shelf area. Inspection of the literature and comparison with specimens in the collection of the Zoological Museum in Copenhagen of all earlier described members of the family indicated that the BIOSHELF specimens represent a new species of the genus *Schizammina*.

The species is here formally described as *Schizammina andamana* n. sp. and its occurrence is discussed and compared to the distribution patterns of other species of the family.

MATERIALS AND METHODS

See Aungtonya *et al.* (2000) for the list of sampling stations. The samples were immediately

fixed in formalin (c. 4%) in seawater with an addition of disodium tetraborate (borax). They were later transferred to 80% alcohol.

Individuals intended for histology were first transferred to distilled water through a falling alcohol series, then to a 5% aqueous solution of hydrochloric acid (HCl) for 1 h in order to remove calcareous particles, and finally to 30% hydrofluoric acid (HF) for 24 h in order to remove siliceous mineral grains. The individuals were washed in distilled water, brought through a series of increasing alcohol concentrations (30, 50, 70, 80%) and finally stored in 80% alcohol. They were embedded in Epon. Sections, 3 µm thick, were made using a Jung microtome fitted with a glass knife. They were stained with toluidine blue for about 2 min and differentiated in 96% alcohol and the coverslips were mounted with Gurr.

Individuals used for scanning electron microscopy were transferred from alcohol to acetone and dehydrated by the use of an Electron Microscopy Sciences 850 critical point drier. The individuals were mounted, broken or entire, on stubs and coated with gold-palladium in an Edwards S150B sputter coater for 5 minutes, and studied in a scanning electron microscope (CamScan MaXim 2040 S) at the University of Aarhus, Denmark.

Some individuals were dried in order to allow the extraction of DNA, but this method failed.

FAMILY SCHIZAMMINIDAE NØRVANG, 1961

Diagnosis: Test free, large (2–10 cm maximum dimension) and either plate-like or forming dichotomously branching tubes. Agglutinated wall thick and firmly cemented. Interior non-septate, consisting of large, flattened space or lumen of tube system. Aperture simple, oval or circular. (After Lee *et al.* 2000, abbreviation of the original diagnosis by Nørvang, 1961).

Scope: Schizamminidae comprises two genera, *Schizammina* Heron-Allen and Earland, 1929 with seven species and *Jullienella* Schlumberger, 1890 with three species. A third genus, *Astrorhizinella* with one species, *A. planata*, was described by Saidova in 1970 and placed in the family, a position kept in her monograph on Pacific benthic Foraminifera (1975) and other papers, and by Beljaev (1983, 1989). *A. planata* has the characteristics of a xenophyophore and was transferred to the genus *Psammmina* by Tendal (1996), a view confirmed in a reinvestigation of the original material by Kamenskaya and Saidova (1998).

History and present status of genera and species: The first genus of the family (as understood nowadays) to be described was *Jullienella* Schlumberger, 1890 with the type species *J. foetida* by monotypy. It was found by a French expedition off West Africa and first believed by the bryozoan specialist Jules Jullien to be a bryozoan. Next came *Schizammina* Heron-Allen and Earland, 1929 with type species *S. labyrinthica* and one other species, *S. furcata*, based on material taken by the British 'Discovery', off West Africa as well. Meanwhile, Percy (1908) had described *Botellina pinnata* from material provided by the South African 'Pieter Faure' in the Indian Ocean off South Africa. The species had a remarkable fate, being divided by Nørvang (1961) into two species, *Jullienella pearcyi* Nørvang, 1961 and *Schizammina pinnata* (Percy,

1908). Buchanan (1958; 1960), during a survey of the fauna off Ghana, found some of the earlier named species, and described *S. arborescens*. Nørvang (1961) investigated a rich material partly taken by the Danish 'Atlantide' (1945–1946) and 'Galathea' (1950–1952) expeditions, partly collected by the Danish zoologist Th. Mortensen in South Africa in 1929, comprising all the species, and added three new ones, *S. atlantideae*, *S. galathea* and *S. reticulum*. A third species of *Jullienella*, *J. zealandica*, was described from New Zealand by Hayward and Gordon (1984).

