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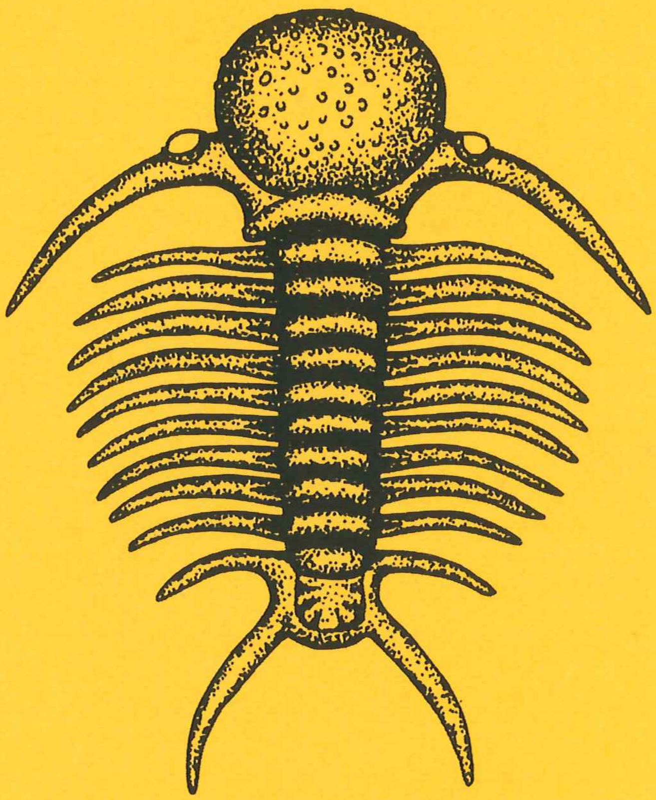

A Lower Silurian (Llandoverian) halysitid fauna from the Berge Limestone Formation, Nordön, Jämtland, central Sweden.

Peter Dahlqvist

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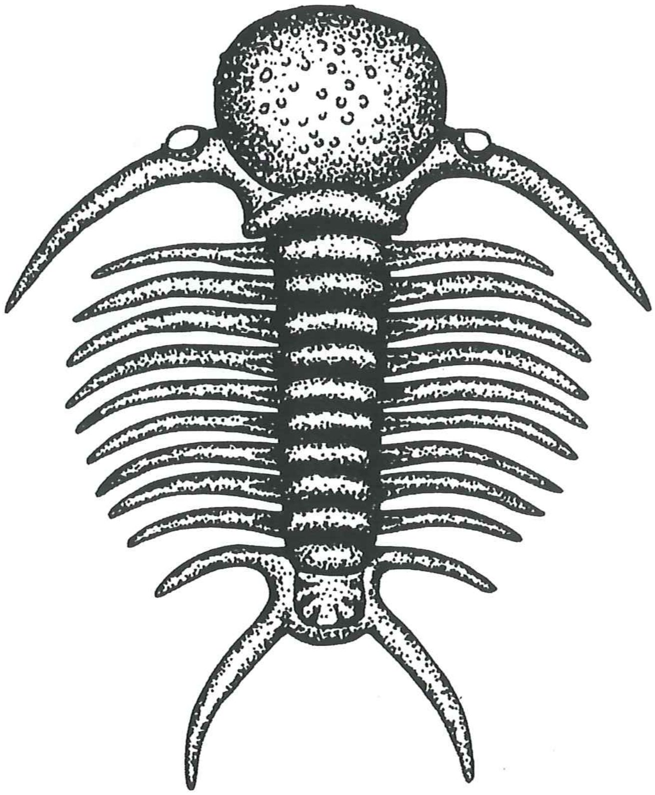

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PETER DAHLQVIST

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Abstract: Halysitid corals from the Llandoverian (Early Silurian) Berge Limestone Formation in Jämtland, central Sweden, are described. The investigation of the halysitid corals was done on material derived from the Norderön Island in Lake Storsjön, central Sweden. The Berge Limestone is rich in fossils, especially tabulate corals, and species described and discussed are *Catenipora distans* (Eichwald), *Catenipora* cf. *maxima* (Fischer-Benzon), *Catenipora* sp.1, *Catenipora* sp.2, and *Halysites* cf. *junior* (Klaamann). The fauna and lithology indicate a muddy/silty environment between fairweather wave base and storm wave base, within the photic zone. The bottom was fine-grained and firm enough for e.g. corals to attach directly to the substratum. The Berge Limestone Fm is correlated with the Rytteråker Fm in the Oslo region (Norway). Problems with taxonomic procedures concerning halysitids are briefly discussed.

Keywords: Halysitids, *Catenipora*, *Halysites*, Tabulate corals, Jämtland, Norderön, Berge Limestone Fm, Sweden, Silurian, Llandovery.

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The purpose of this paper is to present a taxonomic framework for halysitids occurring in the Berge Limestone Fm in Jämtland and to perform a paleoecologic analysis based on these corals and other fossils from the limestone. The Berge Limestone Fm (type locality at Berge in the parish of Offerdal), previously called the Pentamerus Limestone, is poorly investigated even though it is rich in fossils such as corals, brachiopods, crinoids, stromatoporoids, echinoderms, ostracods, trilobites and bryozoans.

The present investigation was carried out on specimens collected on the Norderön Island in the summer 1998. The material consists of hand specimens and a number of thin sections. The preservation is not very good for taxonomic work, some coralla being silicified and all specimens being subjected to diagenetic changes due to elevated pressure and temperature, which can be related to Caledonian tectonic events. This makes structures in the coralla, especially microstructures and e.g. septal spines, difficult to investigate.

The fieldwork on Norderön was mainly done on the west side of the island (Fig. 1). On this side there are numerous exposures along the shore. A great part of them extend below water surface, which means that some of them are hard to investigate during mean and high water levels. Most of the outcrops are only a few meters in width and approximately one meter high, but there are exceptions. In locality B there is a body of limestone (7 x 1.5 m), a reefal complex that because of the nature of the outcrop could not be designated as either a biostrome, bioherm or a mound. (Fig. 2). This is probably the reefal complex that Wiman (1893) found. The limestone is in some places developed into beds, about one meter thick. The beds are tilted differently, from almost horizontal to almost vertical. This is due to tectonic movements in the area. As the limestone is affected by tectonic movements and exposures are mostly small, it is difficult to work out a full section. Along the shore, especially at the ferry berths, a lot of corals can be found in loose material.

The Berge Limestone Fm and the geological history of the area is treated in Thorslund (1940, 1943, 1948), Thorslund & Jaanusson (1960), Gee & Kumpulainen (1980), Bassett et al. (1982), Gayer & Greiling (1989), Cherns & Karis (1995) and Karis & Strömberg (1998). Lindström (1872) and Wiman (1893) are the only authors who described fossils from the Berge Limestone Fm.

Halysitid corals belong to the subclass Tabulata and have a stratigraphic range from Middle Ordovician to Late Silurian. They are widely distributed, occurring on most continents, and in a wide variety of lithologies, most commonly in carbonate facies. Halysitid corals have corallites (Fig. 4), mostly oval in shape, united laterally into a chain-like anastomosing network, building up a cateniform colony (Hill 1981). The family Halysitidae is divided into two subfamilies, Cateniporinae and Halysitinae, the latter having a coenechymal tubule between corallites. This feature is missing in corals belonging to the subfamily Cateniporinae (Hill 1981). Hill (1981) considered the halysitids to belong to the Order Heliolitida, while Young & Elias (1995) considered the Halysitida to be a separate order, not a suborder of the Heliolitida.

