Palaeocope and eridostracan ostracodes

DALIP K. SETHI

Our current knowledge of palaeocope ostracodes from Gotland is very uneven. Beyrichiaceans have been described in an exellent monograph by Martinsson (1962). Silurian primitiopsaceans have been studied in some detail in Estonia (Sarv 1968) and Latvia (Gailite 1967), but only a few species have recently been described from Gotland (Martinsson 1955, 1956). The remainder of the palaeocopes are poorly known, not only on Gotland but also in the Silurian of the Balto-Scandian region in general. Although a number of species have been described their firm identification is frequently difficult if type or topotype material is not available for comparison. For a few species relevant to the present study such material could be examined but for the remainder open nomenclature has had to be used. This extensive use of open nomenclature also reflects the presence in the Vattenfallet material of numerous new taxa, some of them of uncertain affinity.

Eridostracans are here regarded tentatively as a separate order-group category. To my knowledge this group has not been reported previously from Gotland, and without a special study of comprehensive material, definition of eridostracan genera and species from Vattenfallet is difficult.

The bulk of palaeocopes and eridostracans from Vattenfallet have been obtained from limestone samples which were broken down into small chips that were scanned under a binocular microscope at ×20 magnification. The rock samples were collected by Liljevall, apart from a few obtained by me in 1975. Prior to identification many specimens had to be prepared with a fine needle, and the total time spent on preparation over five years was considerable. A minor fraction of the palaeocopes was obtained from marl samples many of which had previously been picked for ostracodes by Liljevall. The total material of palaeocope ostracodes examined comprises more than 15,000 specimens from some eighty different levels in the section. About 60 eridostracan valves were found.

Annotated faunal list

Palaeocopa

Leperditellacea

Neoprimitiella versipella (Neckaja), *N.* cf. *litvaensis* (Neckaja), *Pseudoaparchites decoratus* (Jones), *Bollia amabilis* Neckaja, *B.* sp. *a, Parahippa vis-*

byensis n. gen., n. sp., *Ulrichia* sp. *a, U.? palisadica* n. sp., *Monoceratella* n. sp. *a* (a single carapace), *Vattenfallia spinosa* n. gen., n. sp., *Opistoplax* sp. *a, O.* sp. *b* (a single valve), *Mirochilina* sp. *a, Aechmina* sp. *a, A.* sp. *b, Aechminaria* sp. *a, A.* sp. *b, A.* sp. *c, A.* sp. *d* (2.3 m, a single valve), Leperditellacea? gen. *a,* sp. *a*, Lepertitellacea gen. *b,* sp. *a,* Leperditellacea? gen. *c,* sp. *a* (12.35 m), Leperditellacea gen. *d,* sp. *a.*

The genus *Brevidorsa* Neckaja, 1973 (type species *Brevidorsa brevidorsa* Neckaja, 1973) is here regarded as a junior subjective synonym of *Pseudoaparchites* Krandijevsky, 1963 (type species *P. latus* Krandijevsky, 1963; junior subjective synonym of *Leperditella gregaria* Sarv, 1962, according to Abushik 1971). *Pseudoaparchites gregaria* Sarv is probably a junior subjective synonym of *Aparchites decoratus* Jones, 1889. Associated with specimens exhibiting the shape and ornamentation of *P. decoratus* are specimens with a smooth surface but otherwise similar to *P. decoratus.* In our present state of knowledge it is not clear whether these specimens fall within the range of variation of *P. decoratus* or belong to a separate species. In the log (Fig. 41) the smooth specimens are recorded as *P.* cf. *decoratus.*

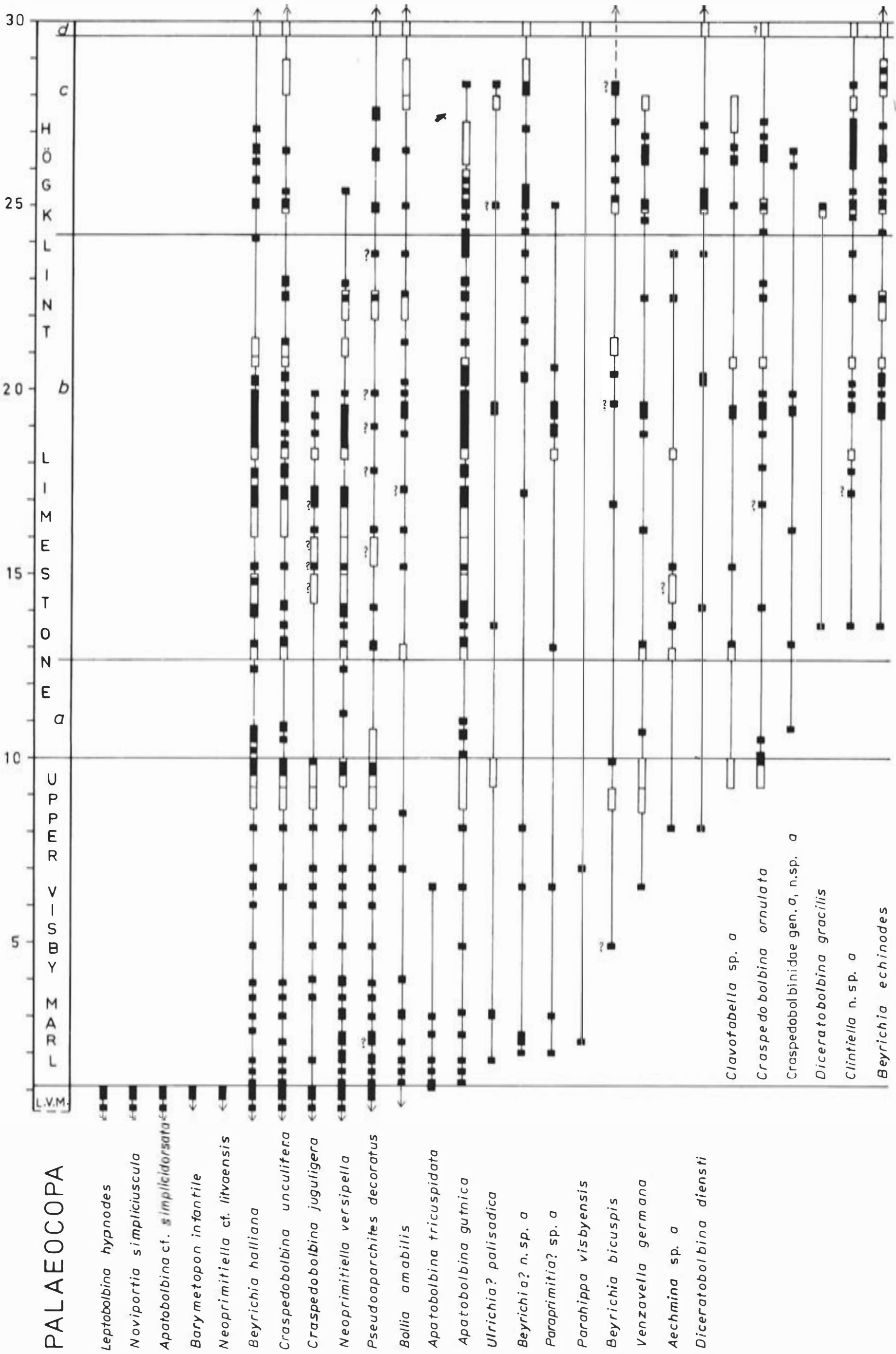
Eurychilinacea
Platybolbina (incertia subgeneris) *lunulifera* Henningsmoen, Eurychilinacea? gen. *a,* sp. *a.*

Primitiopsacea
Clavofabella sp. *a, Venzavella germana* Sarv, *V.* sp. *a, Signetopsis* sp. *a,* Primitiopsidae gen. *a,* sp. *a,* Primitiopsidae gen. *b,* sp. *a* (one tecnomorphic valve).

Primitiopsidae gen. *a,* sp. *a* has a *Clavofabella*-like shape to both valves and the dolon, but it lacks an adductorial pit and has a smooth surface. Primitiopsidae gen. *b,* sp. *a* has a coarsely reticulated surface and tecnomorphic velar ridge, but lacks an adductorial pit. The specimens of *Venzavella* exhibit considerable variation, particularly in the number and orientation of ridges, and without a study of larger samples the definition of species is somewhat uncertain.

Hollinacea
Diceratobolbina diensti (Kummerow) n. gen., *D. gracilis* n. sp.

