Bryozoans

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The first serious attempt to monograph Silurian bryozoans from Gotland was by Hennig (1905, 1906, 1908). Some additions and revisions have subsequently been published by Borg (1965) and Brood (1968). A new monographic study of Gotland bryozoans, excluding the trepostomes, has been started by the present author, and the first part, comprising Cyclostomata, has been published (Brood 1975), whereas the second part, dealing with Cryptostomata and some cystoporates, although completed serveral years ago, is still unpublished. In the present contribution it has been advantageous to use my manuscript names for two new species (referred to as Brood MS in the faunal list) instead of applying an open nomenclature. The trepostomes and the bulk of cystoporates from Gotland still require modern revison. The cryptostomates of the Silurian of Estonia, including some species from Podolia, have recently been described by Kopaevich (1975) and many of the species occur also on Gotland. Some Silurian trepostomates of Estonia have been described by Astrova (1970).

In the fauna from Vattenfallet bryozoans form one of the most abundant groups. The available material comprises about 2300 specimens that can be classified as macrofossils (0.5 cm long or larger), and innumerable small specimens. In addition, many species could be identified in thin sections or dry peels prepared from rock samples.

With respect to the way in which material was collected, five categories can be distinguished. (1) Specimens picked up or extracted from the rock in the field by Liljevall during his systematic collecting from the section in 1908. In this collection small species are clearly under-represented. (2) From some levels rich in fossils, slabs of varying size were brought home by Liljevall and on these slabs the bedding surfaces mostly abound in bryozoans of varying size. (3) Liljevall also collected a number of marl samples from which bryozoans and other fossils were extracted in the laboratory. In order to complement this material, I collected an additional series of marl samples in 1976 from the lower half of Högklint *b,* and similar samples were obtained by S. Lindbom from the Lower Visby Marl. (4) Many corals and stromatoporoids, as well as occasional other large fossils, are encrusted by numerous bryozoans, especially on the lower side of colonies (see also Spjeldnaes 1975). Most such fossils were examined for encrusting bryozoans. (5) Most bryozoans can be identified in thin sections or dry peels from rock samples. For this reason all thin sections used for lithological study were examined for bryozoans, and dry peels were prepared from all available rock samples. The identifications based on sections or peels are entered in the log as open circles (Figs. 54–55).

From the upper part of Högklint *b* (above 20.5 m) no marl samples were available, and Högklint *c* lacks marly intercalations. In these beds the coverage of bryozoans is less complete than lower down in the section. However, the quantitative data indicate that bryozoans are relatively less abundant in these beds than in the rest of the section, and the low taxonomic diversity there is therefore probably real.

Annotated faunal list

Cyclostomata

Clonopora gotlandica Brood, *Sagenella consimilis* (Lonsdale), *Corynotrypa hennigi* Brood, *C. dissimilis* (Vine), *C.* n. sp. *a*, *Diploclema regulare* (Vine).

Corynotrypa n. sp. *a* (RM By23689) differs from other Silurian species of the genus in having much smaller zooecial dimensions (length of zooecium 0.3 mm, width of aperture 0.04 mm).

Cryptostomata

Helopora lindstroemi (Ulrich), *Nematopora visbyensis* Brood MS, *Phaenopora lindstroemi* Ulrich, *Ptilodictya lanceolata* (Goldfuss), *P. triangularis* Hennig, *P. flabellatiformis* Kopaevich, *Hemipachydictya holmi* (Hennig), *H. macropora* (Hennig), *Saffordotaxis gotlandicus* Brood, *Glauconomella disticha* (Goldfuss), *Thamniscus toernquisti* Hennig, *Archaeofenestella rigidula* (M'Coy), *Fenestella subantiqua* D'Orbigny, *Reteporina reticulata* (Hisinger), *Isotrypa gotlandica* Ulrich, *Semicoscinum clavatum* Kopaevich, *Sphragiopora silurica* Hennig.

Cystoporata

Crepipora lunariata Hennig, *Fistulipora pusilla* Brood MS, *"F."* sp. *a*, *Ceramoporella lindstroemi* (Hennig), *Ceramopora armata* Hennig, *Fistuliporella* sp. *a* (9.8 m).