Colony formation has not been studied much; Buehler (1955), Hamada (1959) and Lee & Noble (1990) are a few exceptions.

Previous investigations on tabulates from northern Europe are sparse. Klaamann (e.g. 1962) and some other works treat the subject, but these are in Russian and hard to find. Aarhus (1978, 1982) studied tabulates from Ringerike, Oslo region, Norway. Stasinska (1967) reported thirty species of halysitids from Norway, Sweden and from erratic boulders in Poland, eighteen of them being described as new species.

Stasinska (1967) did not figure, or define her measured characteristics. On a visit to the Swedish Museum of Natural History in Stockholm, I had the opportunity to see and measure some of Stasinska´s material. My measurements show little agreement to Stasinska´s descriptions. A similar result based on studies of Stasinska´s material was obtained by Mari-Ann Motus, Tallin, (personal communication, 1999), when she was in Bergen and Oslo, studying halysitid material. My opinion is that Stasinska measured her halysitids in a different way than I have done, probably in the same way as Aarhus (1978) did. Both measured the length of corallites between the midpoints of intercorallite walls on sides of the tabularium. Their width measurements include walls on both sides of the tabularium, i.e. not internal measurements either in length or width, like in this study.

Aarhus (1978) merged some of Stasinska´s species together. In general, the species from the Baltic region have been split up far too much, and all of them should be assessed as objectively as possible (Graham Young, Manitoba, personal communication 1998).

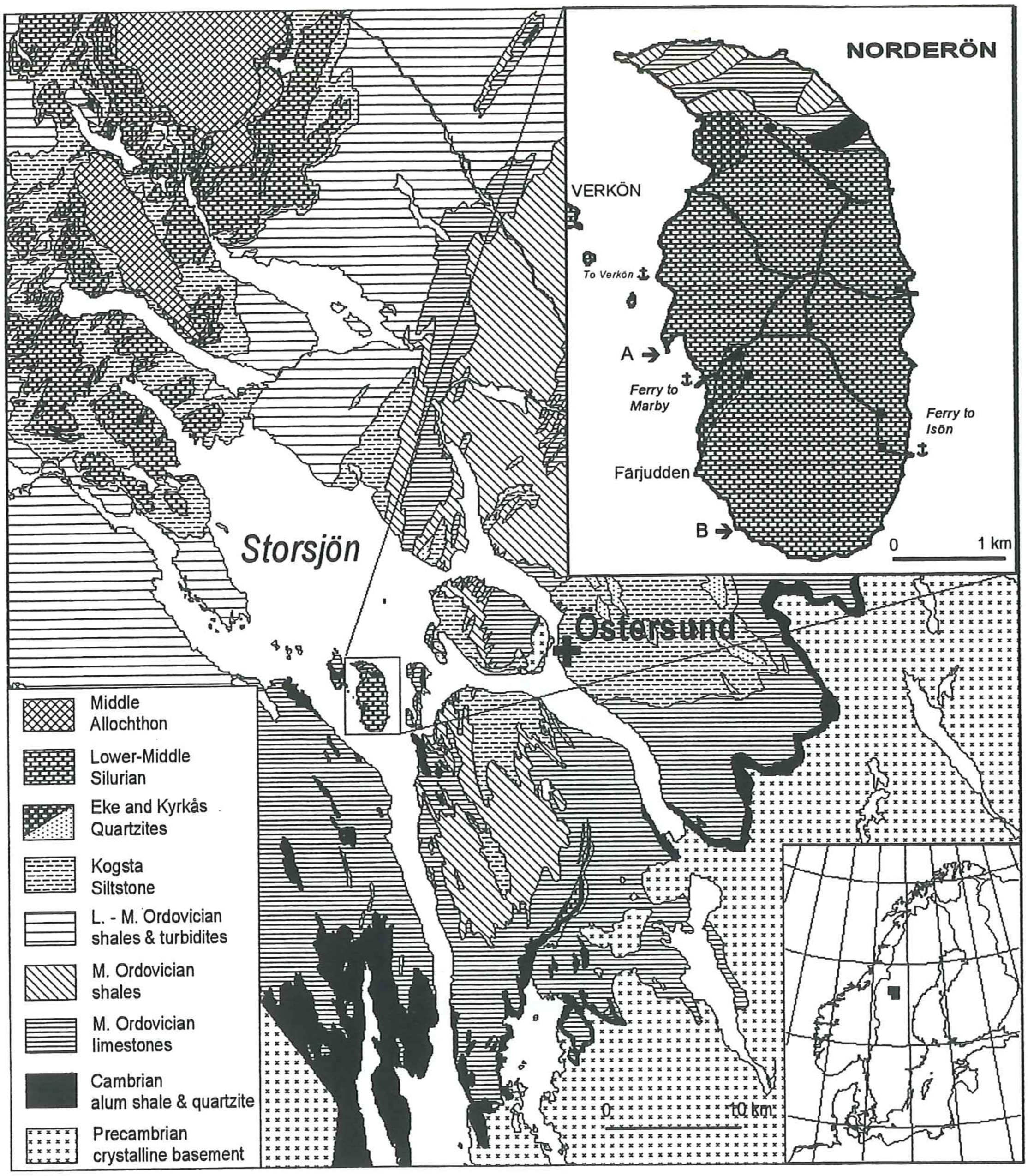

Fig.1. Geological map of the Storsjön area, central Jämtland, including the Norderön Island, with localities referred to in the text.

Geological setting

The Berge Limestone Fm is exposed in numerous places in the area around Lake Storsjön, and e.g. on the island of Norderön. (Fig. 1). According to Gayer & Greiling (1989) late Precambrian and Cambrian strata in the area were deposited in a passive margin basin, while Ordovician and Silurian strata were deposited in a foreland basin, developed from the passive margin basin, due to initial extension of the Balto-Scandian margin.

The Berge Limestone Fm, with a maximum thickness of about 75 meters (Thorslund & Jaanusson 1960), belongs to the Änge Group (Fig. 3), the uppermost group in the Jämtland Supergroup, which forms the main part of the Lower Allochton (Gee & Kumpulainen 1980). The Änge Group is initially transgressive (Cherns & Karis 1995), following the transgression initiated during the Late Ordovician. The sequence starts with the Ede Quartzite Fm, a nearshore deposited quartzite, which passes gradationally into the Berge Limestone Fm, and over this follows the Bångåsen Shale Fm, with graptolitic mudstone. The Ekeberg Greywacke Fm, a fining upward sequence towards more distal deposits, which were deposited by storm events, succeeds this shale. The Ekeberg Greywacke Fm turbidite facies indicates an unstable environment. Due to tectonic influence, the basin was filled rapidly and that resulted in the initial stage of a regressive sequence, when the arenaceous Röde Fm, was deposited in a fluvial environment (Bassett et al. 1982).

