Chitinozoans

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Chitinozoans are flask-shaped organic-walled microfossils of problematical origin. It seems probable that the first chitinozoan ever figured was a *Conochitina* specimen from the Mulde Beds on Gotland, illustrated and described by Hinde (1882, Pl. 1:5) as a scolecodont of the genus *Eunicites* (see Eisenack 1975:250). It was not until the 1950's that the Chitinozoa of Gotland were reported on, described and illustrated in detail (Eisenack 1955a:178; 1955b:314, 317, Pl. 1:14–15; 1959). Since then, Eisenack has continued his important studies of these fossils in a series of publications entirely or partly dealing with Gotland material (Eisenack 1962a, b, 1964, 1968, 1972). Taugourdeau & De Jekhowsky (1964) and Laufeld (1973, 1974, 1975, 1977, 1979) have also discussed chitinozoans from Gotland. One of my publications (Laufeld 1974) is a monographic study through the complete sequence.

For this account 50 gram samples were processed by my previously described technique (Laufeld 1974:4–6). The chitinozoan taxa were recorded both qualitatively and quantitatively, and with regard to state of preservation. In addition, the following acid-resistant fossils were recorded semiquantitatively: acritarchs with and without spines, foraminifers, "chitinous" hydroids, scolecodonts, eurypterid fragments, graptolite fragments, and melanosclerites. Kerogene was also recorded semiquantitatively.

For distribution of chitinozoans in the Vattenfallet section see Fig. 21.

Faunal list

Ancyrochitina
A. ancyrea (Eisenack, 1931), *A. pachyderma* Laufeld, 1974, *A. primitiva* Eisenack, 1964.

Angochitina
A. longicollis Eisenack, 1959.

Conochitina
C. flamma Laufeld, 1974, *C. leptosoma* Laufeld, 1974, *C. proboscifera* Eisenack, 1937, *C. proboscifera* forma *gracilis* Laufeld, 1974, *C. proboscifera* forma *truncata* Laufeld, 1974, *C. visbyensis* Laufeld, 1974.

Desmochitina
D. acollaris Eisenack, 1959, *D. densa* Eisenack, 1962, *D. opaca* Laufeld, 1974.

Margachitina
M. margaritana (Eisenack, 1937).

Abundance

All 33 samples processed yielded chitinozoans. One sample contained more than 5000 specimens (100 per gram), and several others also yielded abundant individuals. Fig. 22 is a graph of abundances through the section. There is a more or less constant decrease of maximum abundance from the lower to the upper part of the Upper Visby Marl. The abundance is low in Högklint *a* and comparatively low to moderate in the lower and middle part of Högklint *b*. In the upper part of Högklint *b* the abundance decreases again and is then low throughout Högklint *c* and *d*. With some deviations, e.g. at 19.8 m, there is thus a general decrease in maximum abundance of chitinozoans from the bottom to the top of the section. This is in good agreement with the pertinent parts of the graph of chitinozoan abundance for all Silurian beds on Gotland (Laufeld 1979, Fig. 1).

Chitinozoans are most abundant in (brachiopod) Benthic Marine Life Zone (BMLZ) 5 on Gotland (Laufeld 1979). They show a high but decreasing abundance through the shallower BMLZ 4 and 3. With few exceptions chitinozoans are rare or absent in the shallowest BMLZ 2 and 1.

Admittedly, several ecological factors, e.g. substrate, food and oxygen supply, currents, temperature, and salinity, play a role in controlling the distribution of brachiopods. It seems evident that factors relating to water depth are very important, at least in low-energy environments such as those of the late Llandoverian to early Wenlockian part of the Gotland sequence. The Lower Visby Marl chiefly represents BMLZ 5, the Upper Visby Marl BMLZ 4, the lower and middle part of the Högklint Beds BMLZ 3, and the upper part of the Högklint Beds BMLZ 2 (Gray et al. 1974:261; Laufeld 1977, 1979; compare with Bassett, this volume).

