Notes – *Notiser*

Comments on chitonozoan classification

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Specimens of *Lagenochitina* Eisenack 1931 from the Arenig of Spitsbergen show structures considered to be homologous with the prosome and operculum. These occur together in the same specimen. The fact that both a prosome and an operculum can exist together, raises doubt as to the validity of grouping the chitinozoans into Prosomatifera and Operculifera.

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During recent years, the application of scanning electron microscope (SEM) techniques has produced much new information on the external morphology of the chitinozoans. However, comparatively few details of the internal structures have been described. Traditionally, chitinozoans have been classified according to shape, size, and details of surface structures, usually based on observations with the aid of a light microscope. Of late, however, more and more chitinozoan workers are using SEM studies to aid descriptions.

Most chitinozoans are flask-shaped or almost spherical, and may have a neck (Fig. 1). The chitinozoans which have a neck are provided with a tube-like structure inside, and/or a disc-like structure closing the aperture. Chitinozoans without a neck are reported to have the aperture closed with a disc. These structures have been considered to be important for classifying the chitinozoans above the family level. However, results from SEM studies have not yet been applied to this classification.

Limestones from a succession of the Lower–Middle Ordovician Valhallfonna Formation on Spitsbergen (Fortey & Bruton 1973), have yielded a rich well-preserved collection of species of *Lagenochitina* Eisenack 1931 (Bockelie 1976). Approximately 6000 specimens have been extracted, and among these are several preserved in full relief. Many of these specimens with the internal structures in place inside the test, were picked for SEM studies.

Morphological features of Lagenochitina

Most of the previous reports on the internal structures of chitinozoans indicate the presence of either an operculum or a prosome. The operculum is a flat, disc-like structure sealing the aperture of the test. The prosome has been described (Combaz et al. 1967) as a cylindrical tube partly filling the internal space of the chitinozoan test.

Because many chitinozoans have a thick test wall, it is difficult to see the internal structures. It is therefore quite common to bleach the chitinozoans with an oxidizing agent before studying the structures with a light microscope. To interpret the details of the internal morphology using this method, is not always easy. This is mainly because the translucency of the tests varies in part due to variation of their thicknesses. In addition, the internal structures could be deformed in various ways giving a wrong impression of their shapes. Consequently, selected specimens of the chitinozoans from Spitsbergen were dissected and photographed with the aid of a SEM, which gives a much better impression of the internal structures. This study was carried out at Elektronmikroskopisk laboratorium for biologiske fag, Universitetet i Oslo.

Chitinozoans belonging to *Lagenochitina* are flask shaped, and may or may not have a collar. No spines or appendices are present on the test. Neither does the aperture have processes (for descriptions see Eisenack 1968:156). The two species included in this study, *Lagenochitina esthonica* Eisenack 1955, and *Lagenochitina* n.sp. (Bockelie 1979), both have a long neck and a pronounced collar. The mean total length of *L. esthonica* is 510 μm (a sample from the Valhallafonna Formation). *Lagenochitina* n.sp. from the same formation has a mean of 460 μm. The length of the neck is approximately 1/3 of the total length in both species. An important difference between the two is that the chamber of *L.*

esthonica is more bulbous than the chamber of *Lagenochitina* n.sp. Both species have either a flat base or possess a basal callus. The test surface is almost smooth in both species when seen in 500 times magnification, but the surface of *Lagenochitina* n.sp. may occasionally also be rugose.

Specimens of *Lagenochitina* from Spitsbergen show the presence of both an operculum and a prosome in the same individual. The operculum in both species is similar. It has a smooth surface (Fig. 2A, C), and is about 1.5 μm thick. The operculum is attached to, or lies in contact with the collar at a level about 1/3 of the total length of the collar measured from its rim. On Fig. 2B, a part of the collar is bent down, and as a result, the operculum is disconnected in this area. The attachment area can be seen as a thin string along the collar margin. The operculum (Fig. 2C) is separated from the collar, and lies isolated in the aperture. The aboral portion of the operculum is attached to the oral portion of the prosome. The operculum is observed to be detached from the prosome in several specimens. Internally, both species are provided with a prosome. Structurally the prosome consists of two parts. Orally it has the shape of a cylindrical tube. This tube extends in the total length of the neck. Aborally from the flexure, the prosome widens in accordance with the shape of the chamber. Laterally, the prosome of *Lagenochitina* n.sp. consists of a thin wall less than 1/10 μm thick. In one specimen (Fig. 2A), the collar is bent slightly out and down, exposing the oral portion of the prosome with the lamellae. Aborally from the flexure, the thin prosomal wall widens and forms a bell-shaped structure. This part of the prosome is hollow and lacks internal structures. A specimen of *L. esthonica* (Fig. 2D) shows the prosome lying loose in the upper part of the neck, partly sqeezed out of the aperture. The prosome is not completely removed owing to the widened aboral part which keeps it in place inside the test. The thin prosomal wall is clearly seen on this specimen. The prosome flares orally concurrent with the shape of the collar. Because the operculum is missing in this specimen, the shape of the oralmost part of the prosome is exposed.

