

## Upper Ordovician Brachiopods from Västergötland, Sweden

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With 10 text-figures and 7 plates

**A b s t r a c t :** The present paper deals with brachiopods occurring in the *Dalmanitina* Beds (Uppermost Ordovician) of Västergötland, south-central Sweden. The *Dalmanitina* Beds consist of a relatively thin sequence (0.9 to 4.7 m) of light-coloured siltstone and calcarenite. The fauna consists mainly of brachiopods but there are also trilobites, bryozoans etc.

Brachiopod affinities are mainly with the *Hirnantia* fauna of Bohemia, Britain, Poland and north Sweden (Jämtland) with at least 9, 6, 5 and 5, species respectively shared.

The following species are figured for the first time: *Orbiculoidea concentrica* (WAHLENBERG, 1821), *Giraldiella bella* n. sp., *Dalmanella pectinoides* n. sp., *Horderleyella fragilis* n. sp., *Drabovia westrogothica* n. sp., *Aphanomena schmalenseei* n. gen. et n. sp., *Titanomena grandis* n. gen. et n. sp., and *Coolinia dalmani* n. sp. A new genus, *Kinnella*, is erected to embrace *Hirnantia? kielanae* TEMPLE, 1965. A new subfamily, Plectothyrellinae, is erected with the rhynchonellaceid genus *Plectothyrella* TEMPLE, 1965, as type genus. Lectotypes are selected and figured for *Orbiculoidea concentrica* (WAHLENBERG, 1821) and *Cliftonia psittacina* (WAHLENBERG, 1821). Three important species, *Meristina? terebratulina* (WAHLENBERG, 1821), *Hindella? cassidea* (DALMAN, 1828), and an undescribed rhynchonellaceid from Mt Kinnekulle, need further investigation and are not treated herein.

**Z u s a m m e n f a s s u n g :** Die vorliegende Arbeit behandelt die Brachiopoden, die in den *Dalmanitina*-Schichten (Oberstes Ordovizium) von Västergötland, Südschweden, vorkommen. Die *Dalmanitina*-Schichten sind eine verhältnismäßig dünne Folge (0,9 bis 4,7 m) von hellen Schluffen und Kalkareniten. Die Fauna dieser Schichten besteht hauptsächlich aus Brachiopoden, es kommen aber auch Trilobiten, Bryozoen u. ä. vor.

Die Brachiopoden-Fauna zeigt große Ähnlichkeit mit der *Hirnantia*-Fauna von Böhmen, England, Polen und Nord-Schweden (Jämtland), mit denen sie jeweils 9, 6, 5 und 5 Arten gemeinsam hat.

Folgende Arten werden zum ersten Male abgebildet: *Orbiculoidea concentrica* (WAHLENBERG, 1821), *Giraldiella bella* n. sp., *Dalmanella pectinoides* n. sp., *Horderleyella fragilis* n. sp., *Drabovia westrogothica* n. sp., *Aphanomena schmalenseei* n. gen. et n. sp., *Titanomena grandis* n. gen. et n. sp. und *Coolinia dalmani* n. sp. Eine neue Gattung, *Kinnella*, wird aufgestellt, um *Hirnantia? kielanae* TEMPLE, 1965 aufzunehmen. Die Gattung *Plectothyrella* TEMPLE, 1965 wird zum Generotypus der neuen Subfamilie Plectothyrellinae. Für die Arten *Orbiculoidea concentrica* (WAHLENBERG, 1821) und *Cliftonia psittacina* (WAHLENBERG, 1821) werden Lectotypen abgebildet.

Drei wichtige Arten der Brachiopoden-Fauna, *Meristina? terebratulina* (WAHLENBERG, 1821), *Hindella? cassidea* (DALMAN, 1828) und ein unbeschriebener Rhynchonellaceide vom Mt. Kinnekulle bedürfen weiterer Untersuchungen und werden hier nicht behandelt.

Previous reports of brachiopods from the

*Dalmanitina* Beds

The *Hirnantia* fauna

Material and methods

Descriptive terminology

Acknowledgments

Descriptions

Superfam. Lingulacea MENKE, 1828

Fam. Obolidae KING, 1846,

Subfam. Uncertain,

*Obolidae* gen. et sp. indet.,

Gen. *Palaeoglossa* COCKERELL, 1911,

*Palaeoglossa?* sp.,

Fam. Craniopsidae WILLIAMS, 1963,

Gen. *Paracraniops* WILLIAMS, 1963,

*Paracraniops* sp.,

Superfam. Discinacea GRAY, 1840

Fam. Discinidae GRAY, 1840,

Subfam. Orbiculoideinae SCHUCHERT & LEVENE, 1929,

Gen. *Orbiculoidea* D'ORBIGNY, 1847,

*Orbiculoidea concentrica* (WAHLENBERG, 1821),

Superfam. Craniacea MENKE, 1828

Fam. Craniidae MENKE, 1828,

Gen. *Philhedra* KOKEN, 1889,

*Philhedra* sp.,

Gen. *Petrocrania* RAYMOND, 1911,

*Petrocrania aperta* (HUENE, 1899),

Superfam. Orthacea WOODWARD, 1852

Fam. Plectorthidae SCHUCHERT & LEVENE, 1929,

Subfam. Plectorthinae SCHUCHERT & LEVENE, 1929,

Gen. *Giraldiella* WILLIAMS, 1951,

*Giraldiella bella* n. sp.,

Superfam. Enteletacea WAAGEN, 1884

Fam. Dalmanellidae SCHUCHERT, 1913,

Gen. *Dalmanella* HALL & CLARKE, 1892,

*Dalmanella testudinaria* (DALMAN, 1828),

*Dalmanella pectinoides* n. sp.,

Fam. Harknessellidae BANCROFT, 1928,

Gen. *Horderleyella* BANCROFT, 1928,

*Horderleyella fragilis* n. sp.,

Fam. Enteletidae WAAGEN, 1884,

Subfam. Draboviinae HAVLÍČEK, 1950,

Gen. *Drabovia* HAVLÍČEK, 1950,

*Drabovia westrogothica* n. sp.,

Gen. *Draborthis* MAREK & HAVLÍČEK, 1967,

*Draborthis caelebs* MAREK & HAVLÍČEK, 1967

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- Subfam. Schizophoriinae SCHUCHERT & LEVENE, 1929,  
Gen. *Hirnantia* LAMONT, 1935,  
*Hirnantia sagittifera* (M'COY, 1851), 10  
Gen. *Kinnella* n. gen.,  
*Kinnella kielanae* (TEMPLE, 1965), 11
- Superfam. Triplesiacea SCHUCHERT, 1913  
Fam. Triplesiidae SCHUCHERT, 1913,  
Gen. *Cliftonia* FOERSTE, 1909,  
*Cliftonia psittacina* (WAHLENBERG, 1821), 11
- Superfam. Plectambonitacea KOZŁOWSKI, 1929  
Fam. Leptellinidae ULRICH & COOPER, 1936,  
Subfam. Leptestiinae HAVLÍČEK, 1961,  
Gen. *Leangella* OPIK, 1933,  
*Leangella cf. scissa* (DAVIDSON, 1871), 12
- Superfam. Strophomenacea KING, 1846  
Fam. Strophomenidae KING, 1846,  
Subfam. Rafinesquininae SCHUCHERT, 1893,  
Gen. *Aphanomena* n. gen.,  
*Aphanomena schmalensei* n. sp., 13  
Gen. *Kjerulfina* BANCROFT, 1929,  
*Kjerulfina?* sp., 14  
Fam. Leptaenidae HALL & CLARKE, 1894,  
Gen. *Leptaena* DALMAN, 1828,  
*Leptaena rugosa* DALMAN, 1828, 14  
Gen. *Leptaenopoma* MAREK & HAVLÍČEK, 1967  
*Leptaenopoma trifidum* MAREK & HAVLÍČEK, 1967 15  
Gen. *Titanomena* n. gen.,  
*Titanomena grandis* n. sp., 16  
Fam. Stropheodontidae CASTER, 1939,  
Gen. *Leptostrophia* HALL & CLARKE, 1892,  
Subgen. *L. (Eostropheodonta)* WILLIAMS, 1951,  
*L. (Eostropheodonta) birnantensis* (M'COY, 1851), 17
- Superfam. Davidsoniacea KING, 1850  
Fam. Meekellidae STEHLI, 1954,  
Subfam. Chilidiopsinae BOUCOT, 1959,  
Gen. *Coolinia* BANCROFT, 1949,  
*Coolinia dalmani* n. sp., 17
- Superfam. Rhynchonellacea GRAY, 1848  
Fam. Ancistrorhynchidae COOPER, 1956,  
Subfam. Plectothyrellinae n. subfam.,  
Gen. *Plectothyrella* TEMPLE, 1965,  
*Plectothyrella crassicosta* (DALMAN, 1828), 19

### Introduction

For some time I have been studying the stratigraphy and the brachiopod fauna of the *Dalmanitina* Beds (Uppermost Ashgillian) in Sweden in order to increase the knowledge of the brachiopods in those beds. The field work in Västergötland was initiated in 1961 on a small scale and was essentially finished in 1964.

Previous to this field work very little was known about the brachiopod fauna of the *Dalmanitina* Beds in Västergötland. Some of the brachiopods were, often erroneously, referred to certain species, but a great part of the fauna was unknown.

The present paper has been much delayed since the manuscript was originally finished in 1965. The main reason for this is that the Ashgillian *Hirnantia* fauna, which was virtually unknown until 1965, has been studied recently by TEMPLE 1965 in Poland and Britain and by MAREK & HAV-

LÍČEK 1967 in Bohemia. When the first manuscript of this paper was finished approximately 15 species of those treated were not named before (some of them do not have a species name in this paper either) and 5 of the rest were only imperfectly known. The above works have caused some changes in this proportion.

### Stratigraphy and localities

The stratigraphy of the uppermost Ordovician of Västergötland will be dealt with in a forthcoming paper. As is evident from text-fig. 1 the *Dalmanitina* Beds in the area investigated include strata above the Nittsjö Formation or the Ulunda Mudstone (cf. JAANUSSON, 1963) and below the basal Silurian "*Leonaspis* Shale". Typically the unit can be divided into three lithologic divisions or members (cf. text-fig. 2). Basally, there is a calcareous siltstone (0–3.4 m thick), which is

Series	Old Stratigraphic Terminology	Current Stratigraphic Terminology	Graptolite zones
Llandovery	Retiolites Sh	Retiolites Sh	C. lapworthi M. spiralis
	Rastrites Sh	Rastrites Sh	M. discus M. revolutus D. extenuatus
Ashgill	Acidaspis Sh	Leonaspis Sh	A. acuminatus G. persculptus
	Brachiopod Sh	Dalmanitina Beds	Insufficiently known
	Staurocephalus Sh	Ulunda Nittsjö Fm	
Caradoc	Red	Mudstone	
	Tretaspis Green	Jonstorp Fm	D. complanatus
	Black	Bestorp Fm	P. linearis

Text-fig. 1: Upper Ordovician and Lower Silurian stratigraphy in Västergötland.

richly fossiliferous in some places. Generally only moulds of the fossils are preserved. The middle division (0.1–1.6 m thick) consists of arenitic (or seldom lutitic) limestone with corals and a poor shelly fauna. As a whole the top division (0.1–2.3 m thick) is similar to the basal one but it contains fewer fossils. For convenience these divisions are referred to below as the lower, middle and upper divisions of the *Dalmanitina* Beds.

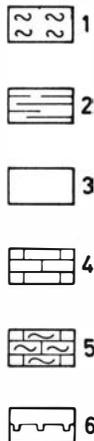
The type locality of the *Dalmanitina* Beds is Ällebergsände. The stratigraphy of the *Dalmanitina* Beds at Ällebergsände is shown in fig. 2.