The Berge Limestone Fm has been referred to the Middle and lowermost Upper Llandovery, based on the occurrence of graptolites in the superimposed Bångåsen Shale Fm (Thorslund & Jaanusson 1960), and on the brachiopod fauna found in the underlying Ede Quartzite Fm (Boucot &

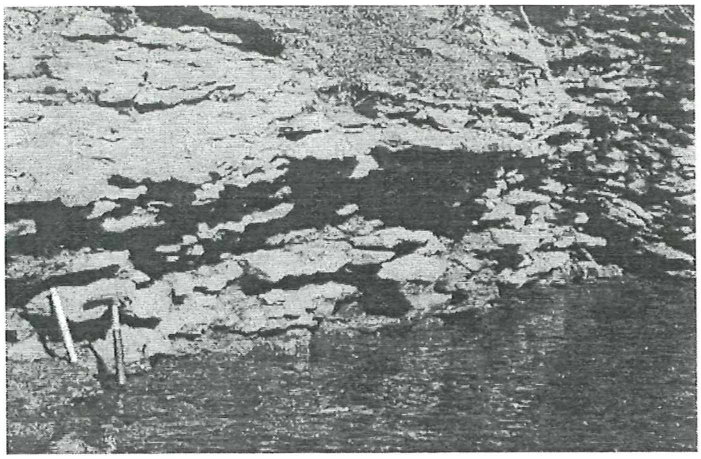

Fig. 2. The reefal complex in locality B

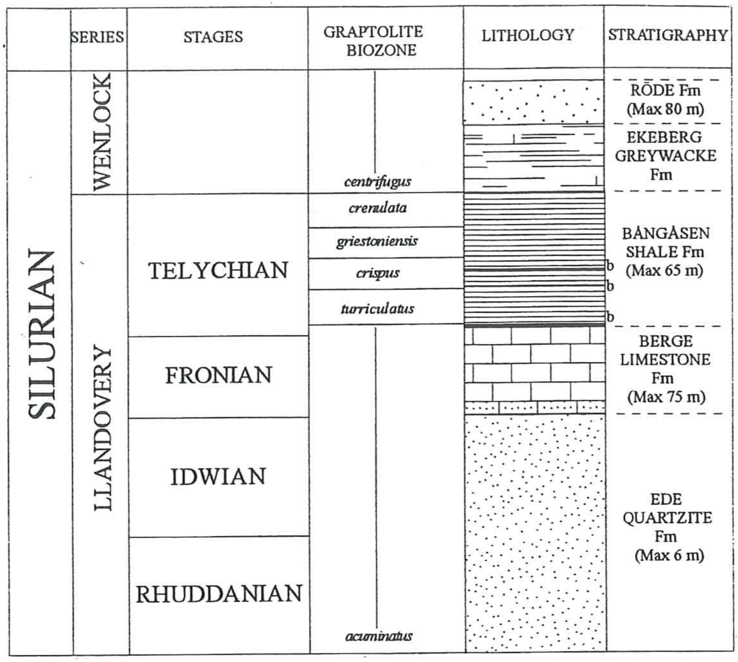

Fig. 3. Stratigraphy based on Thorslund & Jaanusson (1960), Gee & Kumpulainen (1980) and Bassett et al. (1982). The lithology column represents the western part of the central Storsjön area, and the Offerdal area.

Johnson 1964). In a recent paper by Karis & Strömberg (1998), the unit is considered to embrace the two lowermost stages of Llandovery.

The Bångåsen Shale contains several horizons of volcanic ashes, bentonites, and according to Thorslund & Jaanusson (1960) the thickest of them occurs at the base of the shale on a rough surface of the Berge Limestone Fm, and is about 0.5 m thick. This bentonite is probably the source for the silica causing silicifaction at some levels in the Berge Limestone Fm.

Lithology and fauna of the Berge Limestone

The Berge Limestone Fm is at its base an arenaceous limestone which shows a gradual transition from the underlying Ede Quartzite. The Berge Limestone Fm is mostly a dark, stratified, fine-grained limestone, with numerous fissures filled with calcite. Some levels are silicified. The dark grey-black colour is possibly due to thermal heating of the limestone. Carbonate content analyses (nine samples) of the Berge Limestone give values ranging between 70-80 %, hence, all investigated lithologies are by definition limestones. The organic content is low, below 0.5 %. Study of thin sections shows a lithology, which can be referred to as a mud/wackestone, but packestones do occur as well. Fragments of crinoids are very common, but also fragments of trilobites and brachiopods can be distinguished. The limestone is strongly affected by diagenetic processes. Some thin sections show dolomitization of the matrix and parts of the corals, and nearly all structures of the latter in thin sections are gone.

The Berge Limestone is rich in fossils, especially corals, brachiopods and crinoids. Some trace fossils, appearing as horizontal burrows have also been observed. No systematic treatment of the Berge Limestone fauna has, so far, been performed.

Age and correlation

The Berge Limestone Fm was previously called the Pentamerus Limestone (Thorslund & Jaanusson 1960). Nestor (1972) correlated pentamerid beds from Estonia, Wales, the Oslo Region (Norway) and Jämtland (Sweden). The name Pentamerus Limestone was formerly also used for the Rytteråker Fm in the Oslo region (Howe 1982). The Rytteråker Fm contains the brachiopod *Pentamerus oblongus*, which is also common in the Berge Limestone. Below the Rytteråker Fm lies the Solvik Fm or the Sælbonn Fm (geographical difference), with a brachiopod fauna (Worsley 1982), which is very similar to the brachiopod fauna reported from the Ede Quartzite Fm (Boucot & Johnson 1964) that is underlying the Berge Limestone Fm. Referring to the discussion by Holland & Bassett (1989) on the definition of the Ordovician - Silurian boundary, Karis & Strömberg (1998) suggested this Norderö fauna by Boucot & Johnson (1964) be referred to the uppermost Ordovician.

Additional evidence for a correlation between the Rytteråker Fm and the Berge Limestone Fm comes from the superimposed shales and their fauna. The Ek Formation, above the Rytteråker Fm, contains graptolites of the

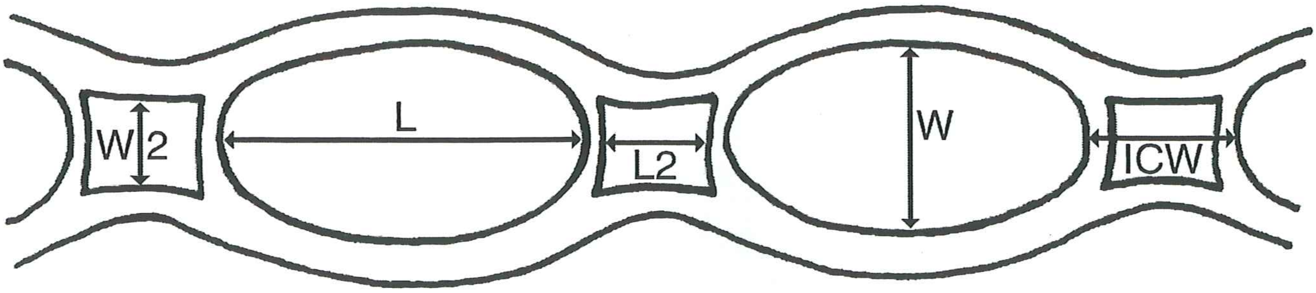

Fig. 4. Schematic drawing, showing horizontal surface of corallites, and measurements. L = Tabularium diameter, length. W = Tabularium diameter, width. ICV = Length of intercorallite wall. L2 = Tubule diameter, length. W2 = Tubule diameter, width.

turriculatus, *crispus*, *griestoniensis* and *crenulata* Biozones according to Howe (1982). A similar fauna is described from the Bångåsen Shale Fm that rests on the Berge Limestone Fm (Gee & Kumpulainen 1980 p. 39). The similarities between the northern parts of the Oslo region and Jämtland suggests that sediments from the two areas were deposited in a continuous trough that was situated parallel to the developing Caledonides (Howe 1982).