Beyrichiacea
Apatobolbina gutnica Martinsson, *A. tricuspidata* Martinsson, *A.* cf. *simplicidorsata* Martinsson, *A.?* sp. *a, Leptobolbina hypnodes* Martinsson, *Craspedobolbina (Craspedobolbina) mucronulata* Martinsson, *C. (C.) juguligera* Martinsson, *C. (C.) ornulata* Martinsson, *Craspedobolbina (Mitrobeyric-*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HÖGKLINT
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LIMESTONE
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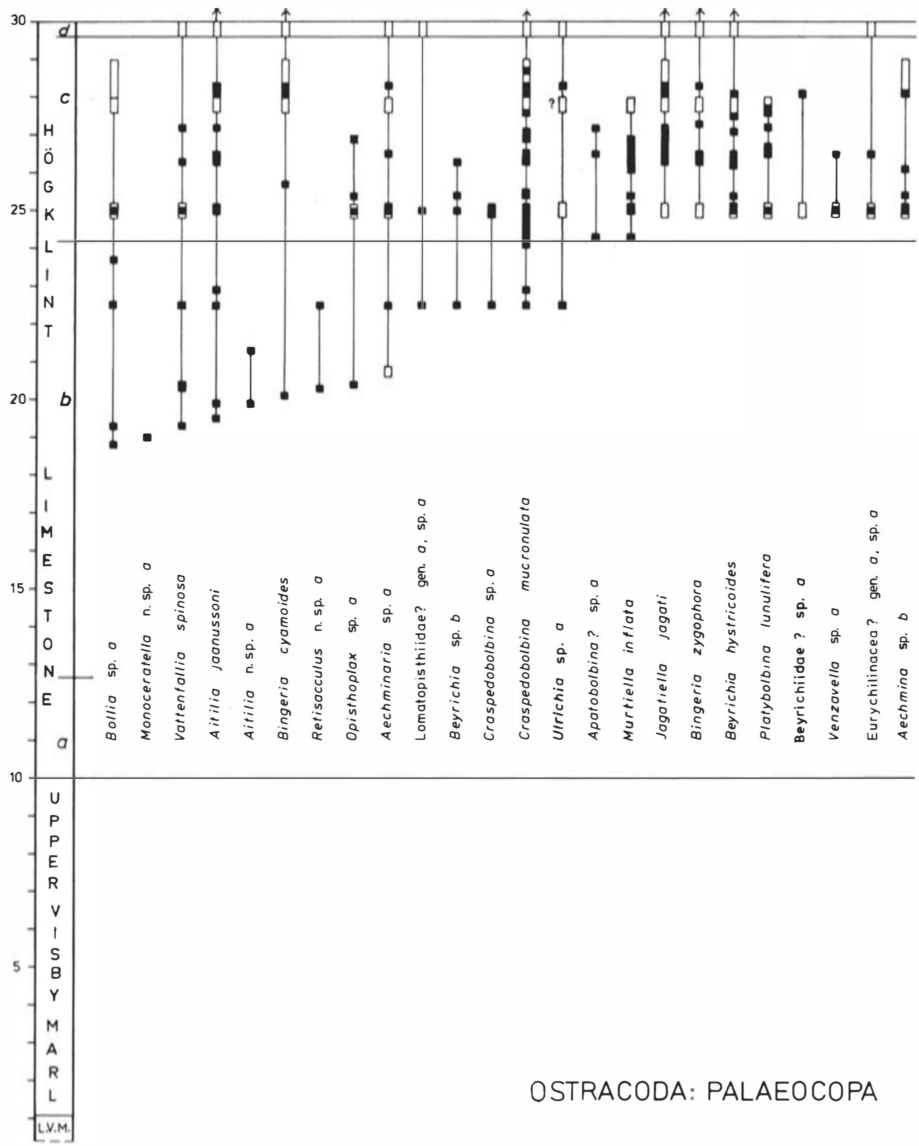
UPPER VISBY MARL
L.V.M.
PALAEOCOPA
Leptobolbina hypnodes
Noviportia simpliciuscula
Apatobolbina cf. simplicidorsata
Barymetopon infantile
Neoprimitiella cf. litvaensis
Beyrichia halliana
Craspedobolbina unculifera
Craspedobolbina juguligera
Neoprimitiella versipella
Pseudoaparchites decoratus
Bollia amabilis
Apatobolbina tricuspidata
Apatobolbina gutnica
Ulrichia? palisadica
Beyrichia? n. sp. a
Paraprimitia? sp. a
Parahippa visbyensis
Beyrichia bicuspis
Venzavella germana
Aechmina sp. a
Diceratobolbina diensti
Clavofabella sp. a
Craspedobolbina ornulata
Craspedobolbinidae gen. a, n.sp. a
Diceratobolbina gracilis
Clintiella n. sp. a
Beyrichia echinodes

Fig. 41.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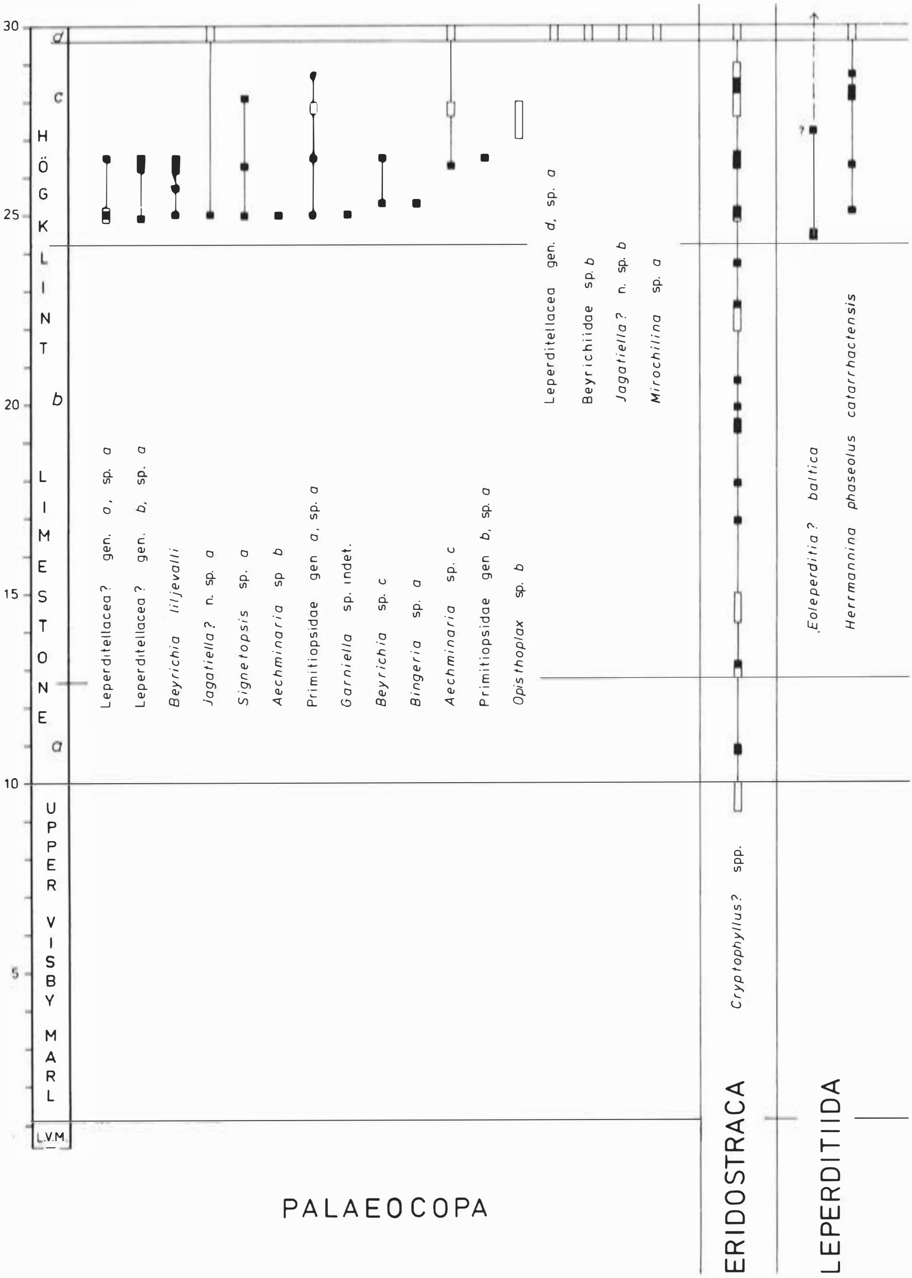
UPPER VISBY MARL
L.V.M.
Bollia sp. a
Monoceratella n. sp. a
Vattenfallia spinosa
Aitilia jaanussoni
Aitilia n. sp. a
Bingeria cyamoides
Retisacculus n. sp. a
Opisthoplax sp. a
Aechminaria sp. a
Lomatopisthiidae? gen. a, sp. a
Beyrichia sp. b
Craspedobolbina sp. a
Craspedobolbina mucronulata
Ulrichia sp. a
Apatobolbina? sp. a
Murtiella inflata
Jagatiella jagati
Bingeria zygophora
Beyrichia hystricoides
Platybolbina lunulifera
Beyrichiidae? sp. a
Venzavella sp. a
Eurychilinacea? gen. a, sp. a
Aechmina sp. b
?
OSTRACODA: PALAEOCOPA

Fig. 42.



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HÖGKLINT LIMESTONE
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Leperditellacea? gen. a, sp. a
Leperditellacea? gen. b, sp. a
Beyrichia liljevalli
Jagatiella? n. sp. a
Signetopsis sp. a
Aechminaria sp b
Primitiopsidae gen a, sp. a
Garniella sp. indet.
Beyrichia sp. c
Bingeria sp. a
Aechminaria sp. c
Primitiopsidae gen b, sp. a
Opisthoplax sp. b
Leperditellacea gen. d, sp. a
Beyrichiidae sp. b
Jagatiella? n. sp. b
Mirochilina sp. a
Cryptophyllus? spp.
Eoleperditia? baltica
Herrmannina phaseolus catarrhactensis
PALAEOCOPA
ERIDOSTRACA
LEPERDITIIDA

Fig. 43.

hia) unculifera Martinsson, *C. (M.)* sp. *a* (4 tecnomorphs), *Aitilia jaanusson* n. sp., *A.* n. sp. *a, A.?* sp. *b* (19.80–19.85 m, a single tecnomorphic valve), *Clintiella* n. sp. *a*, *Barymetopon infantile* Martinsson, *Garniella* sp. indet. (two early tecnomorphs), *Retisacculus* n. sp. *a* (4 tecnomorphs), *Noviportia simpliciuscula* Martinsson, Craspedobolbinidae gen. *a,* n. sp. *a* (10 heteromorphs), *Beyrichia (Beyrichia) halliana* Martinsson, *B. (B.) bicuspis* Kiesow, *B. (B.)* sp. *b, Beyrichia (Simplicibeyrichia?)* sp. *c* (2 tecnomorphs), *Beyrichia* (inc. subgeneris) echinodes n. sp., *Beyrichia (Asperibyrichia) hystricoides* Martinsson, *B. (A.) liljevalli* n. sp., *B.?* n. sp. *a* (only tecnomorphs), *Bingeria zygophora* Martinsson, *B. cyamoides* Martinsson, *B.* sp. *a* (a heteromorphic valve), *Murtiella inflata* n. gen., n. sp., *Jagatiella jagati* n. gen., n. sp., *J.?* n. sp. *a*, *J.?* n. sp. *b,* Beyrichiidae? sp. *a* (2 tecnomorphs), Beyrichiidae sp. *b* (one heteromorphic and one tecnomorphic valve).

I consider *Craspedobolbina (C.) mucronulata* Martinsson, 1962 and *C. (C.) perornata* Martinsson, 1962 to be conspecific. The types of the species came from the same locality and horizon, and the material from Vattenfallet includes specimens that are morphologically intermediate (the crista on the syllobium only partially developed). For the species the name *C. (C.) mucronulata* is used here.

The differences between *C. (C.) juguligera* and *C. (C.) mucronulata* may lie at subspecies rather than at species level, but more material from different localities needs to be studied in order to solve this problem.

The Vattenfallet material includes a number of specimens with an anterodorsally pointed syllobium and pointed anterior lobe but which are otherwise similar to the contemporaneous *Craspedobolbina (Mitrobeyrichia) unculifera*. These specimens are believed to fall within the range of variation of *C. (M.) unculifera*.

Apatobolbina? sp. *a* has a reticulated surface and a distinct preadductorial boss.