Most of the localities of the *Dalmanitina* Beds studied by me have been known for a long time. In spite of this very little has been published about these localities. WESTERGÅRD (1928: 49–50; 54–57) gave detailed accounts of the localities Toran, Öglunda grotta, Ulunda and Dälderna, all on Mt Billingen. Further, TROEDSSON (1921: 6–10) described the localities Ällebergsände on Mt Älleberg, Bestorp on Mt Mösseberg, Stommen on Mt Varvsberget, and Skogastorp on Mt Plantaberget. HENNINGSMOEN (1848: 380) and WAERN (1948: 435–437) examined the *Dalmanitina* Beds in the Kullatorp core, the site of which is on Mt Kinnekulle.

The known surface localities and sites from which cores have been taken, are recorded below and in fig. 3, wherein the numbers 1 to 30 (barren localities omitted) correspond to the numbers in the list of localities. Pertinent references to the literature, if any, will be given for each locality. For practical reasons and according to custom the whole district is subdivided into three areas: (a) the Falbygden area, comprising Mts. Mösseberg, Älleberg, Gisseberg, Gerumsberget,

ÅLLEBERGSÄNDE SECTION

SERIES	FORMATIONS ETC.	THICKNESS IN METERS	COLUMNAR SECTION
ASHGILL	RASTRITES SHALE	COVERED	1
			2
	UPPER DIVISION		3
			M. DIV.
	LOWER DIVISION		4
			5
	NITTSJÖ FM		6
	7		
		CONTINUED	



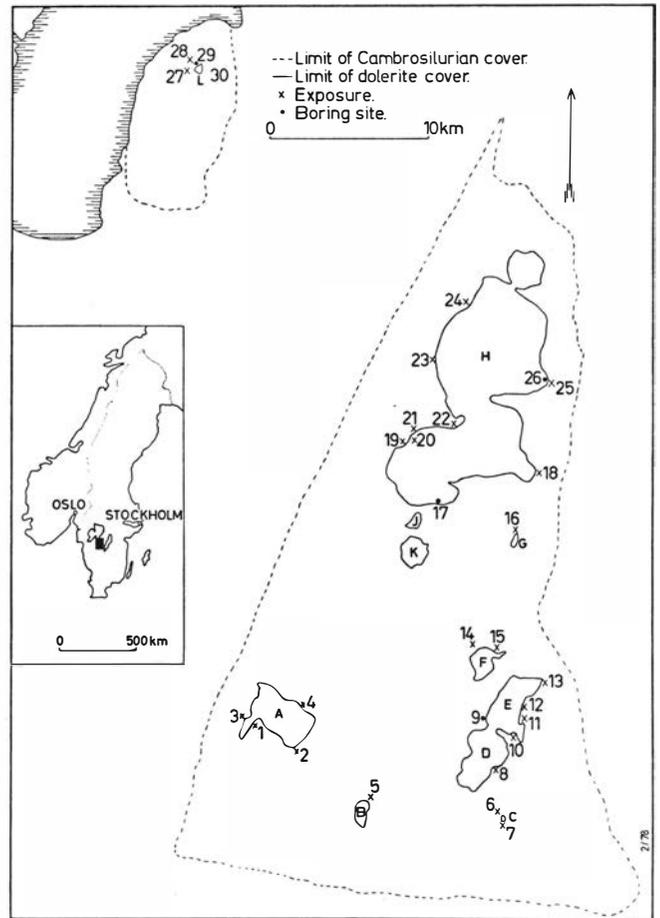
Text-fig. 2: The type section of the *Dalmanitina* Beds at Ållebergsände (locality no 5). 1, speckled mudstone; 2, light grey shale; 3, light-coloured siltstone; 4, grey calcarenite with crossbedding (lower contact abrupt with smooth surface, upper surface with indication of slight erosion); 5, grey calcilitite; 6, discontinuity surface.

Varvsberget, and Plantaberget; (b) the Billingen area, comprising Mts. Borgundaberget, Billingen, Myggberget, and Brunnhemsberget; and (c) the Kinnekulle area, comprising Mt Kinnekulle. If possible the position in the grid net of the topographical map of Sweden (Topografisk karta över Sverige) on 1:50 000 is given. The *Dalmanitina* Beds localities occur on the following map sheets: 7D Ulricehamn NV and NO; 8D Skara SV, SO, NV and NO; 9D Mariestad SV, of which only the Skara SO, NV and NO and Mariestad SV have yet been published.

(a) Falbygden area

Mt Mösseberg (map sheet Skara SV):

- 1 Vrågården (VE 103511);
- 2 Bestorp, two ravines (LINNARSSON, 1869: 52–53; MUNTHE, 1906a: 32; TROEDSSON, 1921: 8–9) (VE 130491 and VE 132492);



Text-fig. 3: Map of the investigated area with the *Dalmanitina* Bed localities indicated. The letters indicate the dolerite-capped mountains: A, Mösseberg; B, Ålleberg; C, Gisseberget; D, Gerumsberget; E, Varvsberget; F, Plantaberget G, Borgundaberget; H, Billingen;

- 3 Ässtorp, occurrence of boulders from the *Dalmanitina* Beds. No exposure is to be found at present. (VE 095514);
- 4 A locality near Jättened could not be found by the writer (LINNARSSON, 1869: 53–54; MUNTHE, 1906a: 32) (VE 133525?).

Mt Ålleberg (Ulricehamn NV):

- 5 Ållebergsände, more exactly the northernmost slope, where the present exposure dates from a rock slide in 1928 (ZENZÉN 1929: 105–115; HENNINGSMOEN's section in THORSLUND & JAANUS-SON, 1960: 13), and three small hills to the south-east of the latter locality (LINNARSSON, 1869: 51–52; MUNTHE, 1906b: 46, 64; TROEDSSON, 1921: 6–8; TROEDSSON, 1923: 425) (VE 178457–181455).

Mt Gisseberget (Ulricehamn NO):

- 6 Exposures in the western slope, not now accessible (LINNARSSON, 1869: 50–51);
- 7 Boulders on the southern slope near Trädgården.

Mt Gerumsberget (Skara SO):

- 8 Ekebacken, a brook section (VE 274478).

Mt Varvsberget (Skara SO):

- 9 Fårdala II, a core drilled by the Geological Survey of Sweden in 1945 (VE 265508);
- 10 Dimmingedalen, boulders on a small hill (VE 286498);
- 11 An unobscured exposure close to the road west of Varv (LINNARSSON, 1869: 50) (VE 294510);

- 12 St. Virvan (Tomten), apparently not exposed now (VE 292519?);
- 13 Stommen (Kungslena), a brook section (LINNARSSON, 1869: 49–50; TROEDSSON, 1921: 10) (VE 308535).
- Mt Plantaberget (= Mt Högstenaberget) (Skara SO):
- 14 Skogastorp, a brook section (LINNARSSON, 1869: 48–49; TROEDSSON, 1921: 9–10) (VE 261560);
- 15 L. Vädgården, a brook section (VE 277561).

## (b) Billingen area

## Mt Borgundaberget (Skara SO):

- 16 No exposure is known but boulders belonging to the *Dalmanitina* Beds occur on the northern slope near Pickagården (LINNARSSON, 1869: 48) (VE 291640).

## Mt Billingen (Skara SV, SO and NO):

- 17 Core drilled by Atomenergi Ltd in 1958 near Häggum pierced, among other units, the *Dalmanitina* Beds (cf. SKOGLUND, 1963: 15–16) (VE 239660);
- 18 Skultorp, quarry opened during the last decade, on the slope above the railroad station (VE 308684);
- 19 Brook section southwest of Strömsberg (WESTERGÅRD, 1928: 55) (VE 210704);
- 20 Brook section north of Strömsberg (VE 216709);
- 21 Ulunda (Pickabacken), ravine in the slope (LINNARSSON, 1869: 46; WESTERGÅRD, 1928: 49–50, 55) (VE 222716);
- 22 Storekullen road-cutting (south of St. and L. Kullen; WESTERGÅRD, 1928: 50–51) (VE 245716);
- 23 Brook section near Öglunda (Öglunda grotta) (WESTERGÅRD, 1928: 49) (VE 238771);
- 24 Slope near Toran (WESTERGÅRD, 1928: 49) (VE 261798);
- 25 An exposure west of Dälderna, no longer accessible (WESTERGÅRD, 1928: 50) (VE 313749); this locality is possibly identical with the locality southwest of Karstorp reported by WESTERGÅRD (1931: 61);
- 26 The *Dalmanitina* Beds were pierced by a core at St. Åsbotorp made by the Geol. Survey of Sweden in 1945 (cf. JAANUSSON, 1964: 30–31) (VE 31157495).

## (c) Kinnekulle area

## Mt Kinnekulle (Skara NV, Mariestad SV):

- 27 Korsbäcken, a brook section (HOLM, 1901: 58–59; WESTERGÅRD, 1943: 80) (VE 070967);
- 28 Kullatorpsbäcken, a brook section between Lukastorp and Kullatorp (LINNARSSON, 1869: 34; HOLM, 1901: 58; WESTERGÅRD, 1943: 80) (VE 072972);
- 29 Core at Kullatorp, drilled by the Palæontological Institute of Uppsala University in 1944 (WAERN, et al. 1948) (VE 074972);
- 30 Exposures on the eastern side of Mt Kinnekulle (LINNARSSON, 1869: 34; HOLM, 1901: 58).

### Previous reports of brachiopods from the *Dalmanitina* Beds

The brachiopod fauna of the *Dalmanitina* Beds in Västergötland has been dealt with by several writers, many of whom, however, have only listed genera or species reported by earlier writers. The first writer on this subject was G. WAHLENBERG (1821: 65–67, 75), who mentioned five species: *Patellites concentricus* (regarded as a mollusk), *Anomites reticularis*, *A. plicatella*, *A. rhomboidalis*, and *A. pecten*. The last four of these "species" included more than one species as we recognize them today, and since 1821 there has been much confusion regarding these names.

After WAHLENBERG the following authors have dealt with brachiopods from the *Dalmanitina* Beds in Västergötland (at

least they have given faunal lists): J. W. DALMAN, 1828, W. HISINGER, 1837, J. G. O. LINNARSSON, 1869, G. LINDSTRÖM, 1880, 1888, F. HUENE, 1899, H. MUNTHE, 1906 (b), G. TROEDSSON, 1921, G. HENNINGSMOEN, 1948, B. WAERN, 1948, and P. THORSLUND, 1958.

### The *Hirnantia* Fauna

In the last few years it has become evident that the brachiopod faunas in the uppermost Ordovician strata were fairly widely distributed. The fauna presented in this paper is of the general type called *Hirnantia* Fauna (cf. TEMPLE, 1965: 417). This fauna seems to be restricted to a muddy-silty environment. According to this investigation and to published faunal lists the following brachiopods are especially widespread and diagnostic: *Dalmanella testudinaria*, *Hirnantia sagittifera*, *Kinnella kielanae*, *Cliftonia psittacina* (or related species), *Leptaena rugosa*, *Leptaenopoma trifidum*, *Eostropheodonta hirnantensis*, and *Plectothyrella crassica*. Moreover, there are on many localities several enteletaceans and thin-shelled, flat and in some instances large strophomenaceans and davidsoniaceans. Atrypaceans and plectambonitaceans are generally absent or few in number. Among fossils others than brachiopods, *Dalmanitina mucronata* and *Brongniartella platynota* are especially distinctive.

The *Hirnantia* Fauna has been found in Britain (N. Wales and the Lake District) and Poland (TEMPLE, 1965), southern Estonia and western Latvia (MÄNNIL, 1966), Bohemia (HAVLÍČEK & VANĚK, 1966; MAREK & HAVLÍČEK, 1967), Sweden (Västergötland, Dalarna and Jämtland, this paper), and possibly in Burma (REED, 1915; TEMPLE, 1965) and South Africa (COCKS, 1967, personal communication). A brief survey of the non-endemic brachiopod elements of the *Hirnantia* fauna is given below.