The fauna in the Rytteråker Fm is typical of Benthic Assemblage 3 of Boucot (1975) (Worsley et al. 1982), and, due to similarities of organisms found in this investigation, and fossils from the Rytteråker Fm, it seems that the fauna in the Berge Limestone Fm also belongs to the same benthic assemblage.

Methods

There are a lot of problems concerning taxonomic procedures when halysitids are treated. There are no established ways to measure the species related characteristic features. Another problem is that there are no agreements, which features should be considered as diagnostic for the various species. These problems are discussed by e.g. Buehler (1955), Hamada (1957), and Aarhus (1978). Since different authors have different ways to measure and establish species, the taxonomic procedures on species level are difficult.

Characteristic features examined herein are based on some of Young & Elias (1995) measurements (Fig. 4). Measurements include tabularium diameter, wall thickness, intercorallite wall thickness, distance between tabulae, tabulae/5 mm in corallites and tubules, number of corallites and lacunae per unit area, and when present, coenechymal tubule diameter. Ranges of corallum means were calculated. Tabularium diameter and tubule diameter are measured at the centre of the corallites, both along the rank L, and across the rank W, because the corallites are mostly elliptical or ovate. It is their internal diameter, from wall to wall that is given. Wall thickness of corallites was measured at the centre of the sides of corallites. Intercorallite walls were measured along the rank. Measurements were made in microscope with a measuring ocular on polished specimens and thin sections.

Variation in some characteristics do occur in a colony, but Young & Noble (1987) found that any random transverse section of a halysitid will yield statistics representative of the colony.

Silicification and dolomitization were investigated by dipping parts of specimens in mixtures staining them. To identify silica, slabs were dipped in a mixture of 1.0 g methylene blue, 150 g concentrated HCl, 1000 g water, the mixture giving silica a dark blue colour and not staining other parts. Dolomite is identified by a light-dark blue colour when the limestone slabs are dipped in a mixture of 0.2 % hydrochloride acid, 0.2 % alizarin red and 0.2 % potassium ferricyanide.

Due to poor preservation, recrystallization and the problem of cutting corallites at right angles, measurements can not be exact. For these reasons measurements are rounded to the nearest half-mm.

Coral growth

Corals occurring in the Berge Limestone Fm on the Norderön Island are halysitids, favositids, syringoporids, aulaporids and rugose corals, the favositids being the predominant corals. Mostly one kind of tabulate coral dominates a surface; if there are lots of favositids the halysitids are sparse, and vice versa. The heliolitids are not very common, but when found, they always seem to have been attached to a stromatoporoid. Nearly all corals grew isolated, often with a round, domical form and appear scattered on the rock. On the studied surfaces, corals seem to have been buried in life position. Even in beds deposited by storms, corals are mostly complete, indicating a high resistance of the halysitid colony.

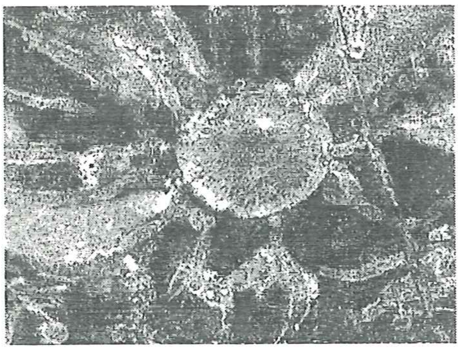

Fig. 5. Initial stage of *Catenipora* sp. 2 on a rugose coral (x 3).

Fig. 6. *Catenipora distans* attached and growing directly to the substratum, possibly a firmground (x 1.7).

Due to silicification and dolomitization at some levels, corals are more resistant to dissolution and show a positive relief, up to a few centimetres from the surface of the outcrop. The corals seem to have been attached directly to the substratum in some cases. The mudstone/wackestone lithology indicates high sediment cohesion, i.e. a stable substrate for colonisation. Corals might have been attached to stromatoporoids, shells or other hard objects, but the corals are quite complete, so only a short *post-mortem* transport could have occurred. One slab studied shows an initial stage of a halysitid (*Catenipora.* sp. 2) attached and growing on a solitary rugose coral (Fig. 5). There are other examples of *in situ* growth, e.g. a halysitid (*Catenipora distans*) with its attachments directly to the substratum, possibly a firmground (Fig. 6).

The reefal complex in locality B is almost entirely built up by corals. The halysitids are the predominant corals and make up at least 80 % of the body, the remaining corals being favositids and rugose corals. The vertical range of the exposure was not possible to determine, due to high water stand, and the nature of the outcrop. In front of the body there occurs a lot of loose material, large boulders, up to one and a half metre, all of them full with halysitids. At this locality specimens of two different halysitids are found, one with large corallites and lacunae (*C. distans*) and another with small corallites and lacunae (*Catenipora.* sp. 2). These are found together, growing on, and beside each other. On one slab (Fig. 7) one can see how sediment influx fills corallites of *C. distans* and killing these parts of the colony, while corallites of *Catenipora.* sp. 2 do not seem to have been affected at all.

In some corallites of *Catenipora* cf. *maxima* there is a vertical change in distance between tabulae in adjacent corallites. At one level the distance between tabulae decreases, and this could be an evidence of environmental change, towards a less favourable environment for the halysitid (Lee & Elias 1991; Buehler 1955, p. 8) (Fig. 8).

Little research on halysitid mode of growth has been done. Lee & Elias (1991) studied *Catenipora rubra*, and their conclusion was that colonies of *C. rubra* lived and grew with their calices just above the substrate, with the lacunae almost entirely filled with sediment. The colony attached to a stable substratum, due to the sediment filled lacunae, had a better wave and storm resistance, and could live in a higher energy environment. Storms could cover parts of the colony with sediment but rapid regeneration of individuals colonised damaged parts of the colony (Lee & Elias 1991). It is likely that other species in the Halysitidae also grew in this way (Graham Young, Manitoba, personal communication 1999). Manten (1971) also suggested that lacunae filled with e.g. marl could serve as storage, giving halysitid colonies possibility to live in very turbid water.

Depositional environments

As mentioned above, the halysitid network was not only adapted to low energy environments, but also resistant enough to environments with a higher energy. Therefore it is difficult to reconstruct the environmental conditions utilising only the occurrence of corals.

In some rocks from the Berge Limestone Fm there are assemblages of pentamerids with shells piled valve-in-valve, sorted by size, and with their concave surface upward. According to Johnson (1989), who recorded similar beds in Norway, this represents an assemblage of shells *in situ* and shells transported and affected by storm events. This indicates that the Berge Limestone was deposited in marine waters between fairweather wave base and storm wave base. The predominant mud/wackestone lithology indicates hemipelagic sedimentation. The large amount of crinoid debris in the limestone indicates close relationship with crinoid meadows. This indicates a low energy environment, with occasional storms.