Aitilia? sp. *b* (not entered in the log) has a prominent spine on the lateral surface of the valve, ventral of S2, instead of a spine or a spur on the velar ridge as in other species of *Aitilia*. For this reason the species is only tentatively included in *Aitilia*.

Beyrichia? sp. *a* has reticulated lobes, a dorsal spine on the syllobium, and some specimens are ornamented with a sparse tuberculation on the ventral side of the valve. Since no heteromorphs have been found, the species is difficult to define at present.

Questionable Palaeocopa
Paraprimitia? sp. *a,* Lomatopisthiidae? gen. *a,* sp. *a.*

In addition to the 71 palaeocope species listed above, the material includes specimens probably belonging to additional species, which for various reasons, such as fragmentary condition or poor state of preservation of the valves, were difficult to define. Most such specimens are from Högklint *d*.

Eridostraca

Eridoconchidae: *Cryptophyllus?* spp.

The taxonomy of eridostracans at the generic level is currently in a state of flux and for this reason the species recorded from Vattenfallet are included only conditionally in *Cryptophyllus*.

Discussion

Previous knowledge of palaeocope ostracodes from Gotland was based mostly on material found in marl samples (Martinsson 1962, 1967, etc.). The study of limestone samples has essentially complemented the previous data and resulted in extended ranges of many taxa, far too numerous to be listed individually. This is especially true with regards to Högklint *c* in which marly intercalations are almost totally absent and which therefore was poorly represented among Martinssons's samples. Moreover, at Vattenfallet this subdivision has far the greatest species frequency of palaeocope ostracodes (Fig. 76).

In the palaeocope faunas the boundary between the Lower and Upper Visby Marl is remarkably sharp at Vattenfallet, being marked by the disappearance of a distinctive assemblage comprising five species (Fig. 41). With the possible exception of *Apatobolbina gutnica* the palaeocope assemblage of the Upper Visby Marl does not include any moderate to high density species which appears in the division.

Martinsson (1967) distinguished within the Högklint Beds two palaeocope faunal assemblages: The *Apatobolbina gutnica* assemblage "in the lowermost member of the Högklint Beds" and the *Craspedobolbina ornulata* assemblage "in the massively reefy parts of the Högklint Beds". The overlying Tofta Beds were reported as containing the *Bingeria* assemblage. The Vattenfallet material shows that elements of Martinsson's (1967) *Bingeria* assemblage are already present in the uppermost Högklint *b (Bingeria cyamoides, Craspedobolbina mucronulata)* or at the base of Högklint *c (Bingeria zygophora)*. The pelletal limestone in these beds at Vattenfallet, especially in Högklint *c*, is similar to that of the Tofta Beds from which this assemblage was previously recorded. This suggests that the *Bingeria* assemblage had a preference for ecological conditions associated with deposition of bahamitic sediments. It is interesting to note that I have also found *Bingeria cyamoides* in the bedded inter-reef limestones of the Halla Beds at Hörsne Kanal, in a depositional environment that may not be very much different from that of Högklint *c*. *B. cyamoides* has been recorded also in the boring Marmorbrottet 1 (Hejdeby Parish) at the levels of 3.42–3.49, 7.62–7.67 (bahamitic limestone), and 8.77–8.80 m. The quarry of Marmorbrottet (Tjautet 1) is in the upper part of Slite *e* and lower part of Slite *g*.

The *Apatobolbina gutnica* assemblage occurs at Vattenfallet in Högklint *a* and *b* (see also quantitative data, Fig. 44). *Craspedobolbina ornulata* appears at the top of the Upper Visby Marl and ranges up to Högklint *d*; however, its relative frequency is low throughout its range. Martinsson's *C. ornulata* assemblage thus appears to be restricted mainly to the reef facies, and the possibility is not excluded that at Vattenfallet the material of the species includes reef-derived valves.

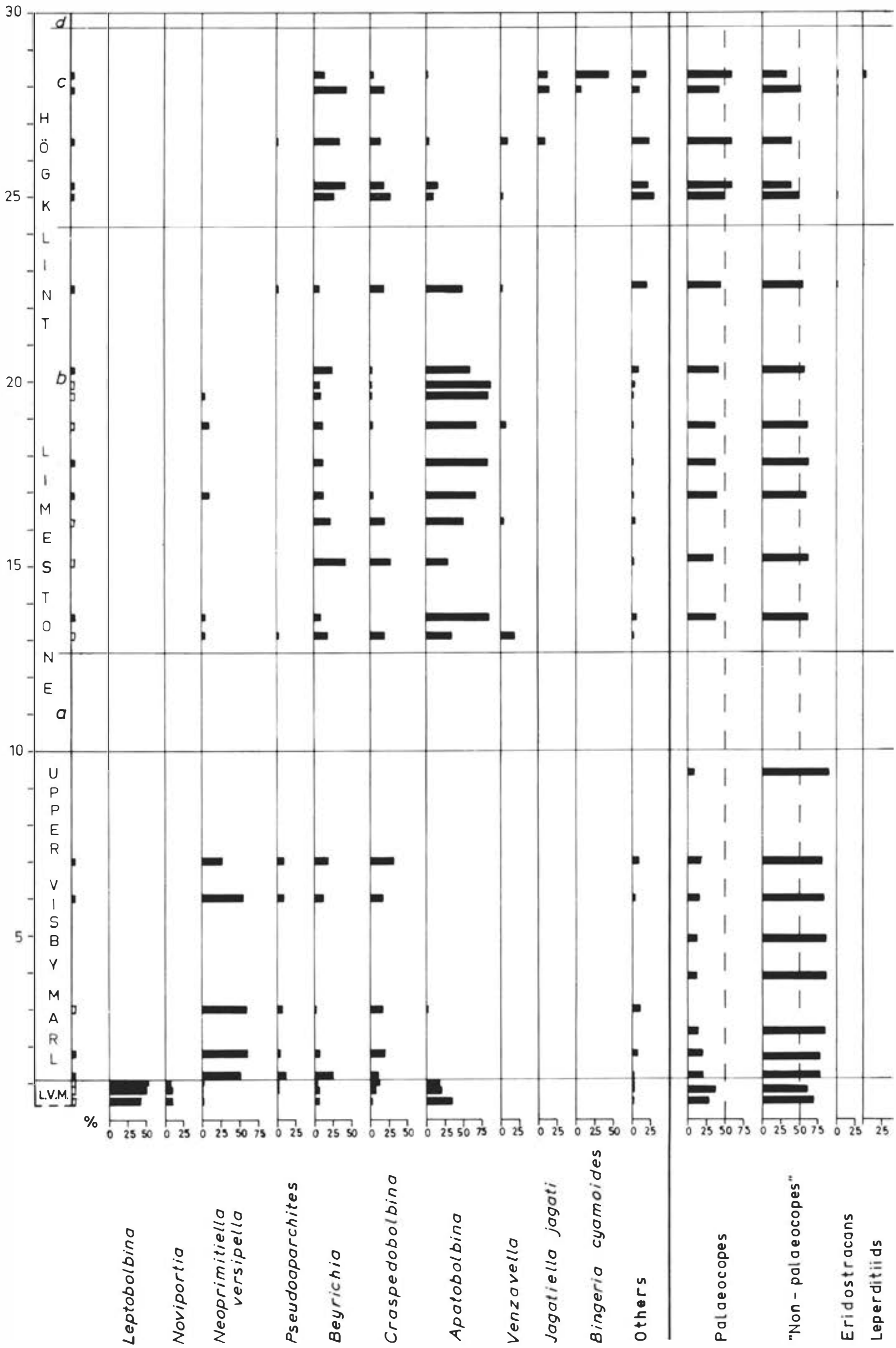
The quantitative distribution of various common palaeocope species, i.e. those which form at least ten per cent of the palaeocope valves in at least one of the samples, is shown in Fig. 44. The data were obtained by counting all palaeocope valves in a sample, and only samples that yielded more than 50 valves are recorded in Fig. 44. In several samples from the Upper Visby Marl palaeocope ostracodes were so rare that I did not succeed in finding the required minimum number of the valves. The total number of counted valves was about 6400.

In the Lower Visby Marl *Leptobolbina hypnodes* is dominant and *Apatobolbina* also occurs in high relative frequencies. The change in quantitative composition of the palaeocopes is very sharp at the boundary between the Lower and Upper Visby Marl.

In the Upper Visby Marl, where the proportion of palaeocopes among ostracodes is low, the small species *Neoprimitiella versipella* dominates. The relative frequency of this ostracode among ostracodes in general is not very much higher there than in some samples from Högklint *b*, but its importance among palaeocopes is high because of the low relative frequencies of other palaeocopes. The relative frequency of *Apatobolbina* is low.

From Högklint *a* none of the available samples yielded the minimum number of palaeocope specimens. Throughout Högklint *b* *Apatobolbina gutnica* is dominant but its importance in Högklint *c* is low. In the upper part of Högklint *c* *Bingeria cyamoides* is the dominant species. In addition to the levels recorded in the log (Fig. 44), it is also the commonest palaeocope at 28.0–28.2 m (c. 40–45 per cent; this was not entered in the log because the total number of the counted valves in the sample was somewhat less than 50).

In *Beyrichia* and *Craspedobolbina* early instars are difficult to identify at species level and therefore only genera are recorded in Fig. 44. However, the material examined indicates that in the Upper Visby Marl the dominant *Craspedobolbina* species are *C. juguligera* and *C. unculifera* whereas in Högklint *c* *C. mucronulata* dominates.



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Leptobolbina
Noviportia
Neoprimitiella versipella
Pseudoaparchites
Beyrichia
Craspedobolbina
Apatobolbina
Venzavella
Jagatiella jagati
Bingeria cyamoides
Others
Palaeocopes
"Non - palaeocopes"
Eridostracans
Leperditiids

Samples from Högklint *d* were not analysed quantitatively. However, rough estimates indicate that *Aitilia jaanussoni* is one of the commonest species. *Apatobolbina gutnica* and *Venzavella* were not found at all. In these beds the composition of the palaeocope fauna resembles to some extent that of the Přidoli Formation in Bohemia. The genera in common include *Parahippa, Mirochilina, Aechmina, Eurychilinacea?* gen. *a,* and *Clintiella* (personal observations and M. Krůta, personal communication).

Description of new taxa

Superfamily Leperditellacea

Parahippa n. gen.

Type species. – *Parahippa visbyensis* n. sp.

Diagnosis. – A non-sulcate to faintly unisulcate genus with a sulcal depression to a faint S2 some distance in front of the midheight of the valve, and a row of seven to nine prominent spines adventrally. Acroidal processes well developed.