Trepostomata

Asperopora asperum (Hall), *A. multiporum* (Bassler), *A. ramosum* (Owen), *A.*? *claviformis* (Hennig), *Monotrypa gotlandica* Hennig, *Bythopora ulrichi* Hennig, *Mesotrypa suprasilurica* Hennig, *Eridotrypa densipora* Hennig, *E.* n. sp. *a*, *Eridotrypella sepizensis* Astrova, *Hallopora elegantula* (Hall), *H. bassleri* Hennig, *Cyphotrypa* cf. *juruensis* Astrova. The trepostomes suffer from lack of recent monographic study and the identifications of species not reported earlier from Gotland should be regarded as tentative.

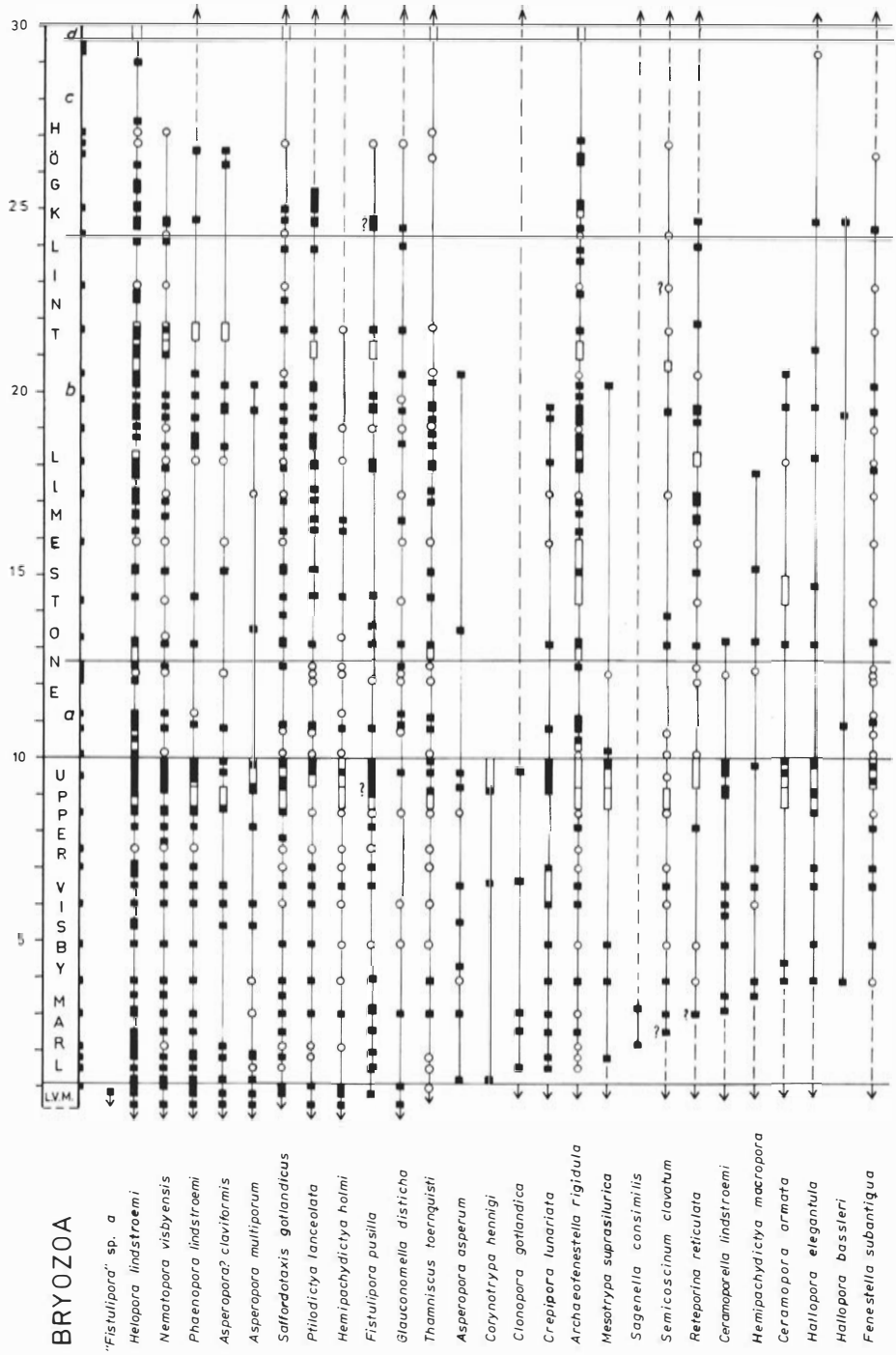

Fig. 54. Distribution of bryozoans in the Vattenfallet section. Continued on Fig. 55. Black rectangles along the stratigraphic column show the levels of thin sections and peels examined for bryozoans and coenitids. The levels in which a species has been recorded only in a thin section or peel are given in the log as open circles.