Lake District, England: According to TEMPLE (1965) the following brachiopod species occur at Hol Beck (percentage frequency of articulate brachiopods according to TEMPLE; the species are arranged in order of decreasing number): *Kinnella kielanae* (32.0%), 99 specimens), *Hirnantia sagittifera* (29.5%), *Plectothyrella platystrophioides* (= *P. crassica*) (15.5%), *Dalmanella testudinaria* (10.7%), *Eostropheodonta hirnantensis* (8.1%), *Bracteoleptaena polonica* (4.2%), and *Philhedra stawyensis* (one brachial valve).

North Wales: According to TEMPLE (1965) the faunal composition at Aber Hirnant is as follows: *Bancroftina* cf. *bouceki* (34.2% of the articulate brachiopods; 81 specimens), *Eostropheodonta hirnantensis* (33.3%), *Hirnantia sagittifera* (23.6%), *Plectothyrella platystrophioides* (= *P. crassica*) (4.6%), *Kinnella kielanae* (3.0%), and *Dalmanella testudinaria* (1.3%).

Girvan District, Scotland: LAMONT (1935) reported *Hirnantia sagittifera* from the High Mains Sandstone of the Drummuck Group, the fauna of which is mainly composed of elements not belonging in the *Hirnantia* fauna.

Góry Świętokrzyskie, Poland: At Stawy the brachiopod fauna consists of the following elements in order of decreasing number (TEMPLE, 1965): *Kinnella kielanae* (58.4% of the articulate brachiopods; 676 specimens), *Dalmanella testudinaria* (17.3%), *Philhedra stawyensis* (91 brachial valves), *Hirnantia sagittifera* (13.6%), *Bracteoleptaena polonica* (4.7%), *Eostropheodonta hirnantensis* (3.8%), *Bancroftina* cf. *bouceki* (1.6%), and *Plectothyrella platystrophioides* (= *P. crassica*) (0.7%).

Southern Estonia and western Latvia: According to MÄNNIL (1966) the inadequately known *Dalmanitina* fauna includes *Dalmanella testudinaria*, *Hindella? cassidea*, *Dalmanitina* cf. *mucronata*, and *Brongniartella platynota*.

Barrandium, Bohemia: According to MAREK & HAFÍČEK (1967) the following species occur in the Kosov Formation (arranged in approximate order of decreasing numbers): *Kinnella kielanae* (several hundreds of specimens), *Dalmanella testudinaria* (several hundreds of specimens), *Eostropheodonta hirnantensis* (common), *Leptaena rugosa*, *Leptaenopoma trifidum*, *Hirnantia sagittifera*, *Cliftonia oxoplectioides* (*C. psittacina*?), *Plectothyrella platystrophioides* (= *P. crassica*), *Draborthis caelebs*, and *Bracteoleptaena polonica*. Moreover, there are several species that may be endemic.

Västergötland, south-central Sweden: According to this investigation the non-endemic elements of the fauna are *Plectothyrella crassica* (10.7% of the articulate brachiopods; 138 specimens), *Eostropheodonta hirnantensis* (9.8%), *Kinnella kielanae* (8.5%), *Hirnantia sagittifera* (8.1%), *Meristina? terebratulina* (7.0%), *Cliftonia psittacina* (6.7%), *Dalmanella testudinaria* (3.5%), *Leptaena rugosa* (3.2%), *Draborthis caelebs* (2.6%), *Orbiculoidea concentrica* (29 specimens), and *Leptaenopoma trifidum* (2.1%). The most common species, *Coolinia dalmani* (25.2%), is known only from Västergötland. This is also the case with a few species of Enteletacea and Strophomenacea.

Östergötland, south-central Sweden: In the rich fauna from Borensult, represented in Dalman's collections, there are a few representatives of the *Hirnantia* fauna, viz. *Dalmanella testudinaria*, *Leptaena rugosa*, *Leptaenopoma trifidum*, and *Meristina? terebratulina*.

Dalarna, central Sweden: *Leptaenopoma trifidum* (in Törnquist's collections) and *Meristina? terebratulina* (Wahlenberg's collection from the type locality) are known from the Upper Ashgillian Boda Limestone of Dalarna. The identification of a single specimen of *Hirnantia sagittifera* from interreef facies at Amtjärn is not quite positive.

Jämtland, northern Sweden: The railroad section at Stengärde has yielded a few specimens of *Orbiculoidea concentrica*, *Hirnantia sagittifera*, *Cliftonia* sp. (probably *C. psittacina*), and *Leptaena rugosa*. The specimens were found in 1965 in a mudstone bed, which according to THORSLUND

(1943: 6, 7, 10; 1958: 346) belongs in the zone of *Staurocephalus clavifrons*. Together with the brachiopods were also found *Dalmanitina mucronata*, *Brongniartella platynota*, and in a small concretion, *Tretaspis* sp. and a *Climacograptus* species reminiscent of *C. indivisus* (but definitely broader than this species). In spite of the presence of *Tretaspis* sp. it seems probable that the Stengärde strata represent the *Dalmanitina* Beds rather than the *Staurocephalus* Shale.

From the Upper Ordovician part of the Kyrkås Quartzite at Rannåsen Thorslund has collected a few specimens of *Leptaenopoma trifidum* together with *Dalmanitina mucronata* and *Brongniartella platynota* (cf. THORSLUND & JAANUSSON, 1960: 49).

Northern Shan States, Burma: According to TEMPLE (1965: 417) the "Llandoverly" fauna described by REED (1915) is a *Hirnantia* fauna. The fauna is still inadequately known. According to TEMPLE *Dalmanella testudinaria* (*D. mansuyi* REED?), *Bancroftina* cf. *bouceki* (*D. mansuyi*, partim?), *Kinnella kielanae* (*Scenidium? medlicotti* REED?), and *Bracteoleptaena polonica* (*Strophodonta macmahoni* REED?) may be represented in the Burmese fauna.

Material and methods

Material: By far the major part of the material studied comes from Västergötland. In the descriptions, Västergötland localities are generally recorded under "Occurrence" without any remarks as to the stratigraphic horizon; invariably, however, this is the *Dalmanitina* Bed. For one species originally described from Dalarna material from that area has been included.

Much material has been brought together through my collecting in Västergötland during the last few years. However, most of the available specimens belong to old collections. The most noteworthy of these are G. Wahlenberg's collection, housed in the Palaeontological Institute of the University of Uppsala; J. W. Dalman's collection in the Swedish Museum of Natural History, Stockholm; and S. L. Törnquist's and G. Troedsson's collections in the Palaeontological Institute of the University of Lund.

Brachiopod species	Distribution on Västergötland localities																		
	1	2	3	5	6-7	8	10	11	12	13	14	18	22	23	24	27	28	29	
Obolidae gen. et sp.		9																	
Palaeoglossa? sp.																			3
Paracraniops sp.		7																	
Orbiculoidea concentrica		15		14															
Philhedra sp.		1																	
Petrocrania aperta				R															
Giraldiella bella		2		7									2						
Dalmanella testudinaria		1		7		3	1			2	1						23	3	4
Dalmanella pectinoides		17		3										1					
Hordeleyella fragilis		6		23						2									
Drabovia westrogothica		3		9		2				1	1			1					
Draborthis caelebs	1	12		7	1	4				2			1		2	1			2
Hirnantia sagittifera	4	28	2	54	3	1	3			5	2								1
Kinnella kielanae	6	21	8	53	9	3	3		1								1	2	3
Cliftonia psittacina	1	5		29	2	3		R	2	39	1							1	1
Leangella cf. scissa														1					
Aphanomena schmalenseei		4		22	1	1			1	13									1
Kjerulfina? sp.																			35
Leptaena rugosa		5	1	19					R	13		1							2
Leptaenopoma trifidum		4		20											2	1			
Titanomena grandis		1		5															
Eostropheodonta hirnantensis	18	5	9	45	15	10	6		1	12	3								2
Coolinia dalmani				270	4	7			1	31	3						8	1	2
Plectothyrella crassica	7	28	6	37	8	15	7		3	26								1	

Text-fig. 4: Distribution of brachiopods in the *Dalmanitina* Beds in Västergötland. The locality numbers are those used in the text. The figures refer to the number of specimens counted. The letter "R" indicates that the species has been reported in the literature but has not been found in the present investigation.

The specimens recorded in text-fig. 4 are those that at present are at my disposal in Lund and which also are accompanied by information of exact locality. Unfortunately, many specimens are labeled only "Västergötland" or "Vg". In most such instances the locality must be regarded as unknown. Apart from the approximately 1200 specimens included in text-fig. 4 I have investigated at least another 3000 (exact number not counted). The most productive locality has been Allebergsände but the Bestorp and Stommen localities have also yielded large collections.

The material figured or otherwise particularly mentioned belongs to different institutes for which the following abbreviations are used:

- LM Museum of the Palaeontological Institute, University of Lund,
- RM Palaeozoological Department, Swedish Museum of Natural History (Naturhistoriska Riksmuseet), Stockholm,
- UM Museum of the Palaeontological Institute, University of Uppsala.

**Material not dealt with:** Three distinctive brachiopod species from the *Dalmanitina* Beds are not dealt with, viz. *Meristina? terebratulina* (WAHLENBERG, 1821) (? = *M? crassa* incipiens WILLIAMS; this species is not a *Cryptothyrella*), *Hindella? cassidea* (DALMAN, 1828), and an undescribed rhychonellaceid species from Mt Kinnekulle. These species need serial sectioning and a comparison with pertinent material, coming from outside Västergötland. A special study on this topic will be published separately.

**Methods:** With few exceptions the fossil specimens are represented by external and internal moulds only. Yet in some there are fragmentary shell remains (often recrystallized), and these had to be dissolved before further studies. This has not been possible in the case of *Kjerulfina? sp.*, the shells of which are found in a limestone matrix.

Casts of the moulds have been made in order to get positive material of the specimens. "Plastiform", made by AB Wilh. Becker, Stockholm, has been used for all figured casts. This material, a medium brown plasticine on a plastic base that can be polymerized if heated for 10 minutes in 150° C (300° F), has proved very useful on shells with relatively simple interior structures. However, if these structures are complicated the plasticine either does not fill the cavities in the mould or the cast will be damaged when removed. In some of the more difficult instances the jelly-like "Castoflex", made by the Castolite Company, Manufacturing Chemists, Woodstock, Illinois, U.S.A., has been tried. It is easily applied on the mould with a finger or an instrument and may be removed after drying for a couple of hours.

Before photographing all material (if not otherwise stated in the text) was whitened with ammonium chloride.

### Descriptive terminology

Recently it has been recommended (WILLIAMS, 1962: 75–76) that the radiating ribs on the exteriors of most brachiopod shells should be divided into "costae" and "costellae" depend-

ing upon whether they originate at, or outside, the protegular node. Earlier, it was the practice to think of a "coarse radial rib" as a "costa" and a "fine radial rib" as a "costella" (SCHUCHERT & COOPER, 1932: 7). Much of the material described in this paper does not allow a distinction between "costae" and "costellae" sensu WILLIAMS, because the state of preservation is not good enough. Moreover, it can be shown in at least some instances that the number of coarse distal ribs is not the same as the number of protegular ribs. Consequently, application of the above terms in WILLIAMS' sense to the present material is impracticable. In describing the costellation pattern on distal parts of valves it would be more useful to employ more subjective morphologic terms. In order to avoid confusion I have decided to use provisionally the simple morphologic term "rib" for all costae and costellae with addition of "coarse" or "fine" if necessary for the description. In other respects the terminology is that used in the Treatise on Invertebrate Paleontology, part H.

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Superfamily Lingulacea MENKE, 1828  
 Family Obolidae KING, 1846  
 Subfamily uncertain

Obolidae gen. et sp. indet.

Pl. 1 fig. 3

A few specimens on a slab of light-coloured siltstone have an

*Obolus*-like character. The available material is considered too poor to merit description. The slab is in Wahlenberg's collection in Uppsala.

Material: 9 specimens.

Occurrence: (2)<sup>1</sup> Bestorp (the lithology makes it certain that the slab was collected from the lower division).