Remarks. – The generic name *Hippa* Barrande, 1872 is a junior homonym replaced by Přibly (1949) with *Trubinella* (type species *Hippa latens* Barrande, 1872). Examination of the types of *T. latens* in the National Museum, Praha, revealed that this Ordovician species is probably close to *Oecematobolbina* and is generically distinct from the second (Silurian) species, *H. rediviva* Barrande, 1872, originally included in *Hippa* by Barrande (1872). For the latter species, as well as for a congeneric species from Vattenfallet, the new genus *Parahippa* is proposed here. By its diagnostic characters *Parahippa* is clearly distinguished from the other related ostracodes. The genus is a member of the Leperditellacea (or Aparchitacea if this group is distinguished) but the familial classification is at present uncertain.

Parahippa visbyensis n. sp.

Fig. 45A–F

Holotype. – A right valve, SGU Type 37 (Fig. 45A–B) from Högklint *d* at Vattenfallet.

Diagnosis. – Valves with a faint, straight sulcal depression dorsal of a distinct, small, rounded adductorial muscle scar.

Fig. 44. Percentage frequencies of palaeocope ostracodes (left), and of all ostracodes (right). Data on palaeocope ostracodes have been obtained by Sethi by counting at least 50 valves per sample. Only those species or genera are recorded which form at least ten per cent of the palaeocopes in at least one sample. Black rectangles along the stratigraphical column show the location of limestone samples and open rectangles the marl samples. The quantitative composition of all ostracodes has been obtained by counting at least 100 valves, up to 19 m by Jaanusson and in the upper part of the section by Sethi; only limestone samples were used.

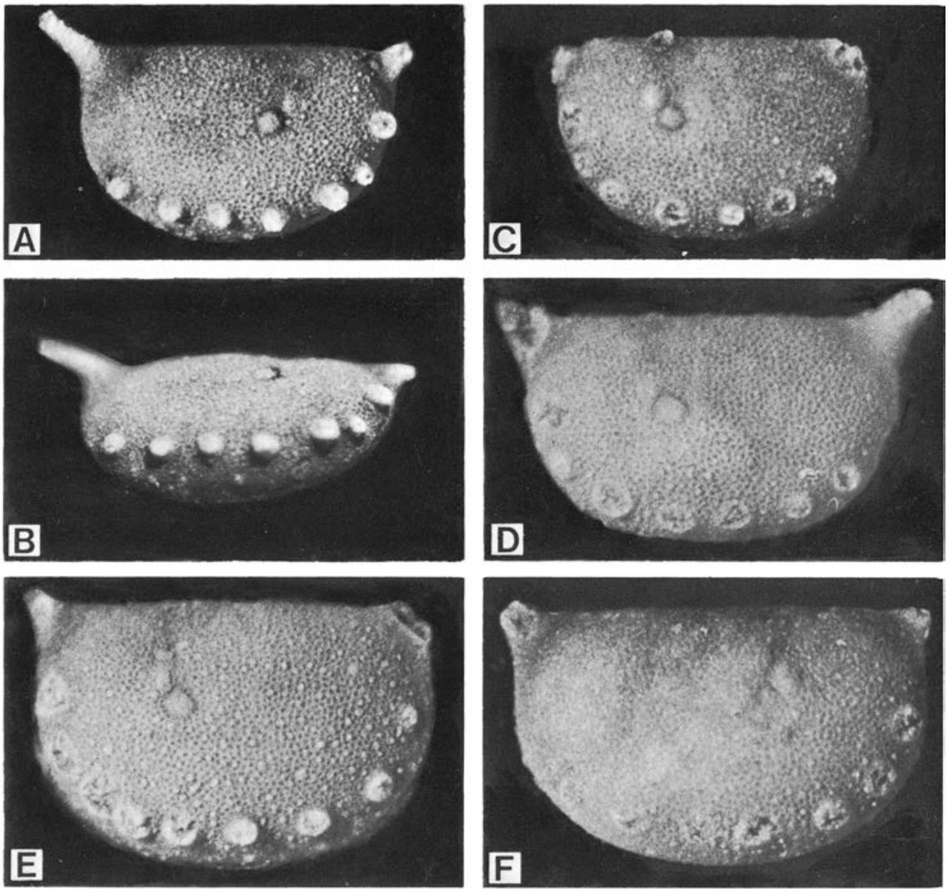


Fig. 45. *Parahippa visbyensis* n. sp. A–B. Holotype, a right valve, in lateral and lateroventral view; SGU Type 37. C. Left valve in lateral view showing the base of a spine at the dorsal margin above the adductorial muscle spot; SGU Type 38. D. Left valve in lateral view; SGU Type 39. E. Left valve with 9 spines in lateral view; SGU Type 40. F. Right valve in lateral view; SGU Type 41. All specimens are from Högklint *d* at Vattenfallet, ×50. Photograph D. Sethi.

Description. – The material examined consists of 46 valves, all except two from Högklint *d*. The species is at present known only from the type locality. The small, rounded adductorial scar is distinctly defined in all specimens. The distance between the dorsal margin of the scar and the dorsal margin of the valve equals about three times the diameter of the scar; the distance between the posterior margin of the scar and the mid-length of the valve is slightly less than twice the diameter of the scar. A faint, rounded preadductorial node is developed anterodorsal of the scar (Fig. 45F). The sulcal depression varies: it is straight and fairly well-defined in some specimens but scarcely traceable in others. The valves have a long acroidal process at both the anterior and posterior cardinal corner. The number of adventral spines varies from 7 to 9. One specimen (Fig. 45C) shows the base of a spine at the dorsal margin of the valve at the level of the adductorial scar. Surface of the valves very finely reticulate with scattered small granules.

Dimensions. – Maximum lenght–maximum height in mm: 0.80–0.49 (holotype), 1.01–0.66, 0.97–0.60, 0.94–0.66, 0.91–0.60, 0.83–0.53, 0.80–0.51.

Remarks. – *Parahippa visbyensis* differs from *P. rediviva* (Barrande) from Bohemia in the presence of a distinct adductorial scar on the lateral surface of the valve, and by having a sulcal depression instead of a faint, narrow sulcus.

Family Bolliidae

Ulrichia? palisadica n. sp.

Fig. 46A–D

Holotype. – A carapace, SGU Type 42 (Fig. 46A–D) from the Upper Visby Marl (9.2–10.0 m) at Vattenfallet.

Diagnosis. – An *Ulrichia*-like species with the posterior node only very slightly behind the mid-length of the valve, forming the dorsal termination of a crest which extends in a broad curve anteriorly and turns in front of the anterior node posterodorsally, almost reaching the dorsal margin of the valve.

Description. – The available material consists of 5 carapaces and 8 valves. The lateral surface of the valve is bordered by a crest-like carina along the whole free margin; subcarinal field slightly concave. The dorsal terminations of the nodes project somewhat beyond the dorsal margin. The posterior node is elongate, distinctly narrower than the anterior node. The crest is narrow, distinct, turns in front of the anterior node postero-dorsally and becomes obsolete slightly before reaching the dorsal margin of the valve. Lateral surface of the valve coarsely reticulate. The holotype is 0.46 mm long and has a maximum height of 0.31 mm.

Remarks. – *U.*? *palisadica* belongs to a group of species, including *Ulrichia* (*U.*) *verticalis* (Copeland 1974, Pl. 12:29–31) and *U.* (*U*). *macgilvrayensis* (Copeland 1974, Pl. 12:37–41) in which the posterior node is narrow and continues anteroventrally in a ridge of crest. The relationship of this group to the true *Ulrichia* is uncertain. *U.*? *palisadica* differs from the other representatives of the group by the development and anterior extent of the crest.

Family Aechminellidae

Vattenfallia n. gen.

Type species. – *Vattenfallia spinosa* n. sp.

Diagnosis. – A trilobate genus with L1 extending almost to the anterior margin of the valve, L2 very small and L3 reaching posteriorly to about the mid-length of the valve; L1 and L3 produced dorsally into long spines. Adductorial pit shallow but distinct.

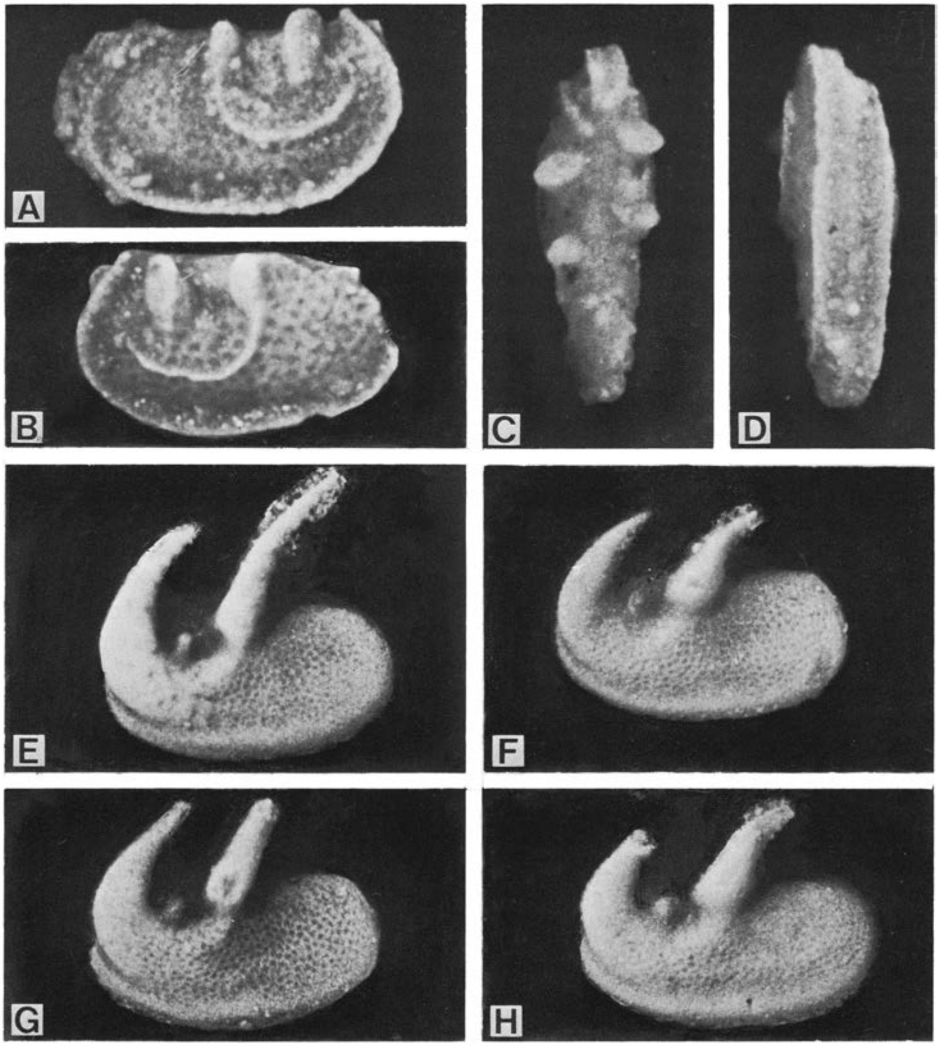


Fig. 46. A–D. *Ulrichia? palisadica* n. sp., holotype, SGU Type 42, carapace in four different views, ×70; Vattenfallet, Upper Visby Marl, 9.20–10.0 m. E–H. *Vattenfallia spinosa* n. gen., n. sp., ×50; Vattenfallet, Högklint Limestone. E. Holotype, left valve; 27.13–27.26 m, SGU Type 43. F. Left valve; 20.30 m, SGU Type 44. G. Left valve; 20.30 m, SGU Type 45. H. Left valve; 19.25 m, SGU Type 46. Photograph D. Sethi.