RESULTS

Schizammina andamana n. sp.

(Figs. 1–5)

Material examined:

St. C-2. 1 February 2000. 9°00' N, 97°55' E. 60 m. Rectangular dredge. Few specimens/fragments. Alcohol.

St. J-3. 26 February 2000. 7°15' N, 98°35' E–7°12' N, 98°34' E. 79–79 m. Agassiz trawl. Numerous specimens/fragments. Alcohol.

St. J-3. 26 February 2000. 7°15' N, 98°35' E. 78 m. Sand. Hyperbenthic sledge. Hundreds of specimens/fragments, Dry.

St. J-48. 23 February 2000. 7°14' N, 98°37' E–7°16' N, 98°42' E. 76 m. Hundreds of specimens/fragments (including the holotype and six paratypes). Alcohol.

St. K-3. 29 February 2000. 7°00' N, 98°41' E–7°01' N, 98°43' E. 83–81 m. Agassiz trawl. Few specimens/fragments. Dry.

St. L-3. 29 February 2000. 6°45' N, 98°43' E–6°46' N, 98°41' E. 83–84 m. Agassiz trawl. Few specimens/fragments. Alcohol.

St. L-3. 29 February 2000. 6°45' N, 98°45' E. 82–81 m. Sandy mud with shell fragments. Hyperbenthic sledge. Few specimens/fragments. Alcohol.

Description of holotype:

The holotype is reddish brown and about 15 mm high. It branches dichotomously four times with good distance between branching points, and a pronounced thickening of the branches just

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below these. Large mineral grains are conspicuous on the test surface (Fig. 2A).

Deposition of type specimens:

The holotype is deposited at the Phuket Marine Biological Center, Reference Collection (PMBC No. 24587). Six paratypes are deposited in the collection of the Zoological Museum, SNM, Copenhagen (ZMUC PRO 11 to ZMUC PRO 16).

General description:

Largest specimens 2–3 cm in length, consisting of a repeatedly dichotomously divided tube system with 5 or 6 dividing points, and 2–6 mm between them. Tubes between points slightly conical with thickest part distally, and 0.8–1.2 mm in outer diameter, mostly just around 1 mm (Fig. 1A–Z).

The branching pattern is characteristic in a way most clearly seen in large specimens (>1.5 cm). The first dichotomy is at a large angle, close to 90°, the following at the same or a smaller angle. The first two branches curve slightly outwards and branch again, but the following pairs of branches are unequally developed, one of them prolonging the original branch in a gentle curve, the other not dividing, but ending blindly, plugged with loose sand grains and fine particles. After 4–5 divisions repeating the pattern of prolongation and curving, the ‘main branch’ almost forms a circle. The branching pattern is not always this strict; the other or both branches in a division may develop, resulting in a more straight part of the test, which itself can be dichotomously divided several times. The branching is essentially in one plane, but slight twisting of single branches out of that plane is seen now and then.

The tube wall consists of quartz grains, up to c. 500 µm in diameter, but mostly 200–250 µm, set in a matrix of organic cement. The large mineral grains extend all the way through the wall. The outer test surface consists of minute mineral grains which often form a rim or smooth surface around the margin of the larger grains (Fig. 3A). Channels for the cytoplasm are found between some of the larger mineral grains. Such channels

often expand into larger hollow structures just below the test surface, but do not seem to penetrate the surface itself.

The test colour is red-orange-brown, except at the tips of the branches where it is white (Fig. 2A, D). The colour changed when individuals were put in a weak hydrochloric acid (HCl) solution. A greenish or yellow-greenish substance was given off to the liquid. The test turned whitish with some greenish cement remaining between the mineral grains (Fig. 2B). This treatment made it easier to observe the distribution of the mineral grains on the outer test surface.

The test lumen is a longitudinal channel along the centre of the test axis (Fig. 3B, D). An organic lining was observed in the light microscopic sections. It is often seen on one side only, but in some sections it was found all the way around the cytoplasm (Fig. 5A, B). The differences are probably fixation artifacts.