From an assessment of the general geology, sedimentology and palaeontology of the Lower and Upper Visby and Högklint Beds, it is apparent that there was a general shallowing of the basin during the time of their deposition. Accordingly the graph of abundance of Chitinozoa in the Vattenfallet section reflects bathymetry, as do the brachiopod Benthic Marine Life Zones in late Llandoverian and early Wenlockian time on Gotland. On this assumption, abrupt deviations from the general trend become interesting.

A rapid decrease of abundance might indicate slumping from shallower areas

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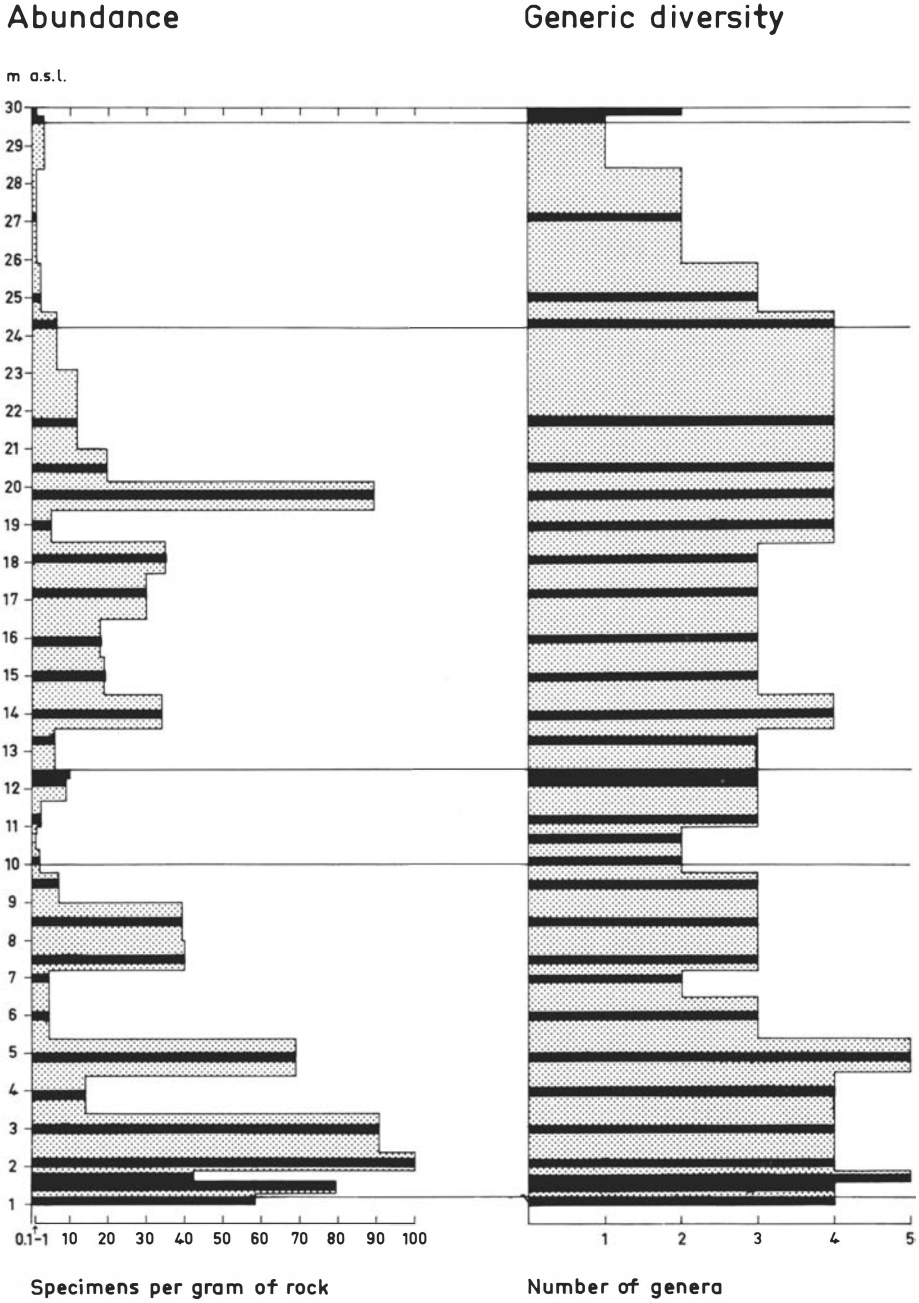

Fig. 22.

or another kind of rapid increase in the rate of sedimentation. On the other hand, a rapid increase of abundance might indicate increasing water depth and/or a decrease of the rate of deposition. It is also possible, though not probable, that the general trend in the graph of chitinozoan abundance reflects a more or less constantly increasing rate of deposition from early Upper Visby through Högklint time at Vattenfallet. A detailed analysis of the total abundance of each species and species diversity through the section will be published elsewhere.