Genus *Palaeoglossa* COCKERELL, 1911

*Palaeoglossa*? sp.

Pl. 1 fig. 1–2

Description: This species is moderately thin-shelled with a shell thickness of about 0.05 mm in the middle of a 15 mm long specimen. When full-grown it is quadrangular in outline with slightly convex, nearly parallel lateral margins. In the interior of the brachial valve a median ridge extends for 2/3 of the shell length. The interior surface is nearly smooth. The exterior ornamentation consists of faint, even growth lines, about 10 in one mm. The umbonal parts are not well preserved.

Material: 4 specimens.

Occurrence: (27) Korsbäcken (lower division).

Remarks: The posterior portions of the valves are not sufficiently well preserved to make a generic designation quite certain. However, the fine ornamentation and the brachial valve ridge seem to be features typical of *Palaeoglossa*.

Family Craniopsidae WILLIAMS, 1963

Genus *Paracraniops* WILLIAMS, 1963

*Paracraniops* sp.

Pl. 1 fig. 4–5

Description: A species with a small oval shell and exterior ornamentation consisting of concentric growth lines, medially numbering about 5 in one mm some distance in front of the umbo.

Pedicle valve interior with triangular muscle field, in which the individual muscle scars are indistinctly separated from each other. The median septum is low and short.

Brachial valve interior with a rounded triangular and moderately elevated muscle platform. The surface is rather smooth and no notable details are discernable.

Material: 7 specimens.

Occurrence: This species is only known from (2) Bestorp.

Superfamily Discinacea GRAY, 1840

Family Discinidae GRAY, 1840

Subfamily Orbiculoideinae SCHUCHERT & LEVENE, 1929

Genus *Orbiculoidea* D'ORBIGNY, 1847

*Orbiculoidea concentrica* (WAHLENBERG, 1821)

Pl. 1 fig. 7–9

1821 *Patellites concentricus* WAHLENBERG, Acta Soc. Reg. Sci. Upsaliensis 8:75.

Numbers within brackets here and in the following refer to the locality list on p. 3–4.

## Descriptions

1837 *Patella? concentrica*, — HISINGER, Kongl. Vet. Acad. Handl. 1826:45.

1921 *Discina concentrica*, — TROEDSSON, Lunds Univ. Årsskr., N. F., Avd. 2, 17, 3:6, 9, 12.

Lectotype: UM Vg 872, selected herein. The specimen is 10.5 mm long, 10.5 mm wide, and is in Wahlenberg's collection. The specimen is labelled "Mösseberg Bestorps latar".

Type stratum and type locality: *Dalmanitina* Beds, (2) Bestorp.

Diagnosis: A species of *Orbiculoidea* with exterior ornamentation consisting exclusively of concentric ridges that are more closely spaced centrally than distally; distance 0–0.8 mm in front of apex smooth; 0.8–1.8 mm with about 6 concentric ridges; 2.0–3.0 mm with about 3 concentric ridges.

Description: Shell almost circular, biconical with an ornamentation consisting of concentric ridges outside of a central, relatively smooth, area, which is about 1.5 mm across. The distance between two succeeding concentric ridges is greater towards the margin of the shell. This distance was measured in a few specimens 1 mm and 2 mm respectively from the apex (values in mm): ?, 0.20; 0.15, 0.25; 0.15, 0.30; 0.15, 0.35; 0.23, 0.37. The convexity of the pedicle valve is greatest around the subcentral apex; distally the valve seems to be nearly flat. Also the brachial valve is most convex around the subcentral apex, but on this valve the distal parts are faintly but clearly convex too. As far as can be seen the pedicle opening is short and fairly narrow.

Pedicle valve interior: The pedicle tube is not intact in any specimen but it is obvious that it occupied 2/3 of the distance between the apex and the posterior margin.

Brachial valve interior: No notable structures are visible.

Material: About 30 specimens.

Occurrence: (2) Bestorp and (5) Ällebergsände (upper division). Specimens in the Lund collections labeled "Kongslena" were probably collected at Ällebergsände. I have also found representatives of this species in the uppermost Ordovician part of the railway section at Stengärde in Jämtland, northern Sweden (1965).

Remarks: TROEDSSON (1921: 6) discussed the identity of WAHLENBERG's *Patellites concentricus* and arrived at the conclusion that it is identical with the species of "*Discina*" (= *Orbiculoidea*) that occurs in the *Dalmanitina* Beds on Mt Mösseberg, the strata and mountain from which WAHLENBERG's *P. concentricus* originates. In the beds in question there is no other species that even remotely corresponds to WAHLENBERG's description. Moreover, there are several specimens of *Orbiculoidea* in Wahlenberg's collection with the inscription "Mösseberg Bestorps latar" (lata = crevice) in Wahlenberg's own handwriting. Unfortunately, Wahlenberg's own labels are now lost, but it cannot be seriously doubted that the *Orbiculoidea* species here described is identical with *Patellites concentricus* WAHLENBERG.

Superfamily Craniacea MENKE, 1828

Family Craniidae MENKE, 1828

Genus *Philhedra* KOKEN, 1889

*Philhedra* sp.

Pl. 1 fig. 6

Description: Brachial valve very small (juvenile?), about 2.5 mm across, with subcentral umbo and radiating ribs, that number about 43 around the shell margin.

Material: One brachial valve exterior, from Wahlenberg's collection.

Occurrence: (2) Bestorp.

Remarks: This specimen seems to agree closely with *Philhedra athenae* WHITTARD & BARKER (1950: 557–558, Pl. 5, figs. 2–5), but a closer comparison is not possible because of the very poor material.

Genus *Petrocrania* RAYMOND, 1911

***Petrocrania aperta*** (HUENE, 1899)

1899 *Philhedra* (*Craniella*) *aperta* HUENE, Verhandl. Kais. Russ. Min. Ges. St Petersburg, (2), 36:316–317, Pl. 13, figs. 12 a–b.

Remarks: The type and only known specimen was collected in the "Brachiopod Shale" on Mt Älleberg by LINNARSSON. The specimen was deposited in Breslau (Wrocław) and is reported to be missing since World War II.

Superfamily Orthacea WOODWARD, 1852

Family Plectorthidae SCHUCHERT & LEVENE, 1929

Subfamily Plectorthinae SCHUCHERT & LEVENE, 1929

Genus *Giraldiella* WILLIAMS, 1951

***Giraldiella bella*** n. sp.

Pl. 2 fig. 1–4

Derivation of the name: From Latin *bellus*, beautiful. Holotype: RM. Br. 10933. A mould of a brachial valve interior, 10 mm long and about 14 mm wide.

Type stratum and type locality: *Dalmanitina* Beds, Mt Älleberg.

Diagnosis: A species of *Giraldiella* with a strongly fasciculate, biconvex shell and a shallow sulcus on the brachial valve; cardinal extremities rectangular; rib density about 2.0 in one mm 10 mm in front of apex; size small, width probably not exceeding 15 mm; muscle field in pedicle valve wide, with width/length about 1.2–1.5/1; anterior border of muscle field transverse; cardinal process low and narrow ridge without any trace of myophore thickening.

Description: Shell biconvex, with pedicle valve more convex than the brachial one. The cardinal extremities are rectangular. The brachial valve has a shallow median sulcus and the pedicle valve a corresponding low fold. The ornamentation is strongly fasciculate with rounded ribs, about 2.0 in one mm. Largest observed length and width (a brachial valve) is 10 and 14 mm respectively.

Pedicle valve interior: The valves seem to be relatively thin and the exterior costellation is distinctly reflected on the interior surface. The muscle scar area is broad and short (relation about 1.3:1), and the adductor scars do not extend beyond the diductor ones. The adductor scars are relatively broad and slightly elevated above the shell surface anteriorly. Brachial valve interior: The muscle scars are not distinctly set off, especially not anteriorly. The cardinal process shaft extends forward as a delicate median ridge that ends just posterior to the anterior-most extension of the socket ridge supports. The angle between the socket plates is about 90°. The distal part of the socket ridge is not preserved in any specimen.

Material: About 20 specimens.

Occurrence: (2) Bestorp, (5) Ällebergsände (lower, middle and upper divisions) and (22) Storekullen.

Remarks: *Giraldiella protensa* (J. de C. SOWERBY, 1839) and *G. protensa flitexta* WILLIAMS, 1951, from Llandovery strata in Wales are easily distinguished by their multicostellate ribbing pattern. *G. giraldi* BANCROFT, 1949, from Lower

Llandovery strata in Wales, is distinguished by its mucronate cardinal extremities, its elongate muscle field in the pedicle valve (longer than wide), and by the small cardinalia (the cardinal process about 1/15 of the shell length as against 1/7 in *G. bella*). *G. subsilurica* MAREK & HAVLÍČEK, 1967, from Upper Ashgillian strata in Bohemia, is different in having an ovoid muscle field in the pedicle valve and more pronounced ribs.

Superfamily Enteletacea WAAGEN, 1884

Family Dalmanellidae SCHUCHERT, 1913

Genus *Dalmanella* HALL & CLARKE, 1892

***Dalmanella testudinaria*** (DALMAN, 1828)

Pl. 2 fig. 5

1828 *Orthis testudinaria* DALMAN, Kongl. Vet. Acad. Handl. 1827: 115–116, Pl. 2, figs. 4 a–e.

1837 *Orthis testudinaria*, — HISINGER, Lethaea Svecica seu Petrificata Sveciae . . . : 71, Pl. 20, figs. 11 a–c.

1963 *Dalmanella testudinaria* — WILLIAMS & WRIGHT, Jour. Paleont. 37: 29–31, Pl. 2, figs. 7, 8, 11–13, 16–19.

1965 *Dalmanella testudinaria*, — TEMPLE, Acta Pal. Polonica 10: 383–392, Pl. 5, figs. 1–7; Pl. 6, figs. 1–7; text fig. 1 a–c.

1965 *Dalmanella testudinaria*, — WRIGHT, Treatise Inv. Paleont. H: H333, fig. 212, 3 a–e.

1966 *Dalmanella testudinaria*, — HAVLÍČEK & VANĚK, Sborník Geol. věd, P, 8: 43–44, Pl. 16, figs. 3, 7, 8.

1967 *Dalmanella testudinaria*, — MAREK & HAVLÍČEK, Věstník Ústř. úst. geol. 42: 280, Pl. 2, figs. 1–4.

Material: About 50 specimens.

Occurrence: (2) Bestorp, (5) Ällebergsände (lower division), (8) Ekebacken, (10) Dimmingedalen, (13) Stommen, (14) Skogastorp, (27) Korsbäcken, (28) Kullatorpsbäcken, and (29) core at Kullatorp. This species is also known from *Dalmanitina* Beds at Borensult, Östergötland (DALMAN, 1828), and from Upper Ashgillian beds in the Lake District, Britain, and Poland (TEMPLE, 1965). Finally, the species has been reported from the Upper Ashgillian Kosov Formation in Bohemia (HAVLÍČEK & VANĚK 1966; MAREK & HAVLÍČEK 1967).

Remarks: It is superfluous to give a description of this species because it is well known from recent studies by WILLIAMS & WRIGHT (1963) and by TEMPLE (1965). TEMPLE observed the small average size of the specimens of different species of the *Hirnantia* fauna (p. 421) and the thin shell structures (pp. 388, 391, 399) in the Polish material relative to British and Swedish material. The statistical data probably tell only a little about the genetic relationships between the different *D. testudinaria* populations, but they may be essential for understanding the different habitats. Comparisons may be made with recent mollusk species, some of which are known to vary within wide limits in size and shell thickness as a result of different environmental factors.

***Dalmanella pectinoides*** n. sp.

Pl. 2 fig. 6–9

Derivation of the name: The trivial name is taken from DALMAN's museum labels, on which the species is termed "*Orthis pectinoides*", apparently because of a supposed similarity to "*Orthis pecten*" (= *Coolinia dalmani* n. sp.).

Holotype: UM Vg 873. A mould of a pedicle valve interior, not quite complete marginally. Coll. P. T. Cleve.