The cytoplasm is not a uniform cell body as in many other foraminiferans, but a kind of compressed network of numerous compacted granuloreticulopodia. Consequently, this cell organisation resembles to some extent the outer part of the cytoplasm in *Toxisarcon synsucidica* Cedhagen and Pawlowski, 2002 (Fig. 2J). The cytoplasm surface towards the mineral grains is therefore not smooth but has numerous irregular holes and cavities (Fig. 3C).

The cytoplasm is full of stercomata (Fig. 3C) and also contains several centric diatoms. The older (lower) parts of the test lumen are entirely filled with stercomata and the active cell parts seem to be located at the tips of the branches (Fig. 2B, D).

The nucleus is up to 100 µm in diameter (Fig. 5A). Its margin can be irregular and on some of the slides it is located in a structure resembling a vacuole. However, this is probably a fixation artifact. The nucleus contains numerous nucleoli and most of them are concentrated towards its periphery, as in many other species (*e.g.*, Cedhagen and Pawlowski 2002).

Free granuloreticulopodia of the shape typical for foraminiferans were found at the tip of

a branch (Fig. 4).

The test is usually free from other organisms but a few species have been observed on it, primarily on the older parts. An undescribed cirriped (Cedhagen and Høeg, unpubl.) and bryozoan colonies are frequently found. Rare epizoans are gastropod egg cases, hydroids, and other agglutinating foraminiferans.

Distribution:

The species has so far been recorded between 6°45'N and 9°N, and can probably be found as scattered fragments also in samples from the two more northern transects. The bathymetric distribution is, for the time being, established as the depths between 60 and 85 m, on sandy mud with shell fragments. It can be the dominant macrofauna organism in some localities (Fig. 2C).