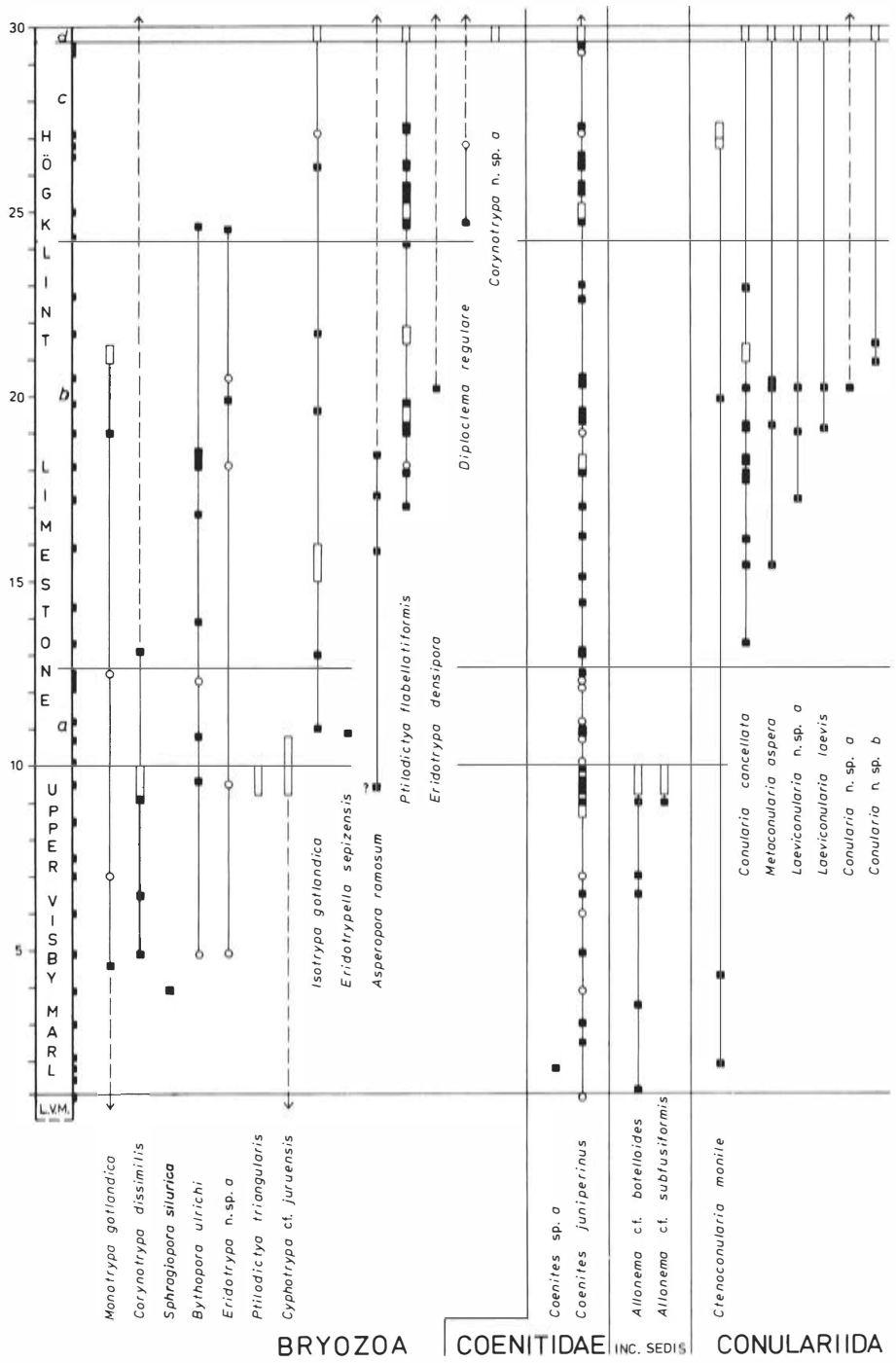
30
25
20
15
10
5
d
c
b
a
HÖGKLINT LIMESTONE
UPPER VISBY MARL
L.V.M.
Monotrypa gotlandica
Corynotrypa dissimilis
Sphragiopora silurica
Bythopora ulrichi
Eridotrypa n. sp. a
Ptilodictya triangularis
Cyphotrypa cf. juruensis
Isotrypa gotlandica
Eridotrypella sepizensis
Asperopora ramosum
Ptilodictya flabellatiformis
Eridotrypa densipora
Diplaclema regulare
Corynotrypa n. sp. a
Coenites sp. a
Coenites juniperinus
Allonema cf. botelloides
Allonema cf. subfusiformis
Ctenoconularia monile
Conularia cancellata
Metaconularia aspera
Laeviconularia n. sp. a
Laeviconularia laevis
Conularia n. sp. a
Conularia n. sp. b
BRYOZOA
COENITIDAE
INC. SEDIS
CONULARIIDA