Remarks. – *Vattenfallia* is apparently a member of the aechminellids and this extends the range of the family down to the Lower Wenlockian. It differs from the other aechminellids most distinctly by the long, flattened post-lobate area which comprises almost half the length of the valve. The genus is at present monotypic.

Vattenfallia spinosa n. sp.
Fig. 46E–H

Holotype. – A left valve, SGU Type 43 (Fig. 46 E) from Högklint *c* (27.13–27.26 m) at Vattenfallet.

Description. – The material examined comprises 25 valves. The lobate area is confined to the anterior half of the valve. L1 strongly curved, extending anteriorly almost to the level of the anterior free margin of the valve or even protruding beyond it; L2 is formed as a minute lobe; L3 is mostly constricted proximally but the amount of constriction varies and in some specimens (Fig. 46E) it is scarcely noticeable. A small, shallow, distinct adductorial pit is developed between the bases of L2 and L3. No adventral structures, but marginal spines have been observed in some specimens. In some specimens the distal part of L3 has been observed to carry a row of small spines both anteriorly and posteriorly, giving the lobe a serrate contour in lateral view. The lateral surface of the valve is finely reticulated. The reticulation extends also to the proximal part of L1 but the rest of the spine-like lobes appear to be smooth.

Dimensions. – Maximum length–maximum height in mm: 0.70–0.37 (holotype), 0.69–0.31, 0.66–0.37, 0.63–0.34, 0.60–0.34.

Occurrence. – Upper part of Högklint *b*, Högklint *c* and Högklint *d* at Vattenfallet Fig. 42); Boring Marmorbrottet 1 (Hejdeby Parish), 36.34–36.42 m and boring Rosendal 1(Follingbo Parish), 50.70–50.80.

Superfamily Hollinacea

Diceratobolbina Jaanusson and Sethi n. gen.

Type species. – *Ctenobolbina diensti* Kummerow, 1924.

Diagnosis. – Valves unisulcate, S2 long, geniculate. Tecnomorphs with a pair of long, curved spurs on either valve, fringed and dorsally partly connected by a thin adventral flange. Heteromorphs with a broad dolon which terminates abruptly posteriorly; inner part of the dolon interiorly with four distinct locular pits and exteriorly with corresponding rounded inflations.

Discussion. – The type species (Fig. 47E–F; Kummerow 1924, Pl. 21:8; for a photograph of the holotype, see Kummerow 1943, Pl. 47:13) is represented in the Vattenfallet material by 7 heteromorphs and 51 tecnomorphs. An additional species, *D. gracilis* n. sp., is described below.

Diceratobolbina is very close to *Grammolomatella* Jaanusson, 1957 and differs from it mainly by the distinctly loculate dolon. A pair of the tecnomorphic spurs and a loculate dolon is present also in *Semibolbina* but in that genus the posterior spur is situated somewhat higher on the lateral surface of the valve and is not incorporated in the dolon.

In addition to the Lower Wenlockian of Gotland (Upper Visby Marl and Högklint Beds), *Diceratobolbina* is known also in the Wenlockian of the Oslo Region and the Upper Llandoverian of Shropshire (recorded as *Ctenobolbina* or *Parabolbina diensti;* for references see Henningsmoen (1954:58).

Diceratobolbina gracilis Sethi n. sp.

Fig. 47A–D.

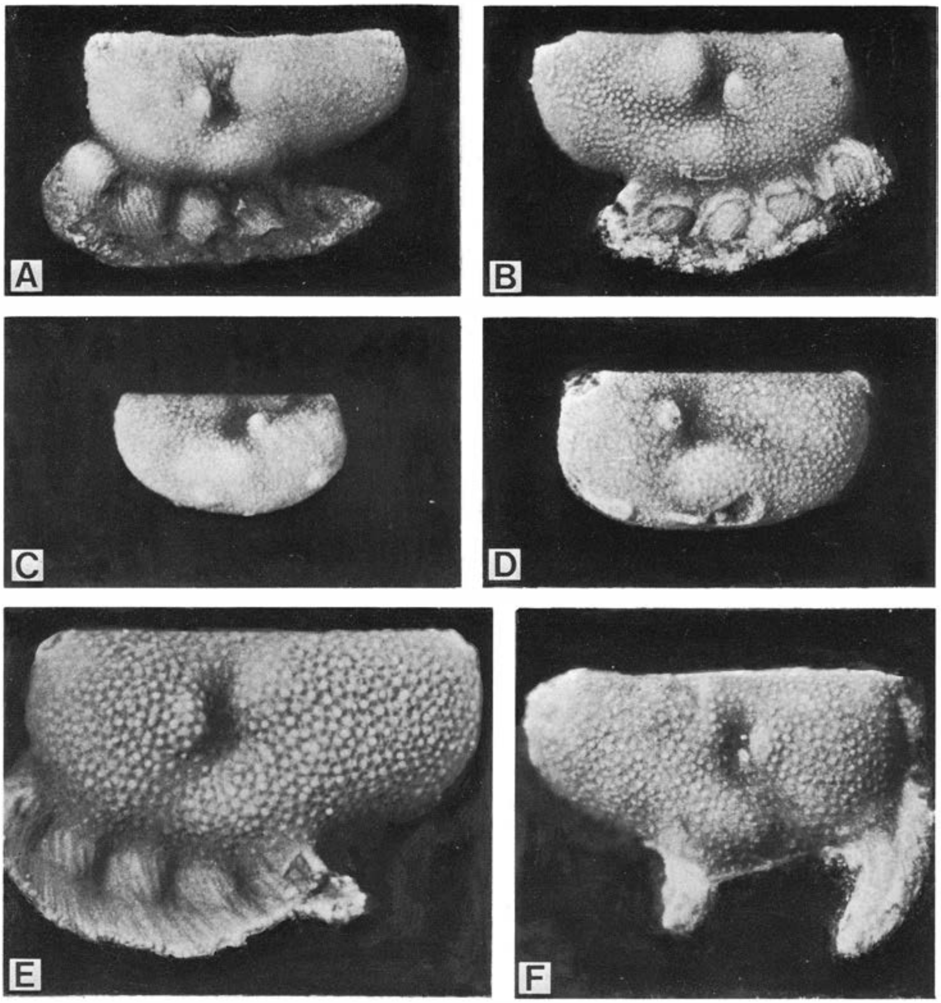


Fig. 47. A–D. *Diceratobolbina gracilis* n. sp. A. Left heteromorphic valve; 13.55 m, SGU Type 47. B. Holotype, right heteromorphic valve; SGU Type 48. 24.80–25.20 m. C. Right valve of an early instar; SGU Type 49, 25.0 m. D. Left tecnomorphic valve; SGU Type 50, 24.80–25.20 m. E–F. *Diceratobolbina diensti* (Kummerow) n. gen. E. Left heteromorphic valve; SGU Type 51, Högklint *d*. F. Right tecnomorphic valve; SGU Type 52. Högklint *d*. All specimens are from the Högklint Limestone at Vattenfallet, ×50. Photograph D. Sethi.

Holotype. – Right heteromorphic valve, SGU Type 48 (Fig. 47B), from Högklint *c* (24.80–25.20 m) at Vattenfallet.

Diagnosis. – A *Diceratobolbina* species with a faint S2 ventral of the geniculum. Valves with inflations behind the dorsal and ventral part of S2.

Description. – The material comprises 2 heteromorphic and 2 tecnomorphic valves, all from the Högklint Beds at Vattenfallet. The adult valves are much smaller and more elongate than in *D. diensti*. The spurs are broken off in the figured tecnomorphs. A thin flange appears to be developed between the bases of the spurs but details are unclear; also in *D. diensti* the exact configuration of the flange is not known because the structure is very thin and easily broken off. The dorsal part of S2 is deep, the ventral part shallow and poorly defined behind a hump-like ventral inflation of the valve; the development of the ventral hump varies: in heteromorphs it is mostly distinct whereas in tecnomorphs it may be poorly defined. Another inflation is located behind the anterior part of the sulcus: in the holotype it is well-defined and resembles both in shape and location the bulbous L3 of many post-Silurian hollinids, but in other heteromorphs the inflation is less distinctly developed and in tecnomorphs it is poorly defined. Dolon as in *D. diensti;* the locular inflations on the lateral surface of the dolon are obliquely striated. Surface of the valve otherwise densely granulate.

Discussion. – *D. gracilis* differs from *D. diensti* in its smaller adult size, poor development of the ventral part of S2, development of inflations behind S2, and a much more finely granulose surface.

Dimensions. – Heteromorphs 1 and 2 (holotype): maximum length (1) 0.77 mm, (2) 0.74 mm; height of the lateral surface (1) 0.37 mm, (2) 0.34 mm; maximum height (including dolon) (1) 0.75 mm, (2) 0.63 mm.

Superfamily Beyrichiacea

Beyrichia (Asperibeyrichia) liljevalli n. sp.
Fig. 48A–D

Holotype.—A right female valve, SGU Type 53 (Fig. 48A–B) from Högklint *c* (26.19–26.37 m) at Vattenfallet.

Diagnosis.—A species of *B. (Asperibeyrichia)* without cusps or spines on the cuspidal parts of the lobes; L1 almost completely obsolete. No lobule between the crumina and L2.