Diversity

The greatest number of chitinozoan species represented in any sample from Vattenfallet is 8. Laufeld (1974:123) pointed out that the main pattern of diversity (expressed as the number of species per sample) on Gotland is similar to that of abundance (expressed as the total number of specimens per gram of rock), i.e. a high species diversity is generally coupled with a high total abundance.

A graph of generic diversity (Fig. 22) reveals general trends in a crude way and is of interest also because the genera represent the five major vesicle types. Furthermore, there can be very little dispute over the generic designations used here, whereas the species taxonomy might be regarded, at least partly, as provincial.

In general the generic diversity is high in the Lower Visby Marl and lower part of the Upper Visby Marl, fairly high in the upper part and in Högklint *a*, fairly high to high in Högklint *b*, and then decreasing through Högklint *c* and *d* from fairly high to moderate or low.

Frequency and palaeoecology

Fig. 23 shows the frequency of specimens referred to genera. *Ancyrochitina* and *Conochitina* predominate, with only two samples dominated numerically by chitinozoans of other genera. The abundance of *Ancyrochitina* specimens fluctuates greatly but the trend increases from the base to the top of the section. The opposite is true of the *Conochitina* specimens. *Angochitina* (represented by *A. longicollis* which is known to have a high abundance in the Lower Visby Marl) is common in the lower part of the Upper Visby Marl but decreases in abundance upwards and disappears in the middle part of this unit. The opposite trend is true of *Margachitina* (represented by *M. margaritana*, a species that seems confined to moderate water depths; it reappears in those parts of the Slite Beds deposited in deeper water than the uppermost part of the Högklint and Tofta Beds).

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Relative frequencies of specimens within each genus