Fig. 55.

Stratigraphical distribution

I have noted elsewhere (Brood 1975 and in press) that in the bryozoan fauna there is little qualitative difference between the Upper Visby Marl and the Högklint Limestone. Most species in these beds range from the upper part of the Lower Visby Marl to the upper part of the Högklint Limestone. Among the 17 cryptostomatous species found in the section, 14 occur both in the Upper Visby Marl and the Högklint Beds. *Sphragiopora silurica,* recorded from the Upper Visby Marl of the section has elsewhere been found in the Högklint Beds. *Ptilodictya triangularis* occurs in the section only in the upper part of the Upper Visby Marl, but it is a rare species and is known from the Högklint Limestone on Fårö.

Two species, *Isotrypa gotlandica* and *Ptilodictya flabellatiformis,* are restricted to the Högklint Limestone. Both are comparatively rare. *I. gotlandica* is normally a reef dwelling species whereas *P. flabellatiformis* is characteristic of high energy, shallow water environments.

Of the six cyclostomatous species recorded, three have been found only in the Visby marls. *Clonopora gotlandica* and *Corynotrypa dissimilis* also occur in higher beds elsewhere on Gotland and their restricted occurrence in the section is probably due to chance. *Corynotrypa hennigi* may be restricted to the Upper Visby Marl. *Diploclema regulare* has been found only in the Högklint Limestone, but it is very rare on Gotland and may have a wider distribution.

The trepostomes are represented in the section by 13 species, of which nine occur both in the Upper Visby Marl and the Högklint Limestone. Because of the lack of a monographic study, ranges on Gotland of several species are uncertain.

The cystoporates are represented in the section by four species all of which have been found both in the Upper Visby Marl and the Högklint Limestone.

Ecological considerations

Bryozoans form an important constituent in the skeletal material at Vattenfallet. The bryozoan content in the rocks is on average about two to three per cent, a value agreeing closely with data from other parts of Gotland (Brood 1976).