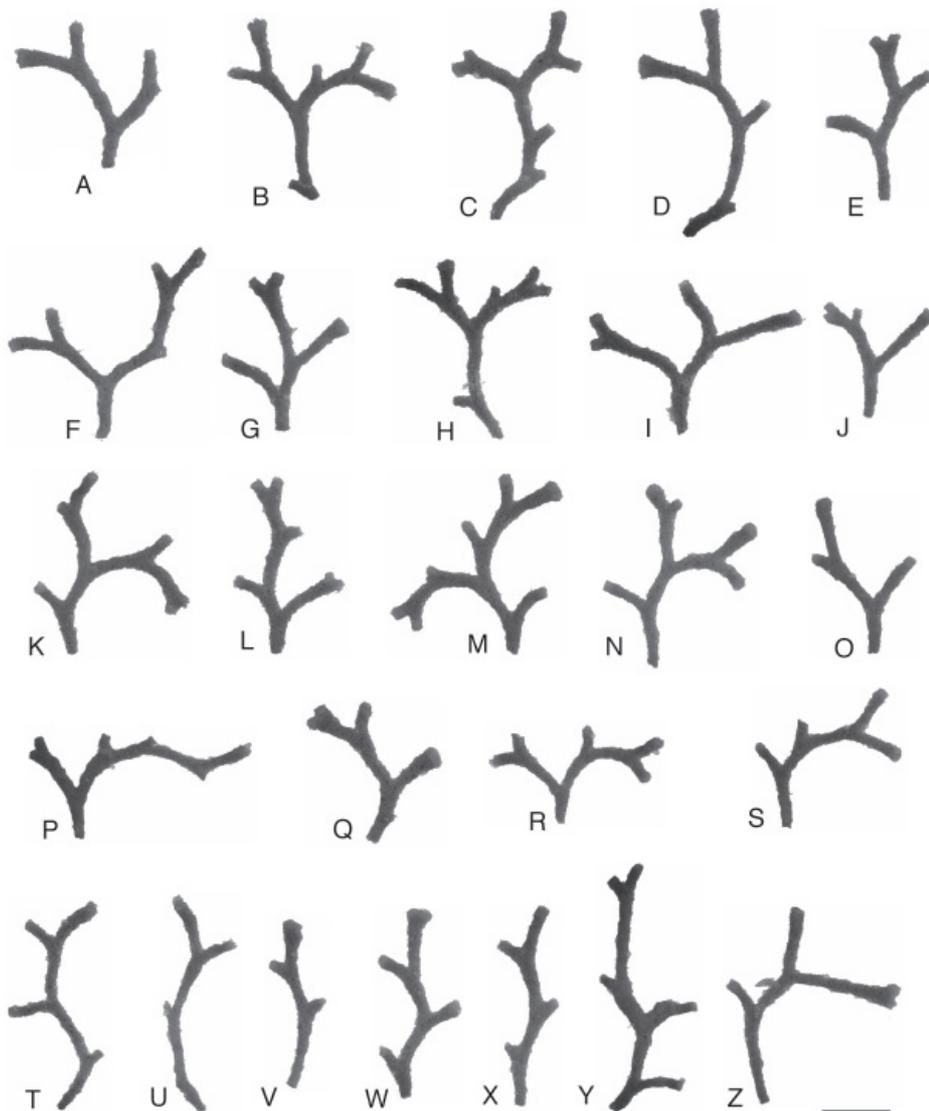


Figure 1. *Schizammmina andamana* n.sp. Specimens collected at the type locality (Andaman Sea, BIOSHELF station J-48). Scale bar = 5 mm.

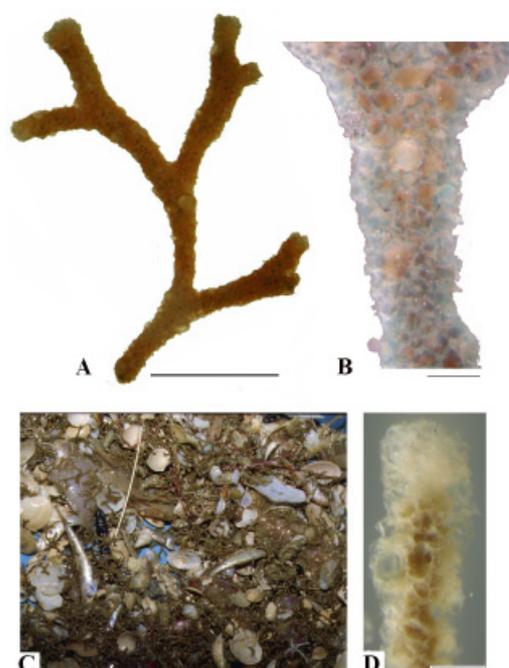
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Figure 2. *Schizammmina andamana* n.sp. A. Holotype, from BIOSHELF station J-48. B. Part of test where sediment particles have been dissolved and the cement connecting them is stained with toluidine blue. C. Small part of sledge sample J-48 as it appeared on the deck immediately following collection. D. Tip of branch where sediment particles have been dissolved. The lighter branch tip contains the active cytoplasm and the brown interior consists of stercomata. Scale bars: A = 5 mm; B & D = 500 μ m.

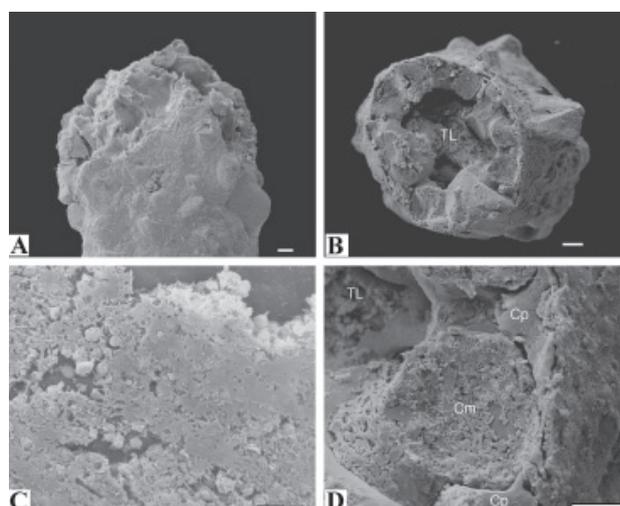


Figure 3. *Schizammmina andamana* n.sp. SEM photos. A. Side view of branch with larger mineral particles surrounded by a matrix of finer particles. The upper part is broken and a part of the cytoplasm filling the test lumen is exposed. B. Transverse view of broken branch showing the test lumen (TL). C. Cytoplasm surface that was attached to a mineral particle. Its structure is 'spongy', like a compressed network of reticulopodia. The round structures are stercomata. D. Enlargement of B showing test lumen (TL) and mineral particle covered by cement (Cm). The central cytoplasm has fallen out but extensions of the cytoplasm (Cp) project between the mineral grains and spread out just under the outer surface of the test. Scale bars: A & B = 100 μ m; C = 10 μ m; D = 50 μ m.