Description.—The material comprises one heteromorphic and 11 tecnomorphic valves, all from Högklint *c*. The species has not yet been found outside the type locality. Valves subamplete with almost obsolete L1. In tecnomorphs S1 very poorly developed, in several specimens obsolete; L2 thus anteriorly with an indistinct boundary, in several specimens almost completely fused with L1. The cuspidal part of the syllobium is rounded, not protruding beyond the hinge line. None of the specimens show a tendency to form any cusps or spines on the cuspidal part of the lobes. There is no syllobial groove or any tendency for the development of a calcarine spine. Early tecnomorphs provided with a short zygal ridge. The velum is developed as a low, rounded ridge. The heteromorphic valve has a shallow S1 anteroventrally. Crumina very large, reaching anteriorly to S2. Lateral surface of the valves ornamented with a coarse, sparse tuberculation; the lateral surface of the crumina is smooth but a narrow strip of the ventral cruminal surface has sparse tubercles along the velar ridge. Hinge length of the holotype 1.29 mm, height along S2 1.03 mm.

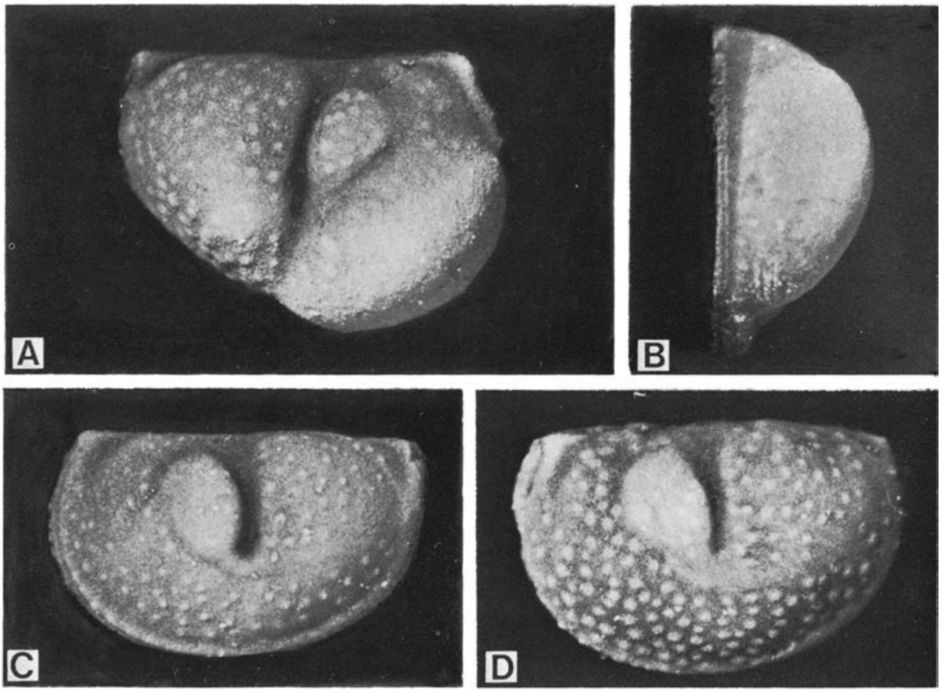


Fig. 48. *Beyrichia (Asperibeyrichia) liljevalli* n. sp. A. Holotype, right female valve; SGU Type 53, 26.19–26.37 m. B. Ventral view of the holotype (posterior end upwards). C. Left tecnomorphic valve; SGU Type 54, 25.0 m. D. Left tecnomorphic valve; SGU Type 55, 25.60–25.80 m. All specimens are from Högklint *c* at Vattenfallet, ×40. Photograph D. Sethi.

Remarks.—This species combines characteristics of two different subgenera. It shares with *Beyrichia (Simplicibeyrichia)* the marked tendency towards obsolescence of L1 and S1 and the lack of lobial cusps. On the other hand the poor differentiation of the crumina from L1 resembles that of *Beyrichia (Asperibeyrichia)*. The closest described species appears to be *B. (A.) hystricoides* Martinsson which differs clearly in having a spinous anterior lobe, and in the presence of a lobule between the crumina and S2.

Beyrichia (incerti subgeneris) echinodes n. sp.

Fig. 49A–F

Holotype.—A right female valve, SGU Type 58 (Fig. 49C) from Högklint *c* (28.60–28.80 m) at Vattenfallet.

Diagnosis.—*Beyrichia* with spinose dorsal margin in adult specimens; L1 obsolete. S2 very shallow and narrow, adductorial muscle spot well defined externally.

Description.—The number of valves examined exceeds 60. L1 not differentiated as a lobe; L2 of varying convexity, very low and indistinctly defined in some specimens. S2 narrow, very shallow, terminating ventrally in a distinct ovate muscle spot which is mostly well defined externally; the latter feature makes it easy to identify even small

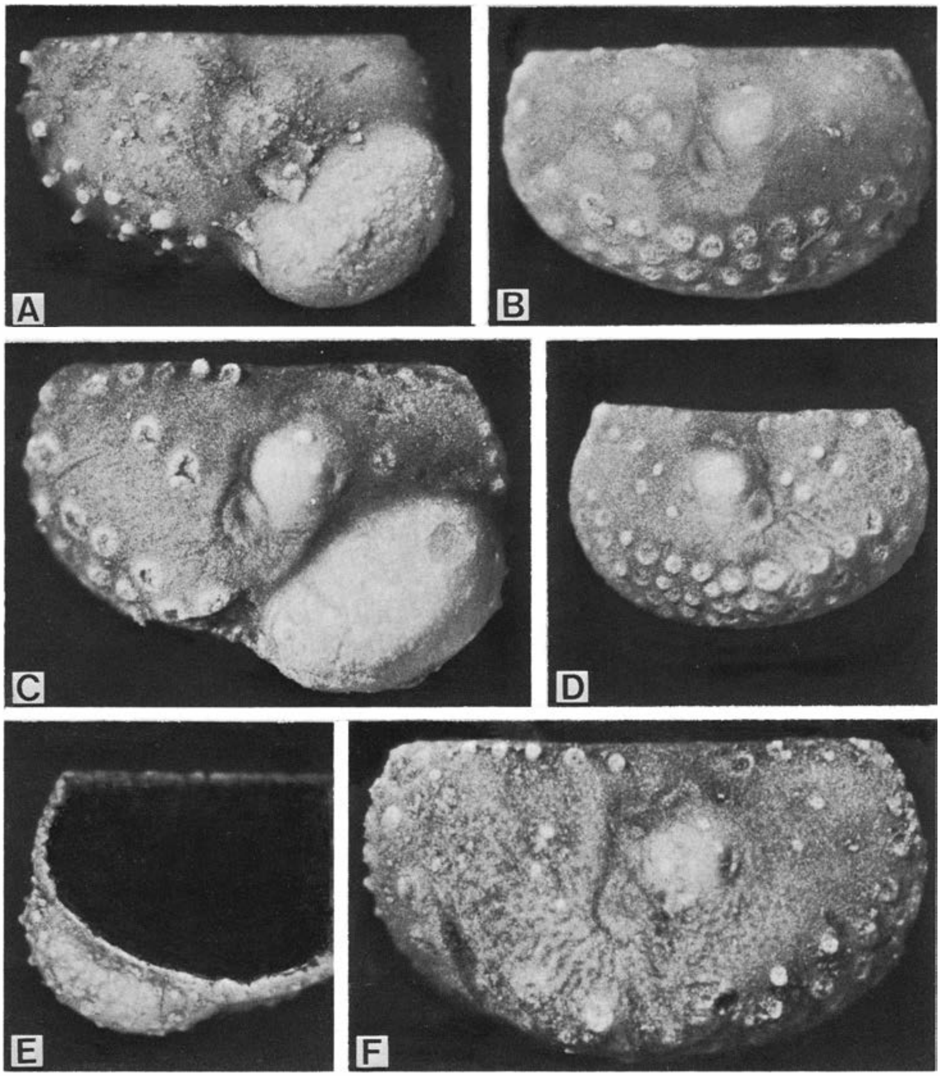


Fig. 49. *Beyrichia* (inc. subgen.) *echinodes* n. sp. A. Right female valve; SGU Type 56, 19.80–19.85 m. B. Right tecnomorphic valve; SGU Type 57, 26.64–26.73 m. C. Holotype, right female valve; SGU Type 58, 28.0–29.0 m. D. Left tecnomorphic valve; SGU Type 59, 26.28–26.37 m. E. Ventral view of the crumina of a right female valve; SGU Type 60, 19.80–19.85 m. F. Right adult tecnomorphic valve showing anastomosing "vascular" markings; SGU Type 61, 20.10–20.15 m. All specimens are from the Högklint Limestone at Vattenfallet; A–E ×40, F ×60. Photograph D. Sethi.

instars or fragmentary specimens of the species. Velar structure formed by a low, rounded ridge. Crumina strongly inflated, without striated field ventrally; the velar ridge can be traced on the ventral side of the crumina as a bend with a row of tubercles. Several specimens show traces of anastomosing "vascular" markings (Fig. 49F), recently discussed by Sohn (1974). Ornamentation consists of short spines which are normally broken off. The spines are sparsely spaced and concentrated in a row along the dorsal margin and on the ventral part of the valve; lateral surface of syllobium has two to five spines, L2 frequently has three, and the lateral surface in front of L2 has a few spines.

Remarks.—Beyrichia echinodes resembles *B. erinacea* Martinsson in having spines dorsally along the cuspidal part of the lobes. The similarity is also hinted at by the name of the species (both the Latin *erinacea* and the Greek *echinodes* mean hedgehog). It differs from *B. erinacea* in having a narrow and shallow S2 and by the obsolete L1 (*B. erinacea* has a low spinose ridge in the cuspidal part of L1).

Dimensions.—Hinge length-Sulcal height of female valves in mm. Vattenfallet specimens: 0.91–0.80, 1.06–0.77, 1.17–0.89 (holotype), 1.22–0.89, 1.31–1.00. Annelund 1 specimens: 1.29–0.91, 1.26–0.87, 1.23–0.87, 1.20–0.86. The average size of the female valves tends to increase from Högklint *b* to *d*.

Occurrence.—Högklint *b, c* and *d* at Vattenfallet (Fig. 41); Annelund 1, loose block, Högklint *c* or lowermost Tofta Limestone; Hejdeby Parish, boring Marmorbrottet 1 7.62–7.67, 24.80–24.90 and 28.70–28.79 mm and boring Katrinelund 1 3.81–3.86 and 11.60–11.64 m.

Murtiella n. gen.