It is difficult to obtain representative quantitative data on bryozoans based on macrofossils, that is, specimens that are 0.5 cm or larger. Apart from encrusting and massive colonies, the zoaria are extensively fragmented and this makes it impossible to estimate the frequency in terms of individual colonies. Liljevall's material was assembled by a non-specialist and many

bryozoans were probably overlooked. This also affects the faunal log (Figs. 54, 55) in which coverage is obviously less complete for bryozoans than for brachiopods or trilobites. Rough estimations based on the available bryozoan "macrofauna" shows that it is strongly dominated by the articulated cryptostome *Helopora lindstroemi,* which is abundant throughout the section. In the Upper Visby Marl the bifoliate cryptostome *Phaenopora lindstroemi* is common whereas in Högklint *b* the fenestrate *Archaeofenestella rigidula,* bifoliate *Ptilodictya lanceolata,* and the articulated *Saffordotaxis gotlandicus* form a subdominant element. In Högklint *c* the comparatively large bifoliate cryptostome *Ptilodictya flabellatiformis* is a dominant species in several beds.

As noted above, bryozoans can easily be identified in thin sections or peels, mostly down to species level. Through point counting the importance of various species in the sequence can be determined by volume. For this purpose dry peels were prepared of 31 rocks samples. Peels were used because a far larger sample surface could easily be produced for counting than on conventional thin sections. When point counting, the grain bulk definition was applied for defining the area of cross-sections of bryozoans to be counted, that is, the whole area, including the cavities, of the bryozoan particle. The results are given on Figs. 56–57, excluding samples in which the total number of bryozoan counts was less than 100. The latter data were considered to be unreliable. Some of the variation in the plotted data is obviously due to chance, particularly with respect to whether or not large colonies of encrusting forms or massive trepostomes happened to be included within the peel area. In order to significantly decrease the effect of chance, the area counted had to be increased beyond what was practically possible to count within the time available for the present study. Nevertheless, the data obtained provide fairly good indications of the quantitative importance of the commonest bryozoan species.

Helopora lindstroemi dominates in most samples also by volume. Bifoliate cryptostomes. such as *Phaenopora lindstroemi, Ptilodictya lanceolata* and *Hemipachydictya holmi* are, on average, far more common in the Upper Visby Marl than in Högklint Limestone. These forms, as well as the erect articulated cryptostomes *Helopora lindstroemi* and *Nematopora visbyensis,* require only small firm substrates for attachment. The quantitative data indicate that massive trepostomes are more common in the Upper Visby Marl than in the Högklint Beds. Also encrusters, such as the cystoporates *Ceramoporella lindstroemi, Ceramopora armata* and *Fistulipora pusilla* and trepostomes *Asperopora multiporum* and *A.? claviformis,* are more abundant in the Upper Visby Marl than in the bedded Högklint limestones. This probably correlates with the relative abundance of colonial organisms in the Upper Visby Beds (see Klaamann and Nestor, this volume) which formed a suitable substrate for many encrusting bryozoans. It is noteworthy thant these encrusting forms are particularly abundant on the lower side of the colonies of stromatoporoids,