Classification of the chitinozoa

Eisenack (1930) gave the first description of the chitinozoans. The following year he formally named these newly discovered microfossils, and erected three families: Lagenochitinidae, Conochitinidae, and Desmochitinidae. He later (Eisenack 1968) added the family Parachitinidae. Eisenack's classification, mainly based on the external shape and structure of the test, is still widely used.

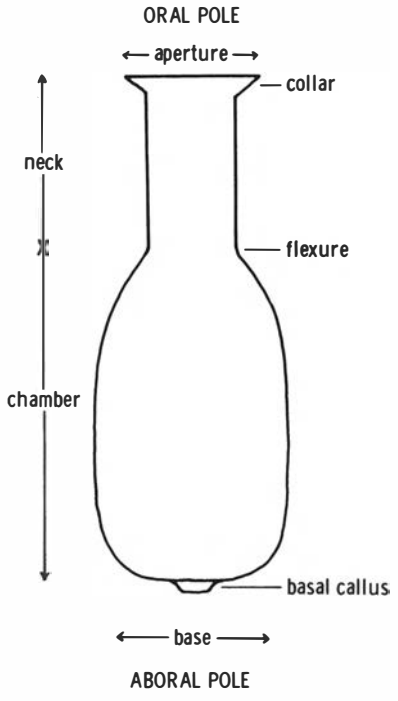

Fig. 1. Generalized chitinozoan test in lateral view with terminology of the major features.

Jansonius (1964) introduced something new in the taxonomic definitions of the families when he paid attention to the internal as well as the external structures of the chitinozoans. In redefining some of the existing taxa, he took into consideration both the presence of a prosome and an operculum, as well as the number of layers of the test wall. The prominent prosomal structure was used as one of the important criteria for his new family Sphaerochitinidae. Jansonius (1967) divided the Chitinozoa into five tribes, but proposed no formal taxonomic names. Each tribe is characterized by the general shape and external structures of the tests, perforation of the base, chain formation, the number of wall layers of the test, and whether an operculum or a prosome is present. Later, Jansonius (1970) erected two new groups above the generic level: Complicioperculati (nom. cor-