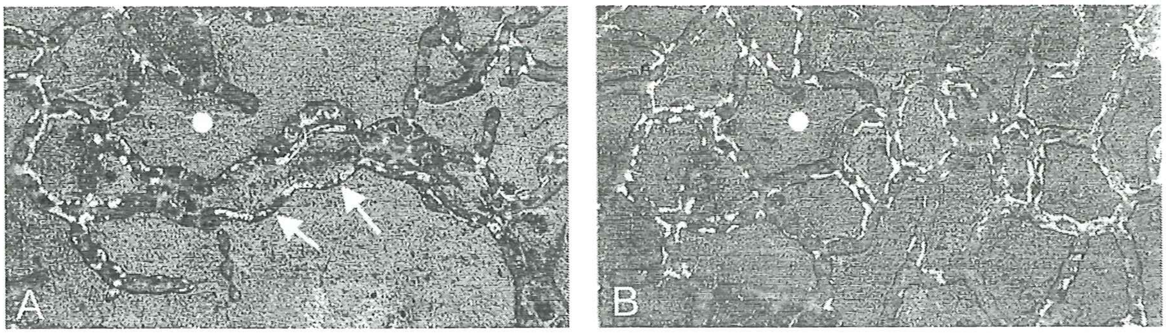

Fig. 7. (x 3) A. *Catenipora* sp. 2 (small corallites) and *Catenipora distans* (large corallites) of halysitids growing together. The sediment filled corallites (white arrows) of *C. distans*, show mortality, while the other species shows no traces of mortality. B. On the other side of the serial section (2 mm thick) there is no trace of *C. distans* but *Catenipora.* sp. 2 has grown over the area and was not affected by the sediment influx. White dots show same lacunae on different sides of the slab.

Conclusions

A study of the halysitid fauna in the Berge Limestone Fm at Norderön island resulted in the distinction of five different species: *Catenipora distans* (Eichwald), *Catenipora* cf. *maxima* (Fischer-Benzon), *Catenipora* sp. 1, *Catenipora* sp. 2, and *Halysites* cf. *junior* (Klaamann). Specimens of *C.* cf *maxima* and *C. distans* are also found in the Rytteråker Fm (Norway). The occurrence of these species and similar lithological properties suggest that this unit can be correlated with the Berge Limestone Fm.

The environment seems to have been between fairweather wave base and storm wave base, but within the photic zone. Fauna and lithology indicate an offshore muddy/silty environment, with normally hemipelagic sedimentation and with frequent storm deposits.

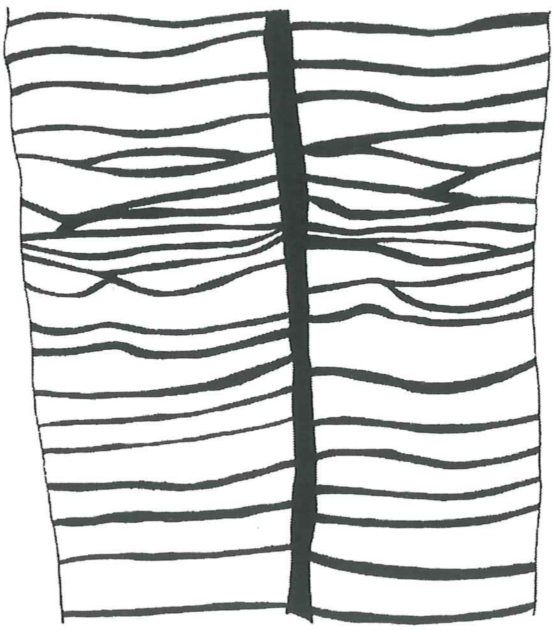

Fig. 8. Vertical surface of corallites in *C.* cf. *maxima*, showing difference in distance between tabulae, possibly due to environmental changes. Incomplete tabulae closer to each other, represent the influence of some environmental factor (Buehler 1955), (x 7.7).

The halysitid fauna of the Berge Limestone Fm is still poorly known. To get a clear picture of the fauna and environment, further investigations have to be done. A large-scale investigation of the Berge Limestone Fm, with sampling and logging is needed.

There are still numerous problems in the taxonomy of halysitids. There are e.g. no established methods to measure characteristic features and there is no agreement on which features should be considered important at species level. A standard for taxonomic procedures concerning the halysitids and a revision of some previous material and works has to be performed to clear up remaining problems.

Systematic Palaeontology

The suprageneric classification and terminology follows Hill (1981).

The material is deposited in the Department of Geology, Lund, Sweden.

Systematic position.- Phylum COELENTERATA Frey &Leuckart, 1847; Class ANTHOZOA Ehrenberg, 1834; Subclass TABULATA Milne-Edwards & Haime, 1850; Order HELIOLITIDA Frech, 1897; Suborder HALYSITINA Sokolov, 1947; Family HALYSITIDAE Milne-Edwards & Haime, 1849; Subfamily CATENIPORINAE Hamada, 1957

Genus CATENIPORA Lamarck, 1816

Catenipora distans (Eichwald, 1829)

Fig. 9.

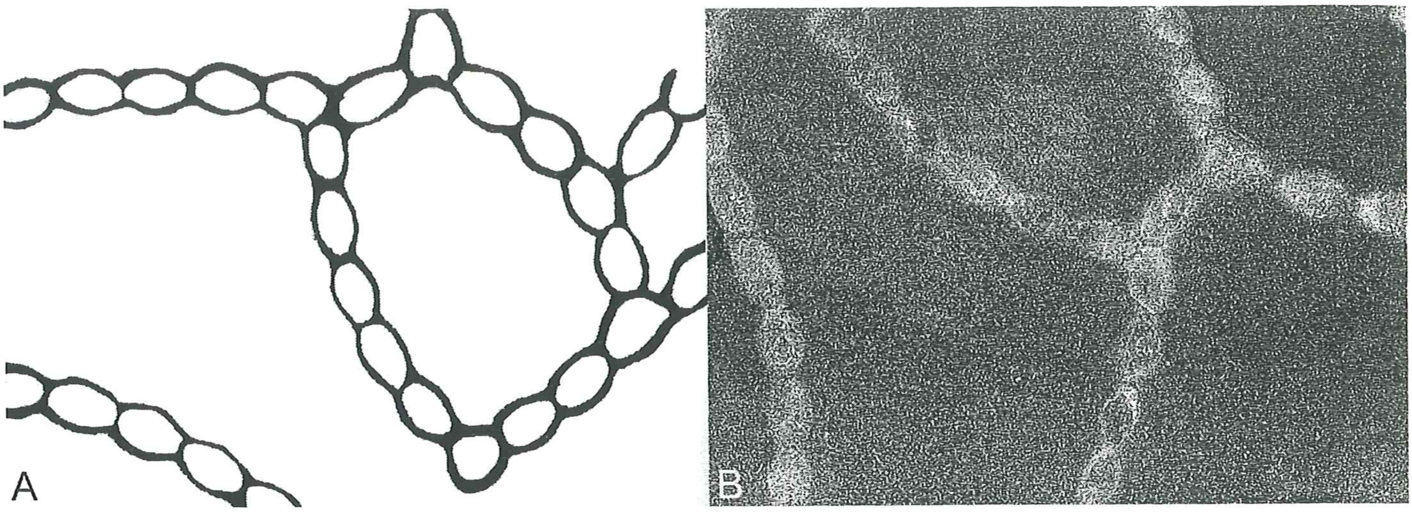

Fig. 9. *Catenipora distans* (Eichwald). A. Transverse section, drawing, (x 3.2). B. Transverse section, polished surface, (x 3.2).