Type stratum and type locality: *Dalmanitina* Beds, (2) Bestorp.

Diagnosis: A species of *Dalmanella* with rounded triangular outline; brachial valve with low convexity and a faint median sulcus; pedicle valve with relatively high convexity along the longitudinal mid-line, giving the complete shell a broad triangular cross-section; ornamentation multicostellate to nearly parvicostellate; about 3.5 ribs in one mm 10 mm in front of apex.

Description: The shell is biconvex, with pedicle valve more convex than brachial one. Brachial valve with a shallow median sulcus. The largest specimen measured is 19 mm long and 23 mm wide. The ornamentation is multicostellate, and in most specimens some ribs (costae) are slightly coarser than average. The ornamentation thus approaches the unequally parvicostellate condition. Ten mm in front of umbo the number of ribs averages 3.5 in one mm.

Pedicle valve interior: The exterior costellation is clearly traced at least distally. The muscle area is bilobed anteriorly and bordered laterally by the nearly parallel prolongations of the dental plates. The adductor ridge is rounded and broad or narrow. The diductor scars are long and narrow, and then extending farther forward than the adductor scars. There is no clear boundary between diductor and adductor scars. The dental plates are not well preserved in the material available. Brachial valve interior: A median ridge extends beyond the middle of the valve. The ridge may be fairly broad and high. In some specimens a faint indication of a ridge separates the posterior and anterior adductor scars, the anterior ones of which are the largest, especially in large valves. The outline of the anterior scar is more or less rounded, whereas that of the posterior scar is more elongated. The cardinal process is triangular in lateral view, with a thin myophore ridge. The socket ridges and their supports form strong plate-like structures. The angle between the ridges is about 65° and between the bases of the socket-ridge supports about 20° (this figure is not very exact). The fulcral plates are well developed.

Material: About 20 specimens.

Occurrence: (2) Bestorp, (5) Allebergsände, and (23) Öglunda.

Remarks: The species is most similar to "*Mendacella*" *challinori* LAMONT but differs in the uneven costellation.

Family Harknessellidae BANCROFT, 1928

Genus *Orderleyella* BANCROFT, 1928

*Orderleyella fragilis* n. sp.

Pl. 2 fig. 10–11; Pl. 3 fig. 1–4

Derivation of the name: From Latin *fragilis*, brittle.

Holotype: RM. Br. 10267. A mould of a brachial valve interior, 12 mm long and (extrapolated on one side) 16 mm wide.

Type stratum and type locality: *Dalmanitina* Beds, Mt Alleberg.

Diagnosis: A species of *Orderleyella* with distinctly angular antero-lateral corners of the pedicle valve muscle field; exterior ornamentation strongly fasciculate; fasciculation combined with soft plication.

Description: The shell is biconvex with the greatest convexity in the pedicle valve. The cardinal extremities are obtuse and the hinge line thus shorter than the greatest width of the valve. The greatest width/hinge length is in four valves: 16, 13; 14, 11; 14, 9; and 11,8 mm. The largest complete (pedicle) valve is 13 mm long and 16 mm wide. The

pedicle valve has a median fold corresponding to a sulcus on the brachial valve. The ornamentation consists of rounded ribs, of which there are 2.4 to 2.8 in one mm 10 mm in front of the umbo. In many (but not all) there are five protegular ribs that are much stronger than the rest of the ribs.

Pedicle valve interior: The adductor-scar field is fairly broad and slightly elevated. The diductor scars are relatively narrow, and reach slightly farther forward than the adductor scars. Postero-laterally, the muscle area is bounded by the delicate dental plates, the base-lines of which diverge 50° to 55° from each other. The vascula media are observable in a few specimens. Distally each vasculum forks dichotomously. No other vascula can be discerned.

Brachial valve interior: A strong median fold is a prominent feature in the interior morphology of the brachial valve. The fold corresponds to the exterior sulcus and extends to the anterior margin of the valve where it is less distinct than posteriorly. The cardinal process is a narrow ridge-like structure with a posterior edge separating two muscle attachment areas. In one well-preserved specimen the angle between the weak socket-ridges is about 58°. The socket-ridge supports are approximately parallel. The muscle scars are generally indistinct. In the only specimen where they can be observed the posterior adductor scar is small, rounded and placed far to the side. The anterior adductor scar is triangular, 1.5 times as long and twice as broad as the posterior scar. The anterior border is nearly half-way between the apex and the anterior margin of the shell. The proximal parts of the vascula media can be discerned in one specimen.

Material: About 30 specimens.

Occurrence: (2) Bestorp, (5) Allebergsände (lower and upper divisions), (13) Stommen and probably (22) Storekulen (the identification of the single specimen from this locality is not quite positive).

Remarks: Except for the present species the genus *Orderleyella* does not seem to be known elsewhere except in the Middle Ordovician of England and Wales. *H. fragilis* is different from the British species in having a muscle field in the pedicle valve with angular antero-lateral corners. The muscle field in the British species is always more or less rounded.

Family Enteletidae WAAGEN, 1884

Subfamily Draboviinae HAVLÍČEK, 1950

Genus *Drabovia* HAVLÍČEK, 1950

*Drabovia westrogothica* n. sp.

Pl. 3 fig. 8–12

Derivation of name: Latinized from Västergötland, a province of Sweden.

Holotype: LM LO 4243. A mould of a brachial valve interior, 9 mm long and 10 mm wide. Coll. J. Bergström, 1961.

Type stratum and type locality: *Dalmanitina* Beds, Stommen.

Diagnosis: Shell biconvex or plano-convex and small, largest specimen measured being 13 mm long and 15 mm wide; ribs fairly coarse, 3.0–3.5 in one mm; hinge short, with length/maximum length being 0.6–0.7/1; dental plates thin and low; muscle scars with very faint delimitations.

Description: The shell is biconvex or plano-convex, the brachial valve varying from almost flat to slightly convex. The outline is rounded with the hinge-line shorter than the greatest width. The ornamentation is ramicostellate,

relatively coarse, and there are 2.0–2.3 ribs in one mm at any distance from the apex. The largest specimen is 13 mm long and 15 mm wide. The angle between the brachial interarea and the plane of commissure is apparently about 45°.

	length	max. width	number of ribs / 1 mm	
			width along hinge	
			5 mm from apex	10 mm from apex
ped.ext.	13	15	9	2.3
ped.int.	13	13	8	2.3
ped.int.	8	10	7	
brach.int.	9	11	8	
brach.int.	9	10	6	

**Pedicle valve interior:** The exterior ornamentation is reflected in the interior of the valve. Traces of punctation have not been identified on the moulds. The teeth are badly preserved in all specimens. The dental plates are long, but low and weak, and in two specimens they diverge from each other at 68° and 79°. Immediately in front of the dental plate the border of the muscle-scar area bends anteromedially, so that the diductor-adjustor field has a triangular outline. This anterior border is, however, seldom visible. The adductor scar area is elongated, has straight borders, and does not extend as far distally as the diductors in the anterior part of the valve.

**Brachial valve interior:** The socket plate with ridge forms a high, thin, plate-like structure. The angle between the socket plates varies considerably as is indicated by figures from three valves: 52°, 61°, and 72°. There is also a considerable variability in the angle between the bases of the socket-plate figures: 8°, 23°, 31°, 22°, and 37°. The myophore area of the cardinal process is divided into two lobes by a median furrow. The anterior and posterior adductor scars are separated by a very faint, oblique ridge. The anterior scar is larger (about twice as long) than the posterior one and elongate in outline; the posterior scar is drop-shaped. A low median ridge separates left and right scar areas.

**Material:** About 20 specimens.

**Occurrence:** (2) Bestorp, (5) Allebergsände (lower and upper divisions), (8) Ekebacken, (13) Stommen, (14) Skogastorp and (23) Öglunda.

**Remarks:** *Drabovia westrogothica* differs from the contemporary *D. agnata* MAREK & HAVLÍČEK, 1967, especially in having more delicately shaped interior structures and relatively shorter hinge-line.

?Subfamily Draboviinae HAVLÍČEK, 1950

Genus *Draborthis* MAREK & HAVLÍČEK, 1967

***Draborthis caelebs* MAREK & HAVLÍČEK, 1967**

Pl. 3 fig. 5–7

1967 *Draborthis caelebs* MAREK & HAVLÍČEK, Věstník Ústř. úst. geol. 42 : 280, Pl. 2, figs. 9, 10, 16, 17.

**Description:** The shell is plano-convex, attaining a width of 14 mm and a length of 10 mm in the largest specimen studied. The ornamentation is ramicostellate; the ribs are triangular in cross-section and sharpened. The number of protegular ribs seems to be about 8 in the brachial valve, and the number of ribs along the margin of a specimen 6 mm long is about 44. The greatest width is along the transverse mid-line.

	length	max. width	number of ribs / 1 mm	
			width along hinge	
			5 mm from apex	10 mm from apex
brach.ext.	13	18	14	3.0
brach.int.	12	17		2.6
brach.int.	10	14	(10)	
ped.int.	10	13		
ped.ext.	6	7		3.5

**Pedicle valve interior:** The exterior surface ornamentation is distinctly reflected in the distal parts of the interior. The muscle scars occupy a short and broad (relation about 0.75:1) area defined laterally by the slightly diverging dental plates. The adductor scars seem to be quite broad (the width of the adductor field is apparently 1/3 of the width of the whole muscle scar) and anteriorly they reach as far as the diductor scars. In most specimens it is impossible to identify the individual scars.

**Brachial valve interior:** In adult specimens (shell length at least 9 mm) the central disc is more or less smooth outside the muscle fields. In a large specimen indistinct traces of pallial markings can be distinguished laterally. In small specimens there is a narrow ridge reaching half-way to the anterior margin of the valve. The ridge passes over into the myophore without a distinct limit. The anterior adductors, which are the largest ones, are rounded in outline, whereas the posterior adductors are triangular. Width:length is 1:1 for both adductors, and the size relation is about 1.25:1. The scars are clearly distinguishable only in the largest specimens. The brachiophores diverge from each other at about 90° or slightly less. A fulcral plate is developed.

**Material:** About 35 specimens.

**Occurrence:** (1) Vrågården (?), (2) Bestorp, (5) Allebergsände (lower and upper divisions), (6) Mt Gisseberg, (8) Ekebacken, (12) St Virvan, (13) Stommen (lower division), (18) Skultorp, (24) Toran, and (28) Kullatorpsbäcken. The species was first reported from the Upper Ashgillian Kosov Formation in Bohemia (MAREK & HAVLÍČEK, 1967).

Subfamily Schizophoriinae SCHUCHERT & LEVENE, 1929

Genus *Hirnantia* LAMONT, 1935

***Hirnantia sagittifera* (M'COY, 1851)**

Pl. 3 fig. 13; Pl. 4 fig. 1–2

1851 *Orthis sagittifera*, M'COY, Ann. Mag. Nat. Hist. 8 : 398.

1852 *Orthis sagittifera*, — M'COY, Description of the British Palaeozoic fossils . . . : 227, Pl. 1 H, figs. 15–19.

1871 *Orthis sagittifera*, — DAVIDSON, Palaeontogr. Soc. 3, 7: 260–261, Pl. 36, figs. 18–21 (non figs. 22–23).

cf. 1935 *Hirnantia sagittifera*, — LAMONT, Trans. Geol. Soc. Glasgow, 19 : 313, Pl. 7, figs. 24–28.

cf. 1951 *Hirnantia* aff. *sagittifera*, — WILLIAMS, Quart. Jour. Geol. Soc. 107 : 97–98, Pl. 4, figs. 17–18.

1956 *Hirnantia sagittifera*, — COOPER, Smithsonian Misc. Coll. 127 : Pl. 145, D, figs. 24–28.

1965 *Hirnantia sagittifera*, — TEMPLE, Acta Paleont. Polon. 10 : 394–401, Pl. 11, fig. 8; Pl. 12, figs. 1–10; Pl. 13, figs. 1–10; Pl. 14, figs. 1–8; text figs. 2 a–b, 3 c–d.