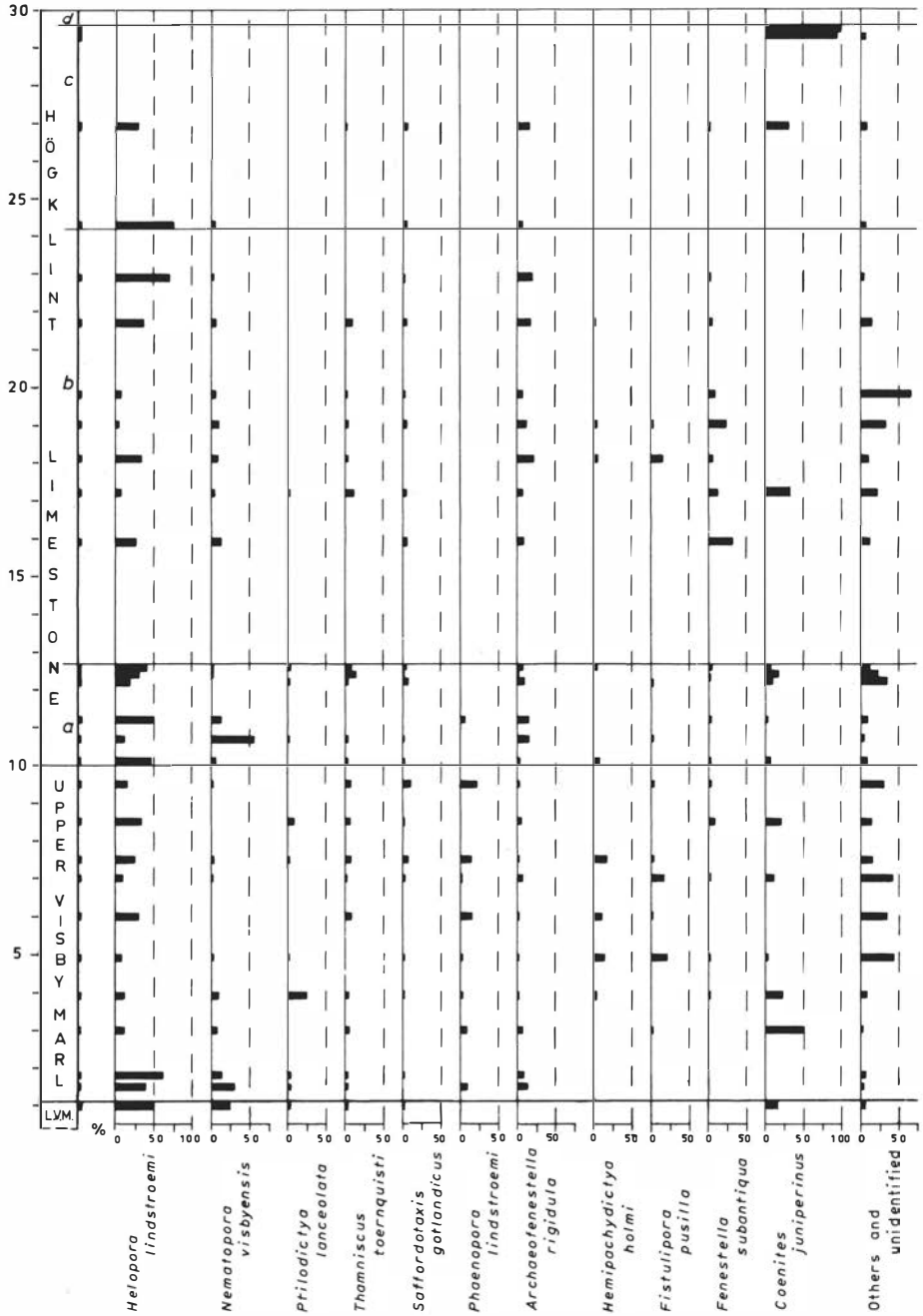

Fig. 56. Quantitative composition of the bryozoan and coenitid fauna by percentage grain-bulk volume, determined on dry peels by point counting. Only those levels are included which yielded a total of at least 100 hits for bryozoans and coenitids together. Only those species are recorded which formed at least ten per cent of the total bryozoan and coenitid volume in at least one sample. The levels of the samples are indicated by black rectangles along the stratigraphical column.