1829 *Catenipora distans* Eichwald, p. 192, pl. 2, fig. 10.

1858 *Catenipora distans* (Eichwald, 1829). Schmidt, p. 229.

1860 *Halysites catenularia* Eichwald, p. 505-506.

1871 *Halysites cavernosa* var. *reticulata* Fischer-Benzon, p. 16-17, pl. 1, Fig. 7.

1955 *Halysites distans* (Eichwald, 1829). Buehler, p. 33.

1966 *Catenipora distans* (Eichwald, 1829). Klaamann, p. 57, pl. 17, Fig. 1-3.

1967 *Catenipora ringerikensis* Stasinska, p. 54-55, pl. 4, Fig. 4a-b.

1978 *Catenipora distans* (Eichwald, 1829). Aarhus, p. 105-106, Fig. 58.

Material. - Fragments of five colonies, some large, some *in situ*. Norderön Island, Locality B, (the reefal complex).

Measurements. – See Table 1.

Description. - The corallites are elliptical, with an average tabularium diameter of about 2.85 x 1.85 mm. Lacunae long, elongated, surrounded with 6-30 corallites, possibly more, as some large lacunae are not seen fully. Ranks consisting of 1-14 corallites, average length 7 corallites. Septa absent. Wall thickness is about 0.20 mm, intercorallite walls are thicker, with an average of 0.25 mm. Tabulae are mostly complete, horizontal or concave in shape, with an average about 9.8 in 5 mm. The distances between tabulae are 0.30-1.20 mm.

Remarks. - The holotype of *Catenipora ringerikensis* (Stasinska 1967) was transferred to *Catenipora distans* (Eichwald) by Aarhus (1978).

Occurrence. – *Catenipora distans* is, besides in the Berge Limestone at the Norderön Island, also found in the Lower Visby Marl and lower part of Upper Visby Marl, Gotland, Sweden; Adavare H, Estonia. In the Oslo region (Norway) the species is found in the Rytteråker Fm. For further Norwegian localities see Aarhus (1978).

Catenipora cf. *maxima* (Fischer-Benzon, 1871)

Fig. 10.

Material. - Fragments from one colony, Norderön Island, locality A.

Measurements. – See Table 2.

Description. - Very large corallites, with an average tabularium diameter of about 3.3 x 1.9 mm. The shape is oval in transverse section. Lacunae are polygonal to oval with 8 to 16 corallites around, ranks composed of 2 to 8 corallites, mostly 4 corallites. Corallite walls are thin; about 0.2 mm, intercorallite walls are slightly thicker. Tabulae are mostly complete, horizontal or slightly concave, spacing eight to sixteen in 5 mm. Septa are absent. New ranks arise from midpoints of the corallites, giving the corallites at corners of lacunae a triangular shape.

Table 1. Tabularium diameter, wall thickness, thickness of intercorallite walls, Dbt: distance between tabulae in corallites (mm), tabulae per five mm incorallites, corallites and lacunae per unit area in *Catenipora distans* (Eichwald) from the Norderön Island.

Characteristic	Mean	Maximum	Minimum	Range of colonial means	Number of coralla studied	Number of corallites measured or counted
Tabularium diameter L.	2.85	3.50	2.25	2.70-2.90	5	119
Tabularium diameter W	1.85	2.50	1.50	1.75-2.00	5	119
Wall thickness	0.20	0.25	0.15	0.15-0.25	5	105
Intercorallite wall thickness	0.25	0.25	0.25	0.25-0.25	5	35
Dbt in corallites	0.50	1.20	0.30	0.4-0.6	5	4
Tabulae/ 5 mm in corallites	9.8	13	8	8.75-11.7	5	4
Corallites/cm2	4.5			4.0-5.2	5	354
Lacunae/ 4 cm2	3.7			3.0-4.5	5	

Remarks. - The specimen differs from the original description by Fischer-Benzon (1871) by having larger lacunae surrounded by more corallites. The large corallites and the triangular shape of corallites at junctions suggest that the specimen from Norderön could possibly belong to *C. maxima*. In vertical section, distance between tabulae follow each other in corallites next to another (Fig. 8). In a few mm the distance between tabulae is only 0.2 mm apart, but above and below this interval the tabulae are 0.4-0.6 mm apart. This could indicate an environmental change (Buehler 1955, p 8; Lee & Elias 1991).

Occurrence. – *Catenipora* cf. *maxima* was found in the Berge Limestone Fm at locality A, western Norderön. *Catenipora maxima* is known from the Upper Visby Marl at Gotland, Sweden; Poland in erratic boulders; Norway: Ringerike, Tyrifjord, Stage 7b; Estonia: Jaani Stage.

Catenipora sp. 1

Fig. 11.

Material. - One nearly complete colony, collected from loose boulders at the Norderön Island, close to the ferry berth to the Verkön Island.

Measurements. – See Table 3.

Description. - Colony large, domical, about 20 centimetres in diameter, and about 3 cm high. Lacunae elongated, irregularly shaped. The length of the lacunae varies between 6 - 48 mm, mostly about 20 mm; the width is about 6 mm. Ranks composed of 1-14 corallites, average length 6 corallites, surrounding lacunae with 6-35 corallites. Corallites oval, longer diameters average 2.10 mm, shorter 1.35 mm. Walls approximately 0.20 mm, walls between

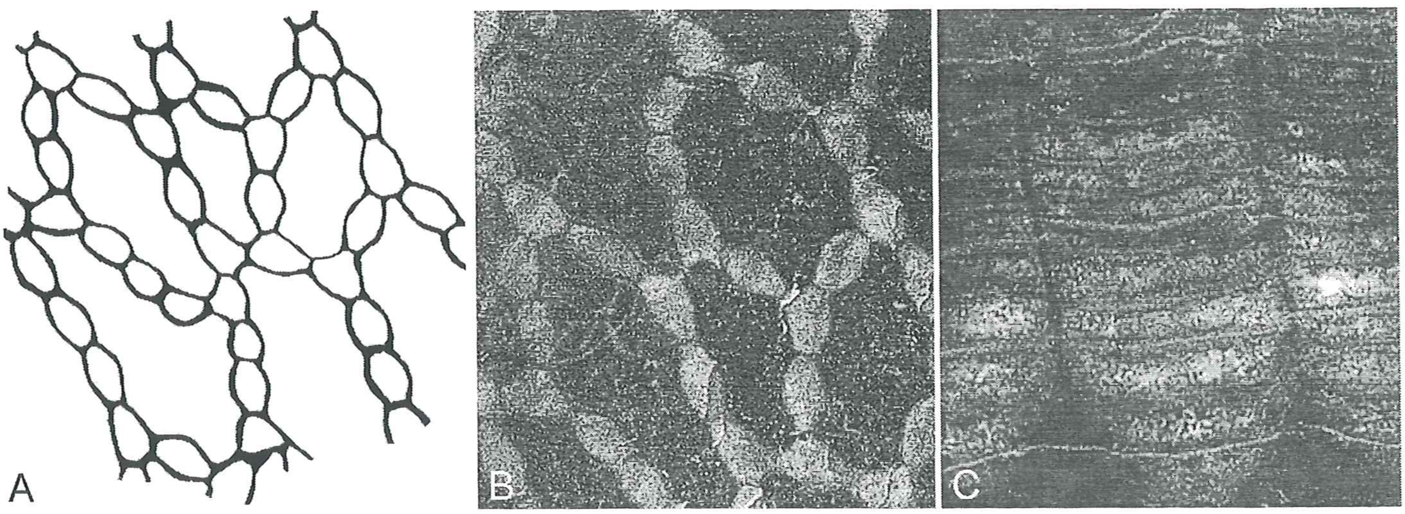

Fig. 10. *Catenipora* cf. *maxima* (Fischer-Benzon). A. Transverse section, drawing, (x 2). B.Ttransverse section, polished surface, (x 2.7). C. Vertical section, polished surface, (x 10).