Type species.—Murtiella inflata n. sp.

Diagnosis.—A small trilobate Beyrichiidae with strongly inflated large crumina which merges anterodorsally and posteriorly into the lobate area without any distinct boundary; smooth ventrally without traces of dolonal scar or ridges. Velar structure represented by a velar bend or low velar ridge; a smooth canaliculus developed in both tecnomorphs and heteromorphs.

Remarks.—The genus is at present monotypic. It is one of the smallest beyrichiaceans known. *Murtiella* has some resemblance to *Frostiella* and *Kloedenia* which also have a well-developed heteromorphic canaliculus. However, otherwise it differs from these genera in a number of characters. The name is derived from the Hindi *murti,* as beautiful as a statue.

Murtiella inflata n. sp.
Fig. 50A–G

Holotype.—A left female valve, SGU Type 62 (Fig. 50A) from Högklint *c* (25.20–26.00 m) at Vattenfallet.

Description.—The material comprises 7 heteromorphic and 25 tecnomorphic valves, all from Högklint *c*; the species has not been found outside the type locality. Tecnomorphs are distinctly trilobate. L1 strongly curved, in some specimens (Fig. 50F) separated posteroventrally from the rest of the lobate area by a depression or shallow groove; dorsal termination of L1 somewhat pointed or rounded. L2 relatively large, prominent;

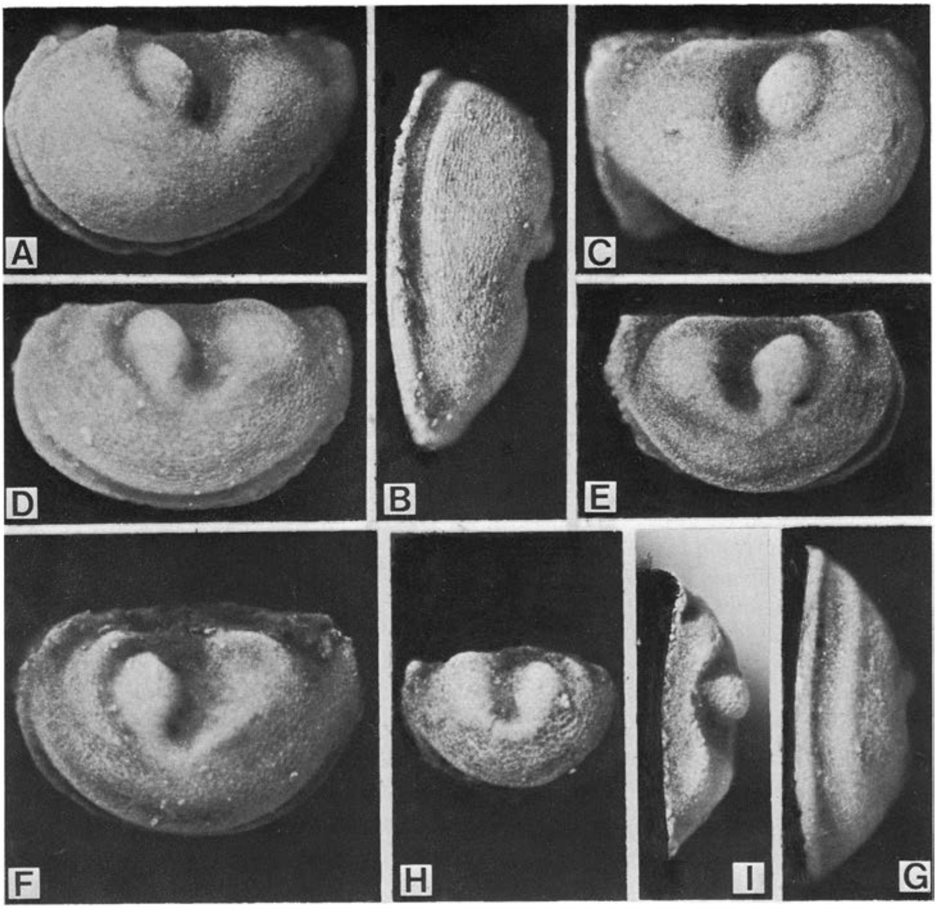


Fig. 50. *Murtiella inflata* n. gen., n. sp. A. Holotype, left female valve; SGU Type 62, 25.20–26.0 m. B. Left female valve in ventral view; SGU Type 63, 26.28–26.37 m. C. Right female valve; SGU Type 64, 25.10–25.20 m. D. Left tecnomorphic valve; SGU Type 65, 26.28–26.37 m. E. Right tecnomorphic valve; SGU Type 66, 26.46–26.55 m. F–G. Left tecnomorphic valve in lateral and ventral view; SGU Type 67, 26.91–27.0 m. H. Right valve of an early instar; SGU Type 68, 26.28–26.37 m. I. Dorsal view of a tecnomorphic valve; SGU Type 69, 25.33 m. All specimens are from Högklint *c* at Vattenfallet, ×50. Photograph D. Sethi.

shape of the syllobium variable, mostly with poorly defined ventral and posterior boundary. Dorsal boundary of the syllobium is formed by a low crest to sharp edge; the edge defines the lateral margin of a vertical, fairly high dorsum which extends from L1 to the syllobium. Cruminal inflation involves L1, except its dorsal tip, and the whole anteroventral part of the lateral surface; the inflation has no distinct boundaries on the lateral surface of the valve. Because of the inflation, S1 is much shorter and shallower than in tecnomorphs. S2 is wide, deep, and well defined. The velar structure is developed as a distinct bend or a low, rounded ridge which laterally defines a narrow, smooth canaliculus. In most specimens the lateral surface of the valve appears to be smooth but in some specimens a very fine, fingerprint-like irregular lineation is distinguishable.

Dimensions. – Hinge length – maximum height in mm; tecnomorphs: 0.83–0.60, 0.80–0.54, 0.71–0.54, 0.69–0.57, 0.63–0.46, 0.60–0.43; heteromorphs: 0.86–0.60, 0.80–0.60, 0.75–0.54 (holotype), 0.74–0.57, 0.74–0.54.

Jagatiella n. gen.

Type species. – *Jagatiella jagati* n. sp.

Diagnosis. – Smooth to finely punctate non-lobate Beyrichiidae with a distinct, large, ovate muscle spot at the mid-height of the valve and a faint sulcal depression or a narrow, straight, fissure-like sulcus extending from the muscle spot to the dorsal margin of the valve. In heteromorphs the domicilium is considerably inflated anteroventrally and ventrally; dorsally the inflated area merges into the lateral surface of the valve without a distinct boundary. The velar structure is represented by a low velar ridge.

Remarks. – In addition to the type species, the Vattenfallet material includes two further species, here referred to as *Jagatiella?* n. sp. *a* and *J.?* n. sp. *b,* which might belong to the genus. For their correct generic assignment more material is needed. A possible further species of *Jagatiella* is *Kiltsiella sarvi* (Copeland 1974, Pl.IV:1–19) from Anticosti, although it appears to lack a distinct adductorial muscle spot and seems to possess a relatively high dorsum. In this species the development of the crumina is very similar to that in *Jagatiella* whereas *Kiltsiella* has an exteriorly well-defined cruminal pouch (Sarv 1968, Pl. 3:8).

The development of the crumina in *Jagatiella* resembles that in *Noviportia* (Martinsson 1962, Fig. 138A, C), but the latter genus lacks a sulcus or a distinct sulcal depression and has a shallow adductorial pit, a high dorsal plica and a clearly different ventral morphology of the crumina.

The name is derived from the Hindi *Jagat,* earth, alluding to the rounded shape of the carapace.

Jagatiella jagati n. sp.

Fig. 51A–I

Holotype. – A right female valve, SGU Type 70 (Fig. 51A) from Högklint *c* (28.0–29.0 m) at Vattenfallet.

Description. – The material comprises more than 100 valves from Högklint *c* and *d* at Vattenfallet, some valves from a loose block at Annelund 1 (Högklint *c* or Tofta Beds) and from Katrinelund 1 boring 2.90–2.92 and 12.50–12.60 m. The sulcal structure varies from a very narrow, fissure-like straight sulcus to a very faint sulcal depression. Adductorial muscle spot relatively large, in some heteromorphic valves surrounded by a narrow depression. Only one articulated tecnomorphic carapace has been available; it shows that the right valve overlaps the left valve along the free margin but the amount of overlap is not great. The velar structure forms a rounded ridge along the whole free margin. The cruminal inflation occupies the anteroventral and ventral part of the female valve and merges dorsally into the lateral surface of the valve without a distinct