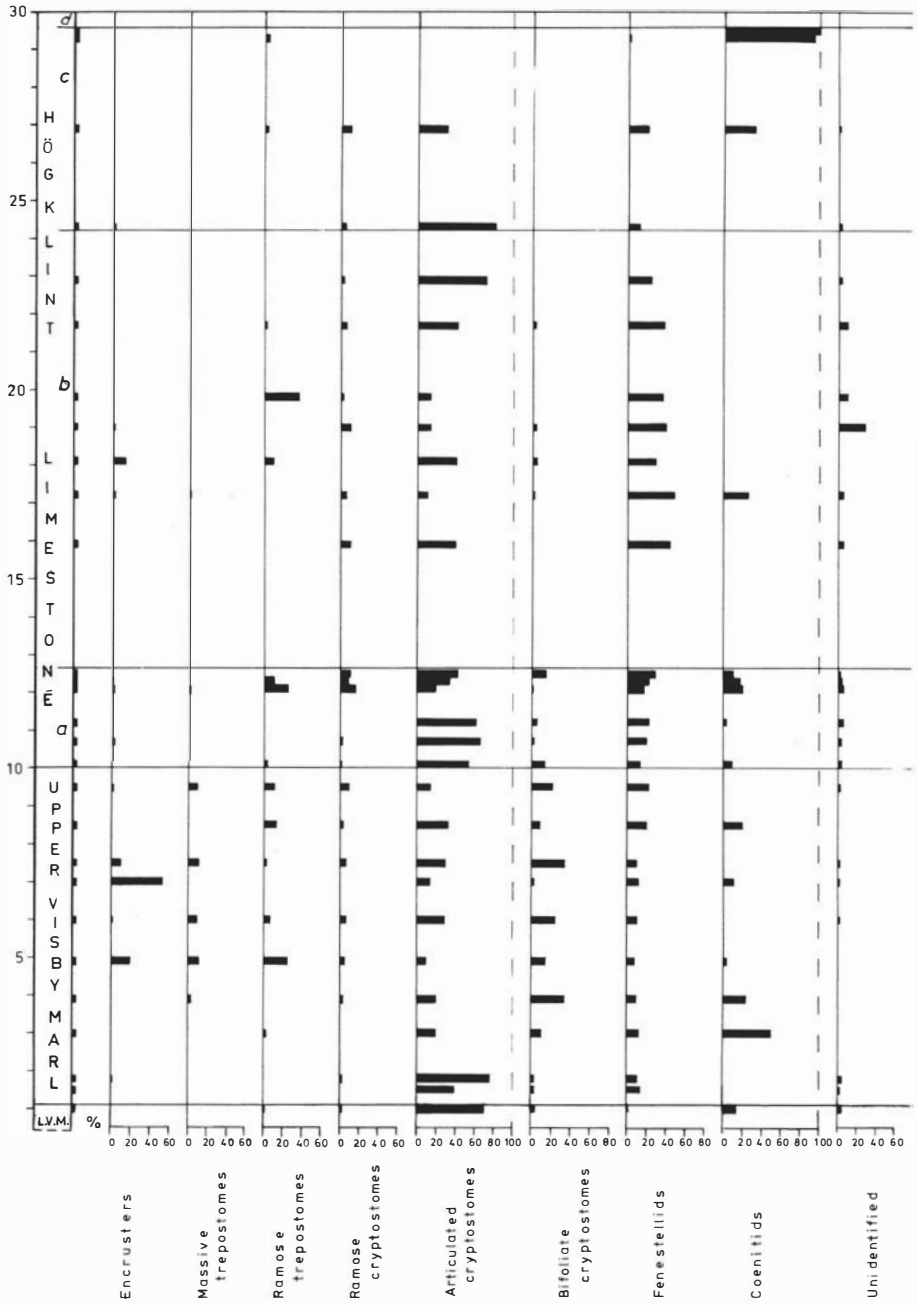

Fig. 57. Quantitative composition of the bryozoan and coenitid fauna by percentage grain-bulk volume according to growth types. The base data are the same as in Fig. 56.

tabulates and heliolitids. Several loose encrusting zoaria were also found in which the substrate had probably consisted of some firm-bodied organism that has perished without trace.

In the winnowed calcarenites of Högklint *a* many bryozoans are probably transported and the quantitative composition of the fauna may not reflect biotic conditions.

The content of skeletal sand in the lower, calcilutitic part of Högklint *b* is low and quantitative data on bryozoans from these beds are unreliable. Higher in the sequence, in the middle and upper part of Högklint *b*, fenestrate bryozoans are significantly more abundant than in the Upper Visby beds. On Gotland, the abundance of fenestellids characterizes reef environments where they form up to 40 or 50 per cent of the bryozoans by volume (Brood 1976). It is possible that these forms were transported from nearby reefs into the relatively quiet water depositional environment in which the bedded, partly pelletal limestones of the middle and upper Högklint *b* were formed.

The content of bryozoans in the pelletal, moderately high energy limestones of Högklint *c* is relatively low and from the available quantitative data no safe conclusions are possible. The large bifoliate cryptostome *Ptilodictya flabellatiformis,* which is not uncommon as a macrofossil in these beds, has not been recorded from the peels or thin sections. This indicates that its contribution by volume to the sediment was low.

In the fine-grained "*Pterygotus*" Beds (Högklint *d*) the bryozoan content is generally very low. This environment was clearly unsuitable for this group.

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