Table 2. Tabularium diameter, wall thickness, thickness of intercorallite walls, Dbt: distance between tabulae in corallites (mm), tabulae per five mm in corallites, corallites and lacunae per unit area in *Catenipora* cf. *maxima* (Fischer-Benzon) from the Norderön Island.

Characteristic	Mean	Maximum	Minimum	Number of corallites measured or counted
Tabularium diameter L.	3.30	3.75	2.70	18
Tabularium diameter W	1.90	2.15	1.65	18
Wall thickness	0.15	0.25	0.10	18
Intercorallite wall thickness	0.25	0.35	0.15	8
Dbt in corallites	0.30	0.60	0.15	26
Tabulae/ 5 mm in corallites	9.7	16	8	10
Corallites/cm2	5			80
Lacunae/ 4 cm2	4.25			

corallites a bit thicker, about 0.30 mm. Tabulae mostly complete, horizontal to slightly concave, spacing about 10 in five mm, tabulae 0.35-0.70 mm apart. Septal spines present, short, maximum 0.25 mm long, and needle like.

Remarks. - Possibly this is a new species as no described species have been found with features matching this specimen.

Occurrence. – The specimen of *Catenipora* sp. 1 was found in loose boulders, Norderön Island.

Catenipora sp. 2

Fig. 12.

Material. - Fragments of two colonies, one from a loose boulder, and one from locality B (the reefal complex) Norderön Island.

Measurements. – See Table 4.

Description.- Corallites are small and oval, tabularium diameter averaging 0.9 x 0.5 mm. Septal spines common, well developed with quite broad bases. The thickness of the walls are 0.15 mm, intercorallite walls are a bit thicker. Distance between tabulae are 0.15-0.45 mm, tabulae spacing 16-20 in 5 mm. Lacunae are irregularly polygonal to elongated, surrounded by 4-13 corallites, 1-7 corallites in ranks average length 3 corallites.

Remarks. – No described species have been found that matched these specimens.

Occurrence. – Berge Limestone Fm, Norderön Island.

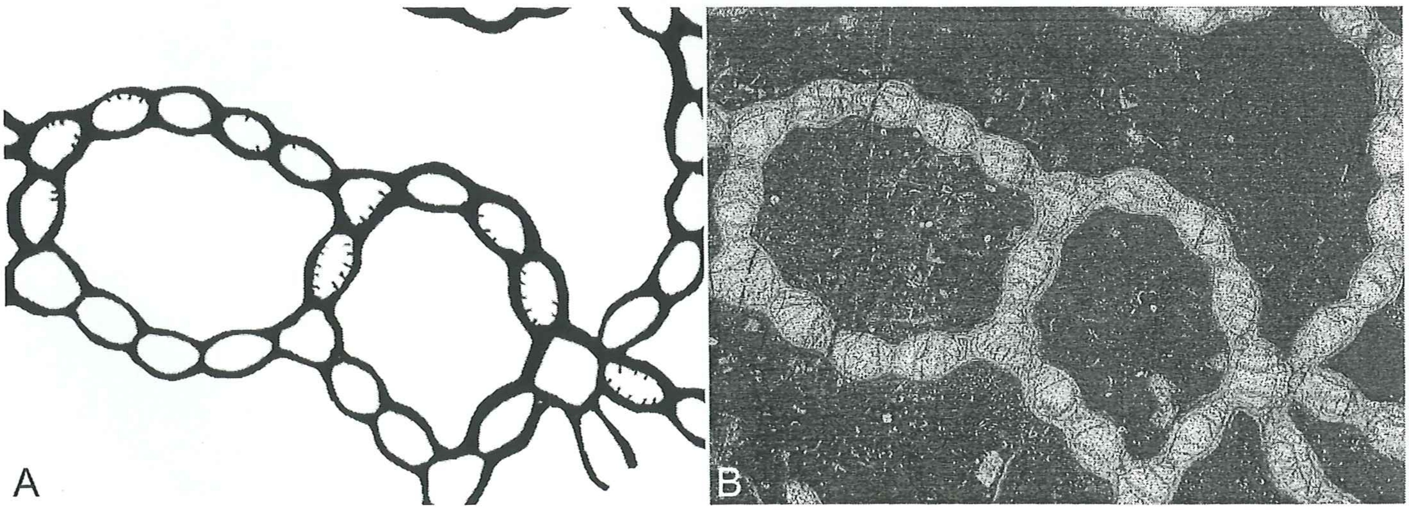

Fig. 11. *Catenipora* sp. 1. A. Transverse section, drawing, (x 3.6). B. Transverse section, thin section, (x 3.6).

Table 3. Tabularium diameter, wall thickness, thickness of intercorallite walls, Dbt: distance bteween tabulae in corallites (mm), tabulae per five mm in corallites, corallites and lacunae per unit area in *Catenipora* sp. 1 from the Norderön Island.

Characteristic	Mean	Maximum	Minimum	Number of corallites measured or counted
Tabularium diameter L.	2.10	2.35	1.90	26
Tabularium diameter W	1.35	1.50	1.25	26
Wall thickness	0.20	0.25	0.15	26
Intercorallite wall thickness	0.30	0.40	0.25	15
Dbt in corallites	0.45	0.70	0.35	14
Tabulae/ 5 mm in corallites	9	10	8	2
Corallites/cm2	6.75			108
Lacunae/ 4 cm2	5			

Subfamily HALYSITINAE Milne-Edwards & Haaime, 1849

Genus HALYSITES Fischer von Waldheim, 1828

Halysites cf. *junior* (Klaamann)

Fig. 13.

Material. - Fragments of one colony, from a loose boulder, not *in situ*, overturned and fragmentary. Norderön Island.

Meas urements. – See Table 5.

Description. - Corallites are oval to rounded, with a tabularium diameter averaging 2.1 x 1.4 mm. Corallite walls are thick, approximately 0.3 mm. Lacunae polygonal to elongated, surrounded with eight to sixteen corallites; ranks curved, consisting of one to six corallites. Tabulae in corallites are flat and mostly complete, in most cases 0.6 mm apart, spacing seven in 5 mm. Coenechymal tubules are quadratic to rectangular, 0.3-0.8 x 0.4-0.7 mm. Tabulae in tubules are flat or concave, complete, and spaced 0.2-0.4 mm apart, with an average of fourteen in 5 mm.

Remarks. - The specimen is poorly preserved, but is similar to *H. junior* Klaamann. Klaamann´s original description has not been found, but two thin sections of *H. junior* from Stasinska´s (1967) original material in the Natural History Museum in Stockholm have been studied. The measurements by Stasinska (1967) are, as mentioned above, made in another way. Characteristics found by me in Stasinska´s two thin sections are similar to characteristics of my specimen, except for the coenechymal tubules, which are more rectangular in the specimen described herein.