1966 *Hirnantia sagittifera*, — HAVLÍČEK & VANĚK, Sborník Geol. věd, P, 8 : 43, 60.

1967 *Hirnantia sagittifera*, — MAREK & HAVLÍČEK, Věstník Ústř. úst. geol. 42 : 279, Pl. 2, figs. 20, 22, 23.

**Description:** A species with a large, biconvex shell that has obtuse cardinal angles and its greatest width (max. about 50 mm) about half-way between hinge-line and anterior margin. The ornamentation is multicostellate.

**Pedicle valve interior:** The muscle-scar area is lanceolate, being widest near the anterior end, with markedly raised borders. The width is about twice that of the distance between the tooth apexes, and the length about  $\frac{1}{5}$  of the shell length. The exterior rib pattern is visible everywhere outside the muscle area and no pallial markings have been observed.

**Brachial valve interior:** The length of the muscle-scar area (measured from the umbo) is about  $\frac{1}{2.5}$  of the shell length. The cardinal process seems to be simple rather than bilobed. Anteriorly it tapers abruptly when running over into the narrow shaft, which is quite low and not raised into a septum. There are no fulcral plates. The socket-ridge supports diverge about  $40^\circ$  from each other in a few badly preserved specimens.

**Material:** About 95 specimens.

**Occurrence:** This species is known from (1) Vrågården, (2) Bestorp (lower division), (3) Ässtorp, (5) Ällebergsände (lower and upper divisions), (7) Mt Gisseberg, (8) Ekebacken, (10) Dimmingedalen, (13) Stommen, (14) Skogastorp, possibly (28) Kullatorpsbäcken, and (29) the Kullatorp boring core (35.65–35.68 m). It has also been collected (1965) in the uppermost Ordovician part of the railway section at Stengårde, Jämtland. Outside Sweden the species occurs in Upper Ashgillian strata in Wales and Scotland (LAMONT, 1935) and possibly in Llandoveryan beds in Wales (WILLIAMS, 1951; it may be a related species). Moreover, TEMPLE (1965) reported it from the Lake District of North England and from the uppermost Ordovician in Poland. It has also been collected from the Ashgillian Kosov Formation in Bohemia (MAREK & HAVLÍČEK, 1967).

#### Genus *Kinnella* n. gen.

**Derivation of name:** From Swedish Kinne which is used as component in geographical names in the Kinnekulle area.

**Type species:** *Hirnantia? kielanae* TEMPLE, 1965.

**Diagnosis:** Biconvex enteletids with high, catacline pedicle valve interarea and relatively low brachial valve interarea; ornamentation multicostellate, possibly with some ribs slightly coarser than the others; some ribs apparently hollow (cf. TEMPLE, 1965: 403, 405); delthyrium and notothyrium open; muscle field of pedicle valve rounded and marginally elevated, with lateral margins subparallel; width of muscle field about equal to distance between tooth apexes; cardinal process with bilobate myophore; process anteriorly continuing into thick and elevated, septum-like shaft.

**Species assigned to the new genus:** *Hirnantia? kielanae* TEMPLE, 1965.

#### *Kinnella kielanae* (TEMPLE, 1965)

Pl. 4 fig. 3–6

1948 *Schizorammina* sp., — HENNINGSMOEN, Bull. Geol. Inst. Uppsala 32: 400, Pl. 24, figs. 13–16.

1965 *Hirnantia? kielanae* TEMPLE, Acta Palaeont. Polon. 10:401–407, Pl. 8, figs. 1–7; Pl. 9, figs. 1–8; Pl. 10, figs. 1–8; Pl. 11, figs. 1–7; text figs. 2 c–f, 3 a–b.

1967 *Hirnantia kielanae*, — MAREK & HAVLÍČEK, Věstník Ústř. úst. geol. 42: 280, Pl. 2, figs. 5–8.

**Description:** Relatively small shells, attaining a maximum width of about 12 mm. It is unequally biconvex with the pedicle valve most vaulted. The length is about  $\frac{3}{4}$  of the width. Punctae have been observed in the specimen figured by HENNINGSMOEN (1948). The length of the pedicle valve interarea is half the valve length or slightly less. The pedicle and brachial interareas are catacline and anacline respectively. The greatest width is somewhat in front of the hinge-line, and the cardinal angles are thus obtuse. The brachial valve is slightly sulcate. The margin is rounded, and may or may not bear a very slight indentation anteriorly. The surface is multicostellate: the ribs are of subequal size and 3 to 4 of them occur in one mm at a point 5 mm in front of the umbo.

**Pedicle valve interior:** The muscle-scar area is elevated above the shell surface. The anterior border of the scar area is rounded. The separate muscle scars are long and very narrow.

**Brachial valve interior:** The cardinalia are of the type described in the generic diagnosis. Fulcral plates are present. The anterior and posterior adductor scars are separated by a faint transverse ridge. The anterior scar has a rounded triangular outline whereas the posterior scar is more elongated. The median ridge is fairly inconspicuous in small specimens. In larger ones it is more or less rounded, very massive, and occupies only about the posterior  $\frac{2}{3}$  of the valve length.

**Material:** 110 specimens.

**Occurrence:** (1) Vrågården, (2) Bestorp (lower division), (6–7) Mt Gisseberg, (8) Ekebacken, (10) Dimmingedalen, (12) St Virvan, (27) Korsbäcken, (28) Kullatorpsbäcken, and (29) the Kullatorp core (35.56–35.68 m). The species also occurs in Ashgillian strata in Poland and in Great Britain (Wales and the Lake District) (TEMPLE, 1965) and also in Bohemia (MAREK & HAVLÍČEK, 1967).

**Remarks:** TEMPLE (1965: 406) pointed out the possibility that *K. kielanae* may be conspecific with *Scenidium? medlicotti* REED, 1915. This may be true, but if so REED seems to have pictured the delthyrium too wide (REED, 1915, Pl. 10, fig. 24), and he also states in the text that the brachial valve does not have a median sulcus, the presence of which is typical of *K. kielanae* (although it is quite shallow).

Superfamily Triplesiacea SCHUCHERT, 1913

Family Triplesiidae SCHUCHERT, 1913

Genus *Cliftonia* FOERSTE, 1909

#### *Cliftonia psittacina* (WAHLENBERG, 1821)

Pl. 4 fig. 7–8; Pl. 5 fig. 1–2

1821 *Anomites psittacinus* WAHLENBERG, Acta Soc. Reg. Sci. Upsaliensis 8: 65.

1828 *Atrypa reticularis*, — DALMAN, Kongl. Vet. Acad. Handl. 1827: 43 (127) (partim); non Pl. 4, fig. 2.

1837 *Atrypa reticularis*, — HISINGER, Lethaea Svecica . . : 75 (partim); non Pl. 21, figs. 11 a–c.

1880 *Atrypa altijugata* LINDSTRÖM, Fragmenta Silurica . . : 23, Pl. 13, figs. 9–13.

cf. 1905 *Atrypa imbricata*, — REED, Geol. Mag., N. S., Dec. V, 2: 451–452, Pl. 23, fig. 16.

1921 *Atrypa reticularis*, — TROEDSSON, Lunds Univ. Årsskr., N. F., Avd. 2, 17, 3: 7, 12.

1921 *Atrypa imbricata*, — TROEDSSON, Lunds Univ. Årsskr., N. F., Avd. 2, 17, 3: 7, 9, 12.

cf. 1951 *Cliftonia (Cliftonia) lamellosa* WILLIAMS, Quart. Jour. Geol. Soc. 107: 105, Pl. 5, figs. 12–15.

cf. 1967 *Cliftonia oxoplecioides*, — MAREK & HAVLÍČEK, Věstník Ústř. úst. geol., 42, 4:281, Pl. 2, figs. 18, 21.

Lectotype: UM D. 1175, a complete specimen. Coll. G. Wahlenberg. Height 12 mm, width 18 mm, length 14 mm.

Type stratum and type locality: Boda Limestone, Osmundsberget, Dalarna.

Description of the Dalarna material: (The description is based on the Osmundsberget population.) Shell biconvex, uniplicate and moderately large. Pedicle valve with apsacline interarea; brachial interarea rudimentary. The cardinal angles are obtuse and the maximum width is along or in front of the transverse mid-line. The surface ornamentation consists of strong concentric growth lamellae (1.0 to 1.7 in one mm) and radial ribs in a multicostellate pattern. The number of ribs is about 5 (4–6) in the sulcus and 6–7 (4–8) along a growth lamella on the fold at a point 10 mm in front of the apex (measured along the shell surface). The number of ribs along the same growth lamella on the lateral flank is between 6 and 16, the variation depending in part upon how near the hinge-line the ribs are discernible. The height (perpendicular to the main commissure plane), width, and length (in the main commissure plane) of Osmundsberget specimens (Br. 7444–72, 102299–302) are given below:

height/width/length			height/width/length		
21	20	17	14	19	15
20	22	19	14	18	15
19	21	18	14	18	14
18	22	19	14	15	14
18	21	20	13	18	14
18	21	18	13	17	14
18	21	15	13	16	13
18	17	17	12	18	15
17	21	18	12	18	15
16	20	15	12	17	15
15	19	15	12	16	15
14	18	15	11	17	13
14	18	14	11	16	16
14	20	16	11	16	13
14	19	16	10	15	12
14	19	16	10	13	11
14	19	15	8	13	11

Material from Dalarna is treated herein only for comparative purposes.

Description of the Västergötland material: Much of the Västergötland material is flattened and destroyed, hence a direct comparison with *Cliftonia psittacina* material from Dalarna is difficult. One of two measurable individuals (Br. 10525, from Älleberg) is 11 mm high, 20 mm wide and about 11 mm long. However, it is somewhat irregularly compressed. The other specimen (from Korsbäcken, lower division) is 12 mm high, 18 mm wide and 17 mm long. Especially the height is probably slightly diminished by exfoliation. The average number of ribs is about 5 (4 to 5) in the sulcus and about 10 on the lateral flank at a point 10 mm in front of the umbo (measured along the shell surface). The size of the specimens is generally comparable with that of the Osmundsberget population. However, some of the specimens, especially those from siltier and less calcareous sediment, are considerably larger than the largest

specimens from Dalarna. One of them is about 30 mm wide. At least to some degree this difference is the result of flattening of the Västergötland specimens.

Pedicle valve interior: There seems to have been a short pedicle tube (cf. WRIGHT, 1963: 744–745). The dental plates are strong and united with the shell floor by callus matter. The muscle scars are diffuse.

Brachial valve interior: The cardinal structures are delicate. Only the basal part of the cardinal process has been observed.

Material: 32 specimens from Osmundsberget, Dalarna, and about 80 specimens from localities in Västergötland.

Occurrence: *Dalmanitina* Beds at (1) Vrågården, (2) Bestorp, (5) Allebergsände (lower and upper divisions), (6–7) Mt Gisseberg, (8) Ekebacken, (10) Dimmingedalen, (11) Varv (according to LINNARSSON, 1869: 50), (12) St Virvan, (13) Stommen (lower division), (14) Skogastorp, (27) Korsbäcken, (28) Kullatorpsbäcken (lower division), and (29) Kullatorp core (lower division: 35.40–35.68 m). *Cliftonia psittacina* also occurs in the Boda Limestone in Dalarna (cf. the above treatment), and in the uppermost Ordovician siltstone at Stengårde in Jämtland (collected in 1965). The same species may be represented in Wales in the lowermost Llandovery (WILLIAMS 1951; cf. the synonymy list).