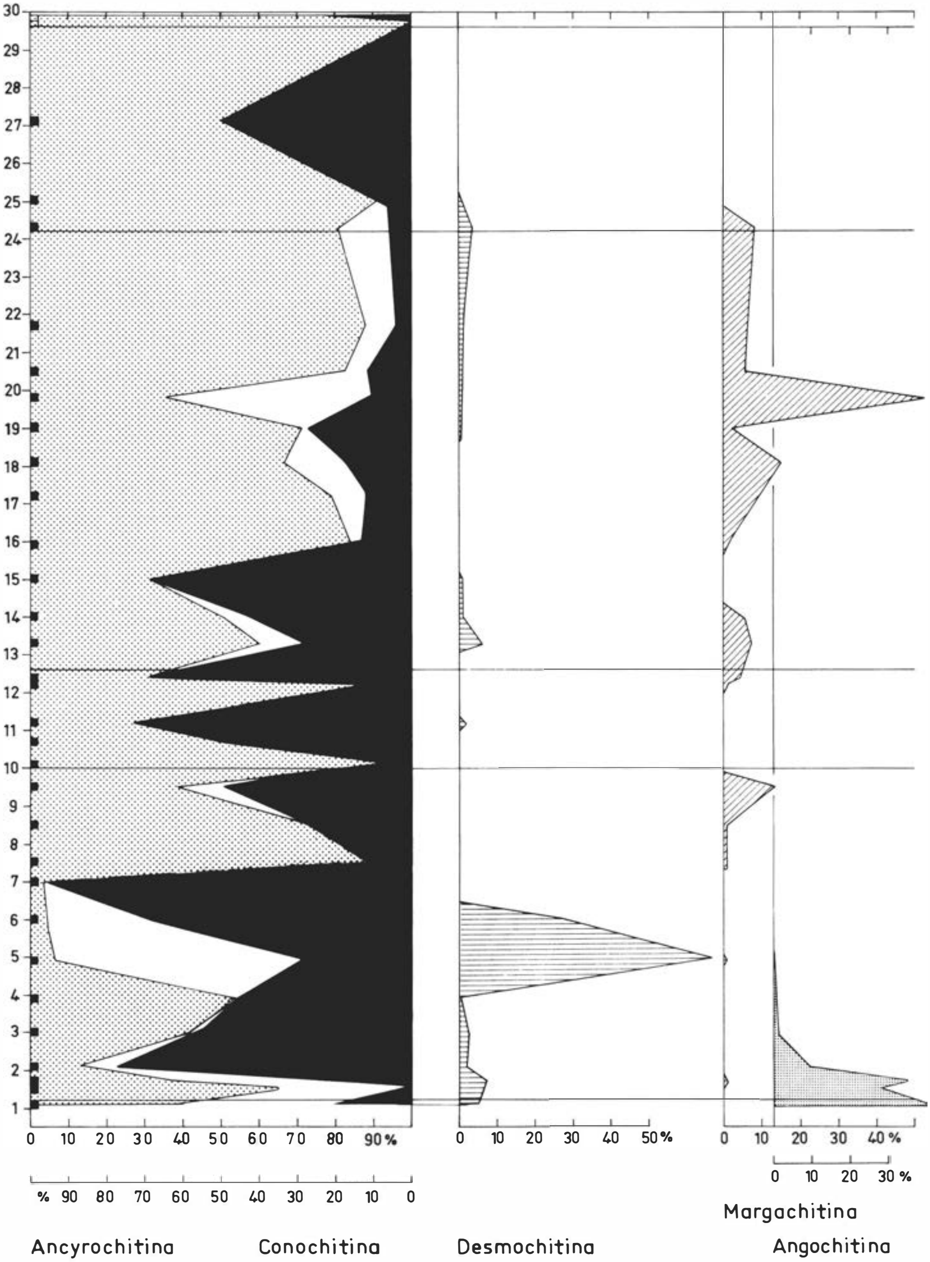

Fig. 23.

Finally, *Desmochitina* specimens also disappear in the uppermost and shallowest part of the Högklint Beds, only to reappear (*D. acollaris*) in the Slite Marl. Of the taxa under discussion only *Ancyrochitina* and *Conochitina* are represented in the uppermost and shallowest part of the Högklint Beds. *Ancyrochitina* specimens almost always dominate where the total abundance of Chitinozoa is low, especially in high-energy environments. This, taken together with the small size and overall morphology of the vesicles of *Ancyrochitina* species, makes it plausible that they were planktic. The large and thick-walled *Conochitina* specimens, however, were probably benthic. This conclusion is supported by the general trend in the frequency graph for *Conochitina*.

Stratigraphical remarks

Thirteen chitinozoan taxa in Fig. 21 occur below the base of the Vattenfallet section. Eight of the taxa in Fig. 21 occur above the Vattenfallet section and the Högklint Beds. The latter chitinozoans reappear in the Slite Beds, since the extremely shallow-water Tofta Beds are barren of these and almost all other acid-resistant fossils. *Ancyrochitina pachyderma, Desmochitina opaca* and *Conochitina leptosoma* were reported to range upwards into the upper, marly southwestern facies of the Högklint Beds (Laufeld 1974, Fig. 77). The facies is possibly correlative with beds somewhere in the lower part of Högklint *c* in the present section, a conclusion that is further supported by the fact that *Desmochitina acollaris* first appears elsewhere on Gotland in the marly SW Högklint facies.

The stratigraphical ranges of the Chitinozoa recorded in the Vattenfallet section agree with those recorded earlier from Gotland by Laufeld (1974, Figs. 77–78) with the important extension of the ranges of *Conochitina proboscifera* forma *truncata, C. visbyensis, C. proboscifera* forma *gracilis,* and *Desmochitina opaca* into at least the topmost bed of the Lower Visby Marl.

The next logical step towards a further refinement of the biostratigraphical use of Chitinozoa on Gotland is to take the graphs of abundance, diversity, frequency, etc., into account. This is the only way to comprehend the influence of various palaeoecological factors and to sort out taxa that are comparatively independent of facies and therefore best suited for the purpose of correlation.

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