Occurrence. – Loose boulder, Norderön Island.

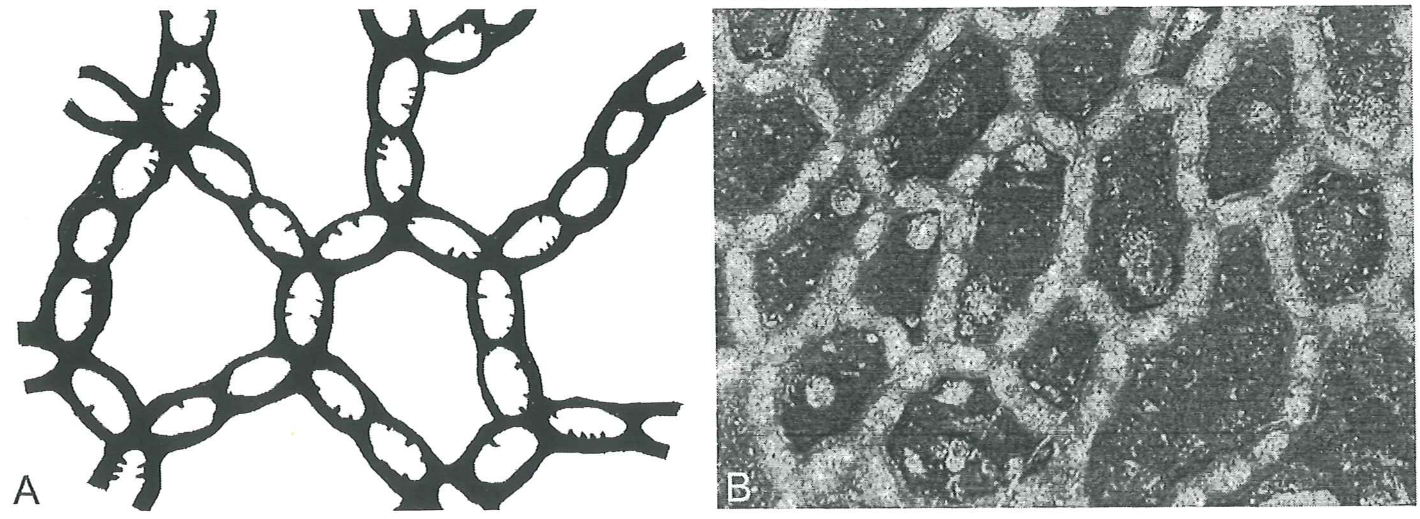

Fig. 12. *Catenipora* sp. 2. *A*. Transverse section, drawing, (x 8.6). B. Transverse section, polished surface, (x 7.1).

Table 4. Tabularium diameter, wall thickness, thickness of intercorallite walls, Dbt: distance between tabulae in corallites (mm), tabulae per five mm in corallites, corallites and lacunae per unit area in *Catenipora* sp. 2. from the Norderön Island.

Characteristic	Mean	Maximum	Minimum	Range of colonial means	Number of coralla studied	Number of corallites measured or counted
Tabularium diameter L.	0.90	0.95	0.8	0.85-0.85	2	16
Tabularium diameter W	0.45	0.50	0.40	0.45-0.45	2	16
Wall thickness	0.15	0.20	0.10	0.15-0.15	2	16
Intercorallite wall thickness	0.25	0.30	0.20	0.25-0.25	2	16
Dbt in corallites	0.25	0.40	0.15	0.25-0.30	2	4
Tabulae/ 5 mm in corallites	18	20	16	18-18	2	4
Corallites/cm2	41			41-41	2	328
Lacunae/ 4 cm2	44.5			46-43	2	

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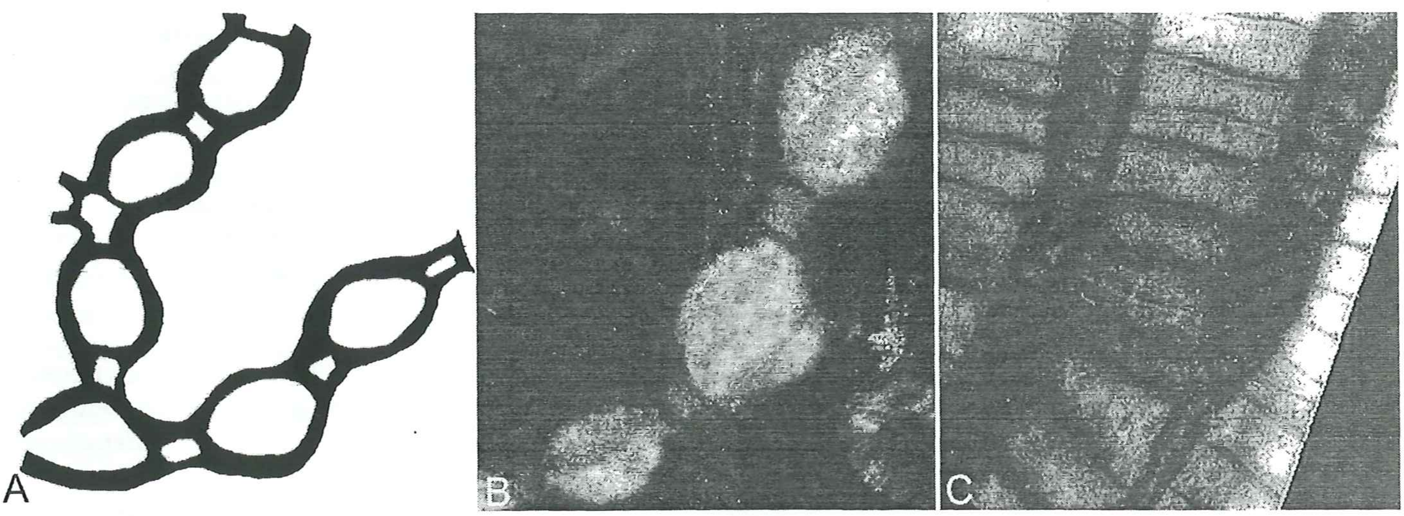

Fig 13. *Halysites* cf. *junior.* A. Transverse section, drawing, (x 7.5). B. Transverse section, polished surface, (x 8.5). C. Vertical section, polished surface, (x 10.5).

Table 5. Tabularium diameter, wall thickness, thickness of intercorallite walls, Dbt: distance between tabulae in corallites, tubule diamater, Dbt in tubules (mm), tabulae per five mm corallites and tubules, corallites and lacumae per unit area in *Halysites* cf. *junior* from the Norderön Island.

Characteristic	Mean	Maximum	Minimum	Number of corallites measured or counted
Tabularium diameter L.	2.10	2.65	1.50	20
Tabularium diameter W	1.40	1.70	0.95	19
Wall thickness	0.30	0.35	0.25	18
Intercorallite wall thickness	0.90	1.40	0.60	8
Dbt in corallites	0.60	0.95	0.45	2
Tabulae/ 5 mm in corallites	7	7	7	2
Corallites/cm2	6			24
Lacunae/ 4 cm2	5			
Tubule diameter L	0.50	0.80	0.30	9
Tubule diameter W	0.50	0.70	0.40	9
Dbt in tubules	0.30	0.40	0.20	2
Tabulae/ 5 mm in tubules	14	14	14	1

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