Superfamily Plectambonitacea KOZŁOWSKI, 1929

Family Leptellinidae ULRICH & COOPER, 1936

Subfamily Leptestiinae HAVLÍČEK, 1961

Genus *Leangella* OPIK, 1933

*Leangella* cf. *scissa* (DAVIDSON, 1871)

Text-fig. 5

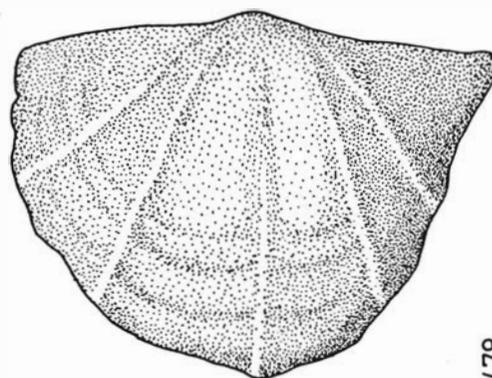
cf. 1871 *Leptaena scissa* DAVIDSON, Palaeontogr. Soc., 3:325–326, Pl. 47, figs. 21–23 (non figs. 24–25).

cf. 1917 *Plectambonites scissa*, — REED, Trans. Roy. Soc. Edinburgh, 51: 880–881, Pl. 14, figs. 34–35.

cf. 1917 *Plectambonites segmentum* var. nov. *woodlandensis*, — REED, Trans. Roy. Soc. Edinburgh, 51: 881, Pl. 14, figs. 36–41.

cf. 1928 *Leptelloidea scissa*, — JONES, Mem. Geol. Surv. Great Britain, 1: 481–485, Pl. 25, figs. 8–12.

cf. 1965 *Leangella scissa*, — WILLIAMS, Treatise Inv. Paleont., H376, fig. 242: 2 a–c.



Text-fig. 5: *Leangella* cf. *scissa* (DAVIDSON, 1871), the single specimen found. LM LO 4247.

**Description:** The pedicle valve is strongly vaulted in the central part, whereas the cardinal angles are flattened. The exterior ornamentation consists exclusively of five distinct ribs, one of which is median. There are faint growth lines. The width is 6 mm, the length 4.5 mm, and the height about 1.2 mm.

**Material:** 1 specimen. Coll. J. Bergström, 1962.

**Occurrence:** The single Västergötland specimen was found at (22) Storekullen. In collections there occur similar specimens from the Ashgillian Boda Limestone in Dalarna. *Leangella scissa* has been reported from Ashgillian strata in Shropshire and from Llandoveryan strata in Wales and Scotland (cf. JONES, 1928).

Superfamily Strophomenacea KING, 1846

Family Strophomenidae KING, 1846

Subfamily Rafinesquininae SCHUCHERT, 1893

Genus *Aphanomena* n. gen.

**Derivation of the name:** From Greek *αφανης* indistinct, hidden, and *μηννη* crescent.

**Type species:** *Aphanomena schmalenseei* n. sp.

**Diagnosis:** Large strophomenids of *Kjaerina*-like type with flat or slightly concave brachial valve; without geniculation; ornamentation unequally parvicostellate with undulating ribs; no median thickened ribs; rugae either missing or very fine; chilidium with median sulcus; cardinal process myophore knobs not thinly blade-shaped, and with myophore groove; socket ridges with denticles; muscle scars indistinct, ventral muscle scars not bounded by subparallel ridges; pseudopunctae small.

**Species assigned to the new genus:** *Aphanomena schmalenseei* n. sp., *Orthis luna* G. LINDSTRÖM, 1880, and *Rafinesquina ultrix* MAREK & HAVLÍČEK, 1967.

**Remarks:** The genus seems to be related to *Kjaerina* (*Kjaerina*) and *K. (Hedstroemina)* but differs in the development of the cardinal process knobs, which are much stouter (not blade-formed) and have a myophore groove on the posterior surface. On the postero-lateral side of the socket ridge there is a series of denticles, which possibly are also developed in some (undetermined) *K. (Hedstroemina)* species. A smooth interior is also shared with the two subgenera mentioned. *K. (Kjaerina)* differs especially from *Aphanomena* in having long, subparallel ridges bounding the ventral muscle scar area and in having a thickened median rib. *K. (Hedstroemina)* is often distinguished by having rugae and geniculation. The chilidium has a median sulcus and is, in this respect, similar to the chilidium in *K. (Kjaerina)*, *K. (Hedstroemina)*, *Leptaenopoma*, *Titanomena* and other genera and subgenera but differs from the evenly rounded chilidium found in *Macrocoelia*, *Oepikina* and *Strophomena*.

***Aphanomena schmalenseei* n. sp.**

Pl. 5 fig. 3–6; Text-fig. 6

**Derivation of name:** In memory of G. C. von Schmalensee, a fossil collector, who on his collection labels noted the difference between this species and *Coolinia dalmani* n. sp.

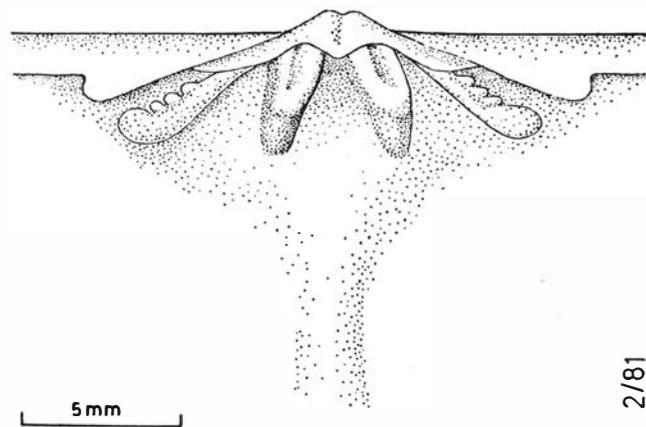
**Holotype:** LM LO 4248. A mould of a brachial valve interior, slightly fragmentary marginally. Coll. G. Troedsson.

**Type stratum and type locality:** Lower division of the *Dalmanitina* Beds, Allebergsände.

**Diagnosis:** An *Aphanomena* species (cf. diagnosis of genus) with ribs that are markedly irregular in plan view; rugae missing; concentric striation very faint.

**Description:** A large, flat and thin-shelled *Aphanomena* species with a brachial valve that is slightly concave immediately anterior to the umbo. Maximal observed length and width 39 and 55 mm respectively. The greatest width is along the hinge-line. The ornamentation is unequally parvicostellate; however, in some specimens the difference between ribs of different coarseness is very small. Twenty mm in front of the umbo, 3.4 to 4.2 ribs have been counted in one mm. The variation depends partly on the variable number (1 to 7) of fine ribs between two coarser ones. A very fine concentric striation crosses the radiating ribs. The interarea is low. The chilidium is high, with a median sulcus. The delthyrium is open.

**Pedicle valve interior:** The interior surface of both valves is a mirror image of the exterior surface; in large specimens it may be quite smooth. Each tooth has on its anterior surface a series of small pits (6 in one well-preserved specimen) which interlock with denticles on the socket ridge. The dental plates are fairly short. Other structures are not easily discernable. The muscle-scar area seems to have been fairly large; the length was possibly nearly half that of the entire valve, and the width was probably considerable, too.



Text-fig. 6: *Aphanomena schmalenseei* n. gen. et n. sp. Holotype, LM LO 4248.

**Brachial valve interior:** The myophore knobs of the cardinal process diverge slightly; in old specimens the knobs are very massive and the divergence is less obvious. On the upper and posterior surface of each knob a longitudinal groove shows the area of insertion of the diductor muscle. The socket-facing surface of each socket ridge bears a row of 3 to 6 small denticles. A very low, smooth median ridge extends forward from a point in front of the cardinal process. Pseudopunctae are not observable except doubtfully in one specimen, in which very fine pustules that are especially notable near the cardinalia seem to represent pseudopunctae. The adductor scars are obscure.

**Material:** About 45 specimens.

**Occurrence:** (2) Bestorp, (5) Allebergsände (lower and upper divisions), (6–7) Mt Gisseberg, (8) Ekebacken, (12) St Virvan, (13) Stommen, (27) Korsbäcken, and (28) Kul-latorpsbäcken.

**Remarks:** *Aphanomena luna* (G. LINDSTRÖM, 1880), which seems to be closely related to *A. schmalenseei*, is a large species with a maximal width of more than 50 mm. It is distinguished from *A. schmalenseei* by its ornamentation, which is more even with only slightly irregular ribs and many relatively fine ribs (4 to 8) between the distinct coarse ribs. This species seems to be confined to bioherm habitats; it is

found in the Upper Ordovician Boda Limestone in Dalarna. As in *A. schmalenseei* there is no distinct concentric striation or rugation.

Another species which seems to be related to *A. luna* was described by WILLIAMS (1951: 123–124, Pl. 8, figs. 1–4) as *Strophodonta (Eostropheodonta)* cf. *mullochiensis* (not *S. mullochiensis* REED, 1917). This species is from Lower Llandovery strata in Wales. It is fairly similar to *A. luna* but is probably distinguished by having a faint and uneven rugation and a fine but distinct concentric striation.

Still another related form was described from Upper Ordovician and Lower Silurian strata by SOKOLSKAJA (1954: 39–40, Pl. I, figs. 4–13; there may be more than one species in these figures) as *Rafinesquina (R.) expansa* (not *Orthis expansa* J. de C. SOWERBY, 1839). It differs from *A. schmalenseei* in that it has a slight rugation along the hinge and a distinct concentric striation.

To this group of brachiopods also belongs *Rafinesquina ultrix* MAREK & HAVLÍČEK, 1967, from the Upper Ordovician Kosov Formation in Bohemia. In this species the concentric ornamentation is quite marked, giving the surface a reticulated appearance. The myophore "shaft" is elevated, and there is a faint rugation along the hinge.

Genus *Kjerulfina* BANCROFT, 1929

*Kjerulfina?* sp.

Pl. 5 fig. 7

**Description:** Small, planoconvex shells with a relatively high pedicle-valve interarea. The largest specimen measured is 6.5 mm long and 10 mm wide. The exterior ornamentation is unequally parvicostellate. It is quite delicate, and in many specimens it is impossible to discern any ribs at all. The whole surface is covered by concentric growth lines, of which there are about 20 in one mm. There is also a vague rugation.

The interior of both valves seems to be devoid of all kinds of structures except pseudopunctae. It is impossible to see any trace of cardinalia or muscle scars. The exfoliation was brought about by the splitting of the core.

**Material:** About 35 specimens, all with shell preserved. **Occurrence:** All specimens have been found in the Kullatorp core (locality 29) between 33.20 and 35.12 m, i.e. in the limestone (middle) division of the *Dalmanitina* Beds.

**Remarks:** It is difficult to place this species taxionomically because of the lack of interior structures. In size the present species is comparable to *Bracteolectaena polonica* (TEMPLE, 1965), in which the ribbing is, however, multicostellate. "*Leptaena*" *costata* TEICHERT, 1937, from the Wright Bay Formation, Greenland, recalls *Kjerulfina?* sp. in general appearance and may be related. There is some similarity between *Kjerulfina?* sp. and *K. broeggeri* (HOLTEDAHL, 1916) in shell ornamentation (rugae and growth lines), and this may be taxionomically significant.

Family Leptaenidae HALL & CLARKE, 1894

Genus *Leptaena* DALMAN, 1828

*Leptaena rugosa* DALMAN, 1828

Pl. 5 fig. 8–9; Text-fig. 7

1821 *Anomites rhomboidalis* WAHLENBERG, Acta Soc. Reg. Sci. Upsaliensis 8 : 65–66 (most of the Västergötland specimens belong to *L. rugosa*; there are several specimens of this species in Wahlenberg's collection).

1828 *Leptaena rugosa* DALMAN, Kongl. Vet. Acad. Handl. 1827 : 106, Pl. 1, fig. 1.

1837 *Leptaena rugosa*, — HISINGER, Kongl. Vet. Acad. Handl. 1826 : 69, Pl. 20, fig. 2.

1869 *Strophomena rhomboidalis*, — LINNARSSON, Öfvers. Kongl. Vet. Acad. Förh. 1868 : 50, (non p. 52: *L. trifidum*).

1906b *Strophomena rhomboidalis*, — MUNTHE, Sver. Geol. Unders. Ser. Aa 120 : 46, line 5 (non line 16: *L. trifidum*).