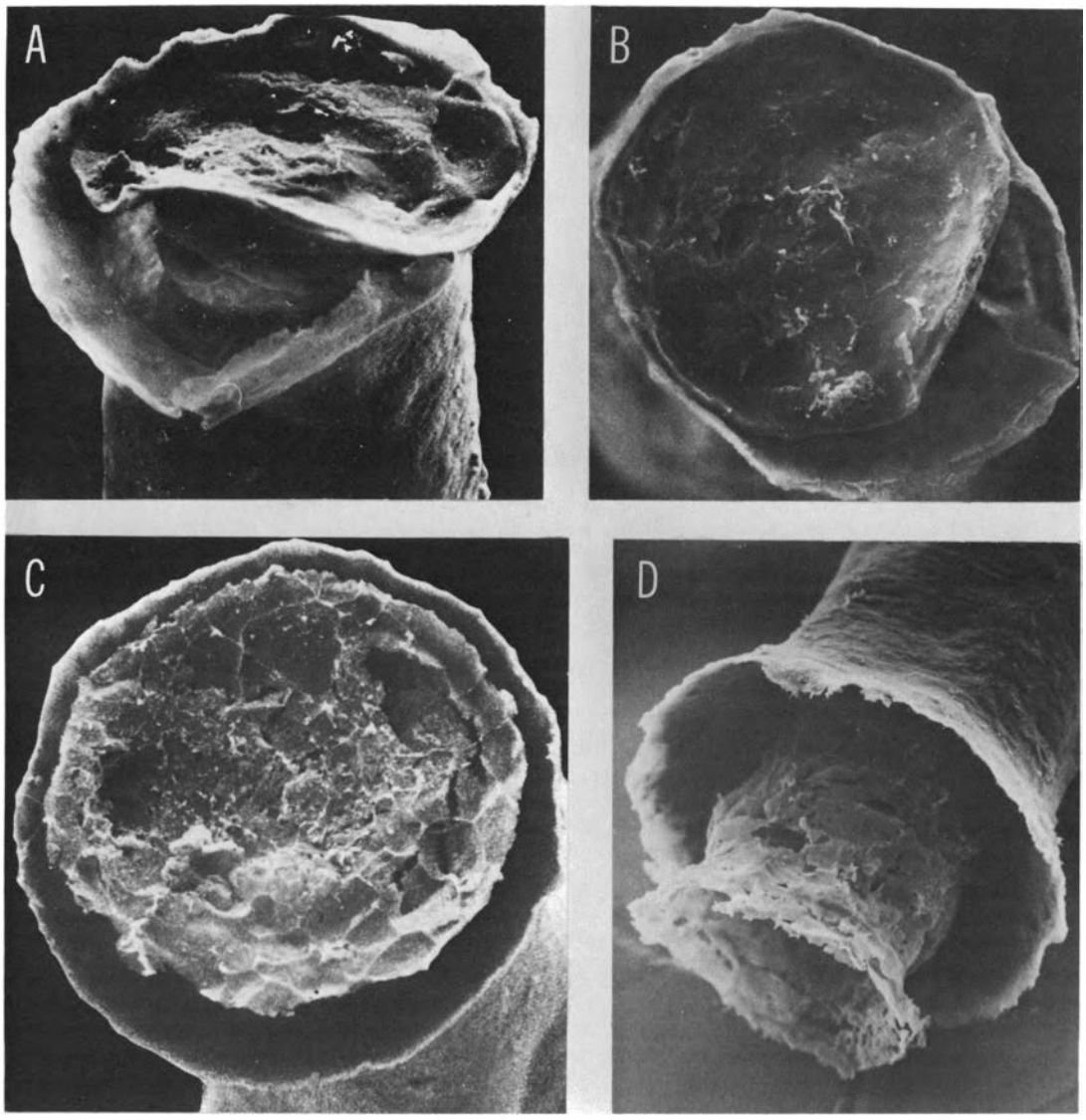

Fig. 2. A–B. *Lagenochitina* n.sp. PMO NF 3271/1. Valhallfonna Formation, Profilbekken Member, *Didymograptus hirundo* graptolite zone.
A. Oral part of the neck with both prosome and operculum in place. The collar is bent slightly out and down. X735. B. Top view of the operculum with smooth surface (the rougher parts are fortuitous). ×700.
C–D. *Lagenochitina esthonica* Eisenack 1955. Valhallfonna Formation, Olenidsletta Member, *Didymograptus deflexus* graptolite zone.
C. Top view of the operculum with partly cracked surface. PMO NF 3289/10. ×785. D. Oblique view of the oral part of the neck. The prosome has been partly sqeezed out of the neck, and the operculum is missing. PMO NF 3285/2. ×650.

rect. for Complexoperculati) for the families Sphaerochitinidae Jansonius 1964 and Tanuchitinidae Jansonius 1964, and Simplicioperculati (nom. correct. for Simplexoperculati) for the families Desmochitinidae Eisenack 1931 and Conochitinidae Eisenack 1931. These two groups were characterized respectively by the presence of a prosomal structure or an operculum. The families were defined on the basis of both the internal and external structures.

In 1968 Eisenack divided the chitinozoans into two groups above the family level, the

Operculida and Prosomida: chitinozoans with an operculum ('Deckel'), and chitinozoans with a prosome ('Propf'). Later (Eisenack 1972a) renamed these groups Operculifera and Prosomatifera.

Umnova (1976) retained Eisenack's groups Prosomatifera and Operculifera, and described several subgroups on the basis of extensive infrared light-microscope studies. These studies show that the internal structures of the chitinozoans are far more complex than previously believed. However, similarities of internal structures common to several genera lead to the conclusion that the chitinozoans on the basis of these structures could be grouped into higher categories above the generic level.

Discussion

On the basis of the morphological descriptions of the two species of *Lagenochitina* from Spitsbergen containing both an operculum and a prosome in the same individual, some doubt can be expressed as to the validity of the Operculifera and the Prosomatifera groups.

Several possibilities seem to be available in explaining this situation. The two species of *Lagenochitina* (ranging through Arenig and Llanvirn) may represent an ancestral group provided with both an operculum and a prosome. Representatives of this group later gave rise to two distinct groups, the Operculifera and the Prosomatifera. Another more plausible explanation is that several representatives of the Prosomatifera may possess an operculum in addition to the prosome. In this context, observations made by Jansonius (1964) may be of great importance. Various internal structures regarded as operculum and prosome were described. However, the lack of scanning electron microscope micrographs or light microscope photographs makes an interpretation difficult. As shown, the operculum of the Spitsbergen material is very thin, and may therefore be difficult to recognize using a light microscope.

This may likewise be the case with other species as well, and consequently the presence of an operculum is seldom recorded. Also, the contact between the prosome and the operculum may not have been a strong one, and during the course of dissolution and preparation of the samples, the two can easily be dissociated. This is often the case with the Spitsbergen species. Eisenack (1972a:76, 1972b:127) observed that some specimens of *Sphaerochitina* (belonging to the Prosomatifera group) possessed a thin translucent disc in the aperture orally of the prosome. He pointed out a possible complexity of the Prosomatifera, and stated that there were certain questions unanswered in connection with the group.

The chitinozoans belonging to the Operculifera group do not have a pronounced neck. The operculum is usually relatively thick and easily observable. In some specimens of this group, however, a thin frill (skirt-like structure) can be seen on the aboral side of the operculum (Umnova 1976). It is a possibility that this structure could be homologous with the prosome, but thorough SEM studies are required to solve this problem.

However, before accepting or rejecting the present supra-generic classification of the chitinozoans, it is quite obvious that more detailed work on the internal structures is needed.

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