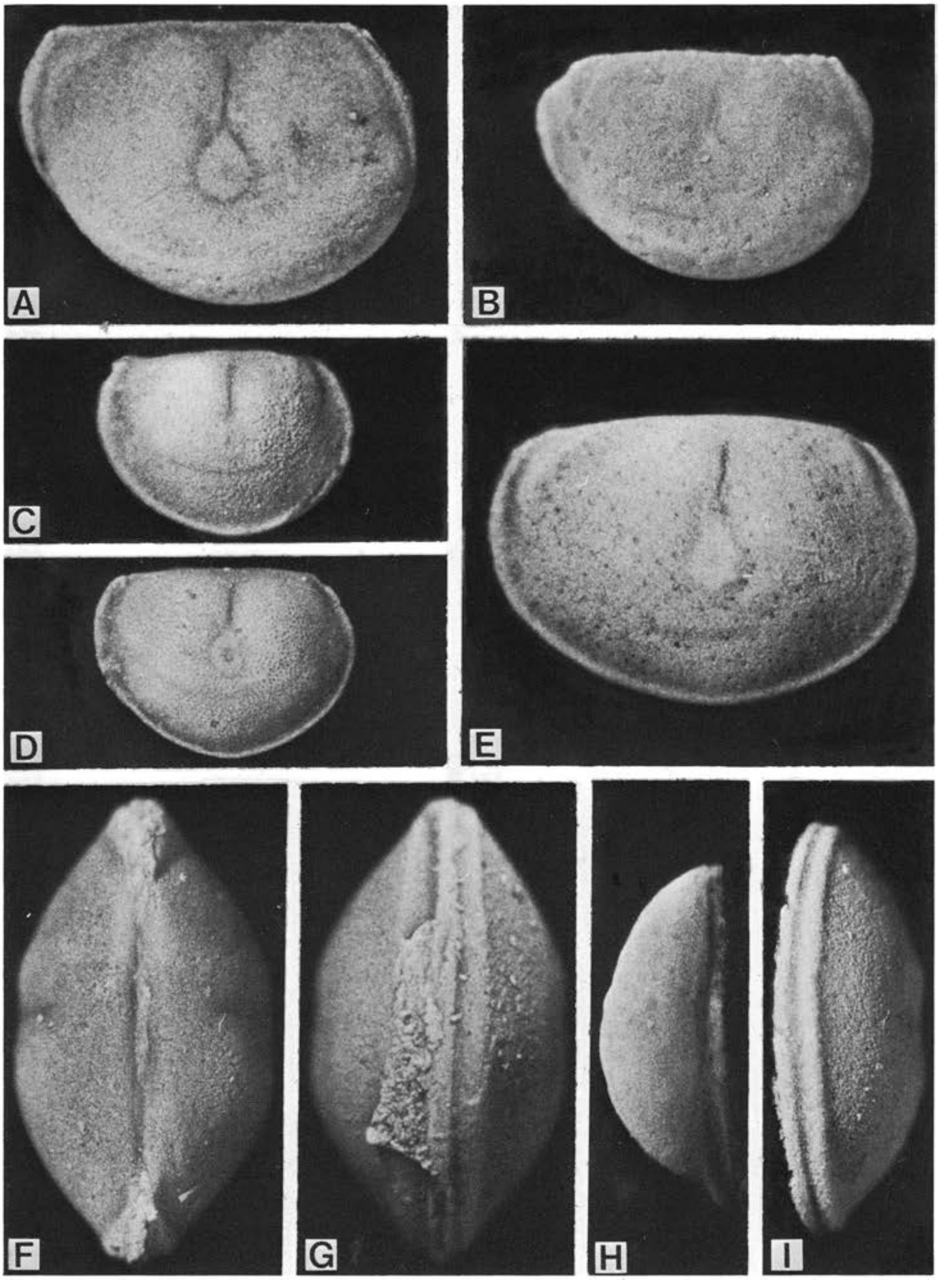
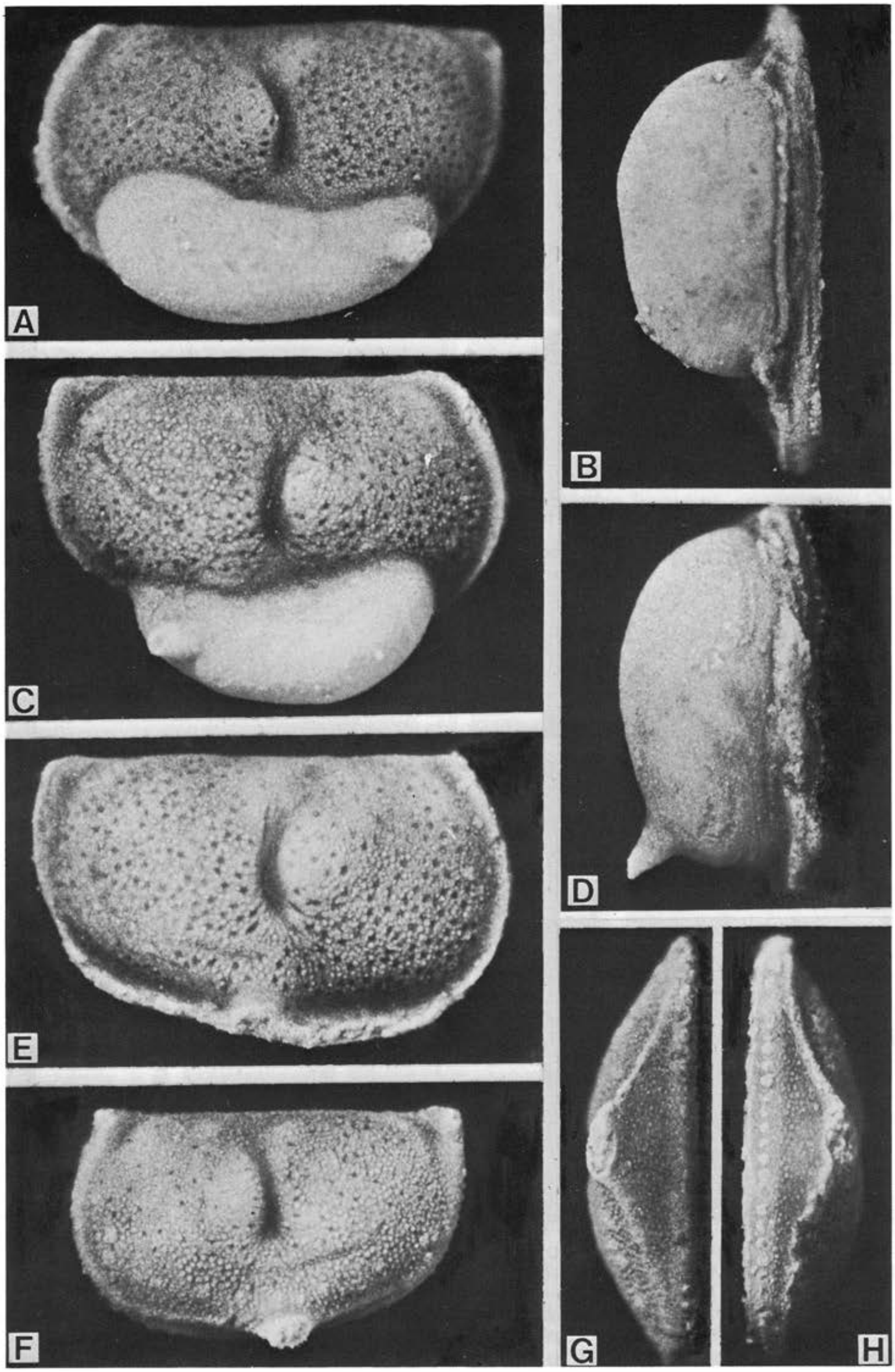


Fig. 51. *Jagatiella jagati* n. gen., n. sp. A. Holotype, right female valve; SGU Type 70, 28.0–29.0 m. B. Right female valve; SGU Type 71, 26.46–26.55 m. C. Right tecnomorphic valve; SGU Type 72, 27.65–28.00 m. D. Right tecnomorphic valve; SGU Type 73, 27.65–28.00 m. E. Right adult tecnomorphic valve; Annelund 1, Högklint *c* or lowermost Tofta Limestone; SGU Type 74. F–G. Dorsal and ventral view of a tecnomorphic carapace; SGU Type 75, 27.65–28.00 m. H. Right female valve in ventral view; SGU Type 76, 26.46–26.55 m. I. Tecnomorphic valve in ventral view; Annelund 1, Högklint *c* or lowermost Tofta Limestone; SGU Type 77. All specimens, except E and I, are from Högklint *c* at Vattenfallet. Magnification ×40. Photograph D. Sethi.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boundary or a clear change in curvature. The velar structure continues on the ventral side of the crumina as a poorly defined ridge. In many specimens the surface appears to be smooth but some show distinct scattered small pits (Fig. 51E). Several tecnomorphic valves exhibit a concentric groove parallel to the free margin, obviously forming a mark of the valve of the preceding instar (Fig. 51C).

Dimensions.—Hinge length—maximum height in females in mm. Vattenfallet: 0.94–0.89 (holotype), 0.97–0.89, 0.97–0.89, 0.86–0.77, 0.86–0.71. Annelund 1: 1.00–1.00, 0.89–0.86. Largest available specimen (Vattenfallet, measurements partly based on extrapolation of broken cardinal corner): 1.29–1.17.

Aitilia jaanussoni n. sp.

Fig. 52A–H

Holotype.—A right female valve, Riksmuseum Ar.51085 (Fig. 52C) from the "*Pterygotus*" Beds (Högklint *d*) at Vattenfallet.

Diagnosis.—*Aitilia* species with a velar ridge in heteromorphs and a velar flange on either side of the calcarine spine in tecnomorphs. Tecnomorphs with a syllobial groove and a long calcarine spine which points laterally and is situated at about the level of S2. Crumina long, with a concave contour dorsally and a calcarine spine close to the posterior end.

Description.—The material comprises more than 100 valves from Högklint *b, c* and *d* of Vattenfallet and some valves from a loose block at Annelund 1 (Högklint *c* or Tofta Beds) and from Katrinelund boring 20.45–20.47 m. Tecnomorphs with a long calcarine spine (broken off in the figured specimens) at about the level of S2; it is incorporated in the velar structure which widens considerably towards the spine and forms a triangular flange on either side of the spine (the peripheral margin of the flange is broken off in the figured specimens). In ventral view the subvelar field forms a high triangular field with the calcarine spine at its apex (Fig. 52G–H). Syllobial groove distinct, oriented roughly parallel to the free margin. Heteromorphs with a smooth sausage-shaped crumina, widest anteriorly and with a concave dorsal contour. The ventral morphology of the crumina is shown in Fig. 52B. The velar structure terminates on either end of the crumina at a laterally directed fold. A conspicuous feature is a distinct furrow (Martinsson's "dolonoid scar") parallel to the free margin. The ornamentation of the lateral surface of the valves consists of densely spaced fine granulae and scattered pits.

Dimensions.—Hinge length—maximum height (including crumina) in female valves in mm: 1.29–0.94, 1.17–0.91, 1.11–0.89, 1.09–0.89, 1.07–0.87, 1.06–0.97, 1.06–0.89, 1.03–0.79, 1.01–0.89 (holotype), 0.91–0.80.

Fig. 52. *Aitilia jaanussoni* n. sp. A. Left female valve; RM Ar. 51086. B. Ventral view of the crumina with the calcarine spine broken off; RM Ar. 51092. C. Holotype, right female valve; RM Ar. 51085. D. Ventral view of a right valve showing the calcarine spine; RM Ar. 51087. E. Right tecnomorphic valve, the calcarine spine and part of the peripheral margin of the velar flange broken off; RM Ar. 51088. F. Left tecnomorphic valve; RM Ar. 51089. G. Tecnomorphic valve in ventral view; RM Ar. 51090. H. Tecnomorphic valve in ventral view; RM Ar. 51089. In the specimens G and H the calcarine spine is broken off. All specimens are from Högklint *d* at Vattenfallet, ×50. Photograph D. Sethi.

Discussion. – This is the earliest *Aitilia* species recorded from Gotland; other species are known from the uppermost Slite, Halla, Hemse, and Eke Beds (Martinsson 1962). *A. jaanussoni* can be easily distinguished from *A. calcarulata* Martinsson and *A. hyrsinicola* Martinsson by the shape and morphology of the crumina, the relative width of the velum and the position of the calcarine spine.

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