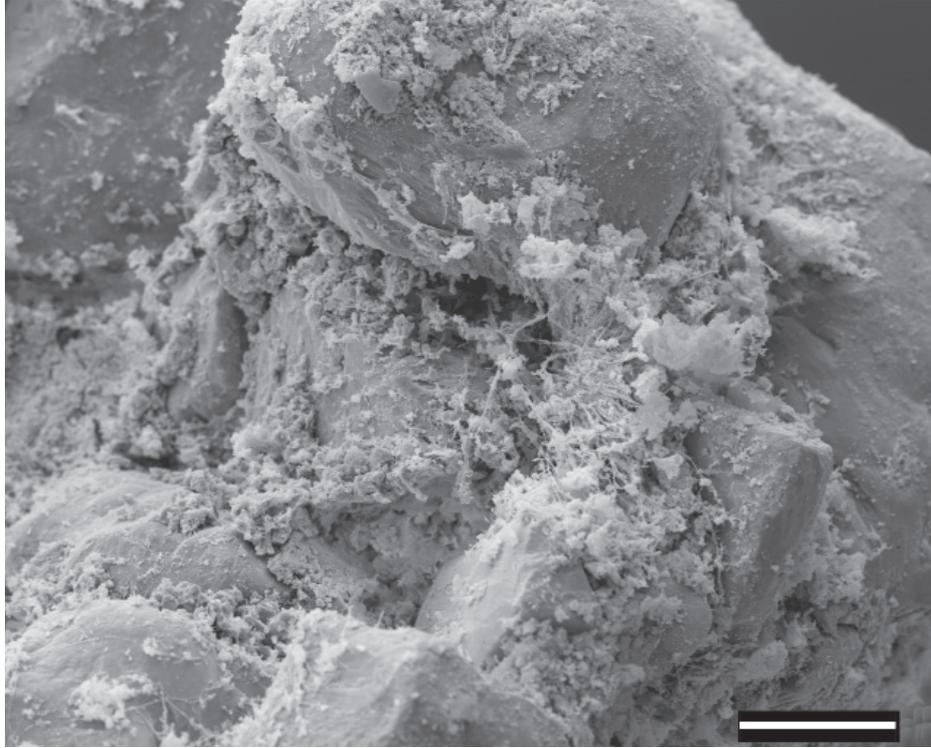


Figure 4. *Schizammina andamana* n.sp. SEM photo of granuloreticulopodia at branch tip. Masses of detritus and finer particles are gathered at the surface. Scale bar = 100 μ m.

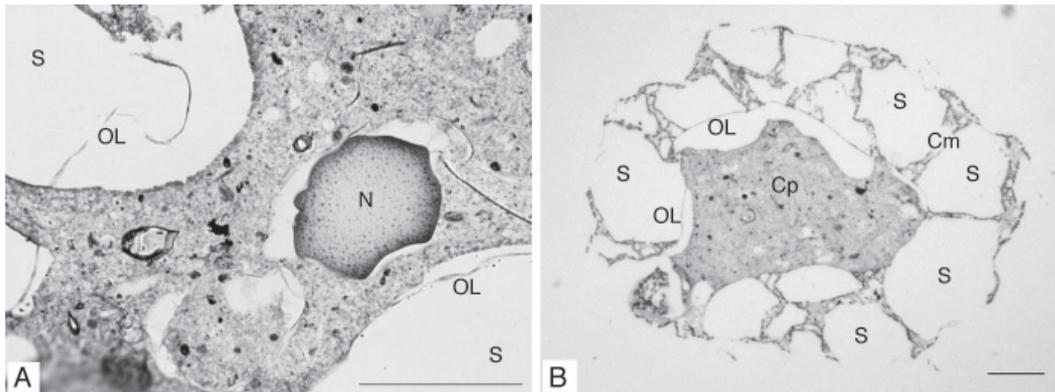


Figure 5. *Schizammina andamana* n.sp. Light microscopic images of 'soft parts'. A. N = nucleus with numerous nucleoli; S = hole after dissolved sand grain; OL = organic lining. B. Transverse section of branch showing the general organisation of the organism; S = hole after dissolved sand grains; OL = organic lining; Cm = cement with finer mineral particles; Cp = cytoplasm. Scale bars = 100 μ m.

DISCUSSION

Systematics

Schizammia andamana agrees with the diagnosis of the genus as given and discussed by Nørvang (1961). The differences to four of the other seven species of the genus, *S. arborescens* Buchanan, 1958, *S. labyrinthica* Heron-Allen & Earland 1929, *S. pinnata* (Pearcy, 1908) and *S. reticulum* Nørvang, 1961, are very obvious, being found in dimensions, branch form or branching pattern.

Distinguishing between *S. andamana* and the last three species, *S. atlantideae* Nørvang, 1961, *S. furcata* Heron-Allen & Earland, 1929 and *S. galathea* Nørvang, 1961, is more subtle since the dimensions and branch form are much the same, and the branching patterns vary in a less pronounced way. It might even be that with more geographic regions represented by samples and a better knowledge of variation, the four species may in the future be united under the name of *S. furcata*, a point of view mentioned by Nørvang (1961) in discussing relationships between *S. furcata* and *S. galathea*. For the time being these slightly morphologically different but geographic well separated populations are considered valid species.

The worst problem for the comparison of samples comes from the fragmentation caused by the mechanical handling during sampling, washing and sorting. It obscures the branching pattern, and older and younger parts are not easily distinguished. Likewise, it can make it difficult to clarify whether one or more species are represented in the catch.

The main difference compared to *S. atlantideae* is that the latter is a smaller (< 20 mm maximum length) species. The branching pattern is furthermore more zig-zag-like because some branches to both sides remain short and unbranched. The branch diameter in *S. atlantideae* is 1.0–1.2 mm. The tube wall has several layers, is about 250 µm thick, and the material is silty (20–50 µm grains), with only few finer grains in the interstices.

Likewise, *S. furcata* seems to be a smaller species (rarely > 20 mm maximum length). The branching pattern is dichotomous with a rather

long distance (ab. 10 mm) between the first two branching points and smaller but constant distances between the later ones. Branchings are few and predominantly on one of the sides, the branches often curving slightly outwards, although not to the degree seen in *S. andamana*. The branches are coarser than in *S. andamana*, the branch diameter, although varying from 0.8–1.2 mm, mostly being over 1 mm and rarely reaching 1.5 mm. The tube wall is single layered, 250–350 µm thick, and the material is sandy (250–350 µm grains), with a filling of silty particles in the interstices on the outside.

S. galathea is poorly known, the original material being scanty and fragmented. It is of a special importance because it, being found off Tranquebar, southeast India, is so far the geographically nearest species to the Andaman Sea. The branching pattern is regularly dichotomous with short distances between branching points. The branch diameter is 1.2–1.6 mm. The tube wall is single layered, 200–250 µm thick, and the material is sandy (200–250 µm grains), with the interstices between grains filled with large amounts of organic cement.

Geographic distribution

Hayward and Gordon (1984), Nørvang (1961) emphasize that the species of Schizaminidae all have regional, restricted distribution areas. The best examples, supported by numerous records, are *Jullienella foetida* found off West Africa, *Schizammia pinnata* and *J. pearcyi* known from eastern South Africa, and *J. zealandica* from off New Zealand.

In the case of *S. andamana* this restricted regional distribution is the eastern shelf of the Andaman Sea. A qualified guess is that the species occurs at mid-shelf depths in the area of seasonal upwelling. The northern limit of distribution could be in the Gulf of Martaban, influenced by freshwater and particle outflow from the Irrawaddy delta. To the south the special hydrographical conditions of the Malacca Strait (strong currents, effects of breaking internal waves, change in sediment composition and structure) might be limiting.

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