1921 *Leptaena rhomboidalis*, — TROEDSSON, Lunds Univ. Årsskr., N. F., Avd. 2, 17, 3:7, 10, and 12 (pars; his material also includes *L. trifidum*).

1957 *Leptaena rugosa*, — SPJELDNAES, Norsk Geol. Tidskr. 37 : 173–174, Pl. 7, figs. 1–2, 4, text figs. 38 G, 39 A.

1965 *Leptaena rugosa*, — WILLIAMS, Treatise on Invert. Paleont. H391, H393, fig. 252 : 5 a–b.

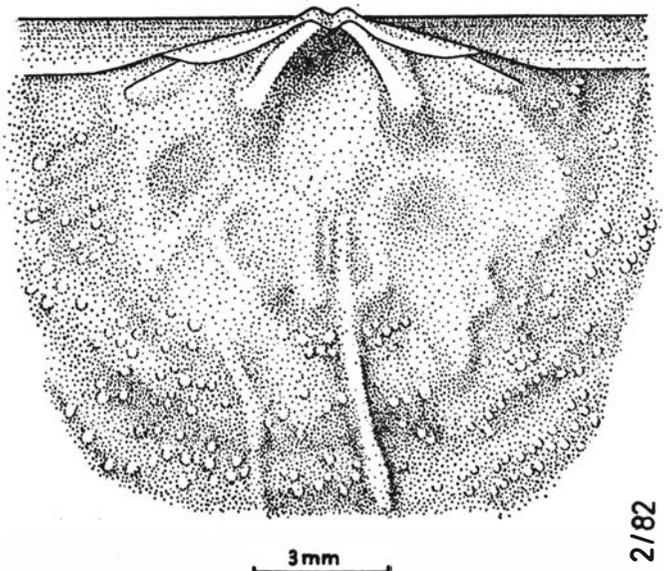
1966 *Leptaena rugosa*, — HAVLÍČEK & VANĚK, Sborník Geol. Věd, P, 8 : 43–44, 61, Pl. 16, figs. 1, 5.

1967 *Leptaena rugosa*, — MAREK & HAVLÍČEK, Věstník Ústř. úst. geol., 42 : 282, Pl. 4, figs. 10–12.

**Lectotype:** RM Br. 10435, selected and figured by SPJELDNAES, 1957.

**Description:** *L. rugosa* is a large *Leptaena* species with central disc 16–22 mm long (measured from umbo to antero-medial part of diaphragm) and 25–32 mm wide (measured 5 mm in front of the hinge-line because the diaphragm is less distinct close the hinge). In most specimens the rugation is very even and the number of distinguishable rugae varies between 7 and 12, depending partly on how well developed and well preserved they are in the umbonal region. The rib ornamentation is multicostellate, and 2.8 to 3.2 fine, rounded ribs, occur in one mm on distal parts of the central disc and on the trail. In some specimens a few ribs around the longitudinal mid-line are slightly coarser than average. The chidium is fairly low and has a well-developed median sulcus.

The pedicle valve interior is well known from SPJELDNAES' studies of this species.



Text-fig. 7: *Leptaena rugosa* DALMAN, 1828. Reconstruction of the cardinal region of the brachial valve, based mainly on specimen LM LO 4252 from (13) Stommen. Coll. J. BERGSTRÖM 1961.

**Brachial valve interior:** The rugae are clearly visible in the interior, commonly even within the muscle-scar area. The pseudopunctae are relatively small. The myophore knobs of the cardinal process are high, plate-like, and diverge from each

other at 70° to 90°. The articulating surface of the socket ridge seems to have had a few denticles in at least one specimen; in other specimens denticles have not been seen. Laterally each cardinal-process myophore merges into a callus that fills the region between the cardinal process and the socket ridge and bends anteriorly to form the lateral border of the posterior adductor scar. This scar is clearly elongated, whereas the anterior-adductor scar is rounded. In some specimens there is a posterior median ridge (as is the case in *Leptaenopoma trifidum*); in others the ridge is not clearly marked. Between the anterior-adductor scars the ridge, if present, seems to divide into a pair of straight (not crescent-shaped) ridges, in front of which there is a fine antero-median ridge.

**Material:** About 40 specimens counted.

**Occurrence:** This species is known from (2) Bestorp, (3) Ässtorp, (5) Allebergsände (lower division; very scarce in the upper division), (11) Varv (lower division; according to LINNARSSON, 1869: 50), (13) Stommen (lower division), (18) Skultorp, and (27) Korsbäcken. Outside Västergötland it occurs in the *Dalmanitina* Beds at Borenhult in Östergötland (DALMAN's collections) and in the uppermost Ordovician part of the railway section at Stengärde in Jämtland (observation in 1965). *L. rugosa* has also been reported from the Ashgillian Kosov Formation in Bohemia (HAVLÍČEK & VANĚK, 1966; MAREK & HAVLÍČEK, 1967).

**Remarks:** *Producta rugosa* HISINGER, 1827, is a nomen nudum. The species intended was observed on Gotland. It is thus of Silurian age and is certainly not identical to *Leptaena rugosa* DALMAN.

*Leptaena rugosa* has been reported by SOKOLSKAJA from Ordovician strata in the Baltic region (SOKOLSKAJA, 1954: 56–57, Pl. 3, figs. 3–9). This form has since been described as *Leptaena rugosoides* ORASPOOLD, 1956, and is well separated from *Leptaena rugosa*.

Close relatives of *Leptaena rugosa* seem to be found in *L. ventricosa* WILLIAMS, 1963, and especially *L. salopiensis* WILLIAMS, 1963, which occur in Caradocian strata in the Bala District in Wales (cf. WILLIAMS, 1963: 464). *Leptaena salopiensis* also occurs in the Caradocian of Belgium (MALAISE, 1873, Pl. 4, figs. 13–14). Specimens in Törnquist's collection in Lund from the Assise de Gembloux in Grand Manil, Brabant, have been valuable in proving the identity. The fauna at the Belgium locality indicates the zone of *Pleurograptus linearis* (cf. MICHOT, 1954: 50).

#### Genus *Leptaenopoma* MAREK & HAVLÍČEK, 1967

##### *Leptaenopoma trifidum* MAREK & HAVLÍČEK, 1967

Pl. 5 figs. 10–11; Pl. 6 figs. 1–2; Text-fig. 8

1821 *Anomites rhomboidalis* WAHLENBERG, Acta Soc. Reg. Sci Upsaliensis 8: 65–66 (partim: in WAHLENBERG's Västergötland collection of *A. rhomboidalis* at least one specimen of *Leptaenopoma trifidum* occurs with *Leptaena rugosa*).

1869 *Strophomena rhomboidalis*, — LINNARSSON, Öfvers. Kongl. Vet. Acad. Förh. 1868: 52 (non p. 50: *L. rugosa*).

1906b *Strophomena rhomboidalis*, — MUNTHE, Sver. Geol. Unders., Ser. Aa 120: 46, line 16 (in all probability at least most of the specimens) (non line 5: *L. rugosa*).

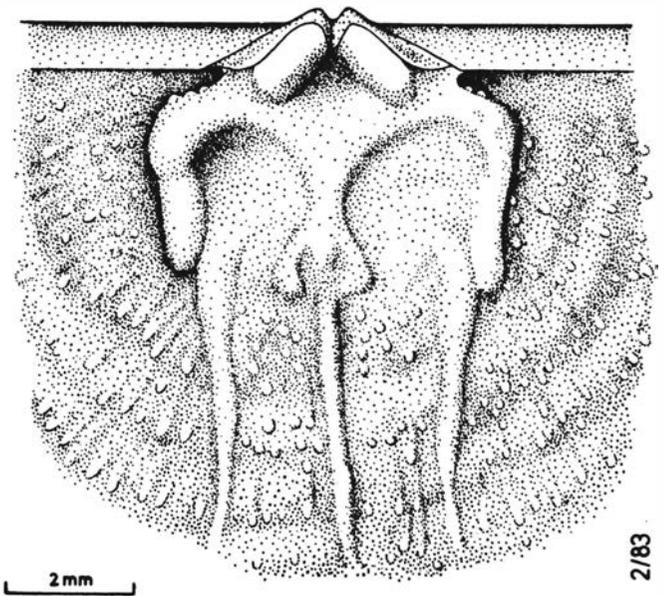
1921 *Leptaena rhomboidalis*, — TROEDSSON, Lunds Univ. Årsskr., N. F., Avd. 2, 17, 3: 7, 12 (partim: TROEDSSON's material also includes *L. rugosa*).

1967 *Leptaenopoma trifidum* MAREK & HAVLÍČEK, Věstník Ústř. úst. geol., 42: 282–283, Pl. 4, figs. 1, 4, 8.

**Description:** *L. trifidum* is a fairly small or medium-sized leptaenoid species with a central disc that is about 10–12 mm long and 14–18 mm wide. The rugae are very even in most specimens and their spacing varies so that the total number may be as small as 4 or 5 or as large as 10. The ornamentation is multicostellate on the central disc, and the ribs are fine and rounded. In most specimens the marginal trail is somewhat unequally parvicostellate. The rib number is 3.3 in one mm on the trail and on distal parts of the central disc. The geniculation is abrupt and there may be an elevated marginal diaphragm around the central disc. The angle between the central disc and the trail is slightly obtuse, 90°–120°. In most specimens the middle part of the trail is nearly flat, and the valve has a trapeziform outline. However, certain specimens are well rounded. The chidium is of "leptaenoid" type with a deep median sulcus (POULSEN, 1943, text-fig. 6).

**Pedicle valve interior:** As in the brachial valve the rugae are nearly as distinct in the interior as on the exterior surface. Some of the pseudopunctae are irregularly arranged; others follow the rugation pattern. Most pseudopunctae are apparently subparallel with the shell surface. Thus they can be traced for a short distance proximal to the summit.

The muscle area is probably oval, and is surrounded by a thin elevated ridge except in the anterior end on either side of a fairly strong median ridge. The adductor scars are relatively large and broad, situated around the posterior end of the median ridge. Surrounding the adductor scars are the diductor scars, the major parts of which are situated on the elevated marginal ridge. Posterior to the diductor scars is a small pit that seems to correspond to the dorsal foramen described by SPJELDNAES (1957: 51). The umbonal region is not well known. In most specimens the pallial disc is separated from the marginal trail by a shallow, concentric sulcus, which corresponds to the diaphragm.



Text-fig. 8: *Leptaenopoma trifidum* MAREK & HAVLÍČEK, 1967. Reconstruction of the cardinal region of the brachial valve, based mainly on specimen LM LO 4253. Note denticles on the socket ridge.

**Brachial valve interior:** In very old specimens only the adductor scars are situated on a complete low platform, the lateral parts of which and the bordering callosity ridges appear much earlier in ontogeny than the central parts. The adductor scars

are separated by a postero-median ridge, which tapers anteriorly and extends partly into a pair of very short, crescent-shaped ridges of a type that is typical of several leptaenoid species. Between, or just in front of, the paired ridges there is a low, narrow anterior ridge. The anterior and posterior median ridges are morphologically different from each other and, ontogenetically, they become distinctly separated. Lateral to the anterior median ridge there is a pair of subparallel, low, narrow ridges. In old specimens the myophore knobs of the cardinal process are fairly thick, plate-like structures that diverge from one another at about 90°. The articulating surface of the socket ridge bears 2 to 3 denticles. The pallial disc is surrounded by an elevated diaphragm.

**Material:** About 40 specimens from Västergötland; a few specimens from Borenhult in Östergötland; and some specimens from Dalarna.

**Occurrence:** (2) Bestorp (upper division), (5) Ällebergsände (middle and upper divisions), (23) Öglunda, and (24) Toran. Outside Västergötland this species is known from the *Dalmanitina* Beds at Borenhult in Östergötland (from specimens in Dalman's collections), from the Boda Limestone at Boda in Dalarna (specimens in Törnquist's collections), from the Kyrkås Quartzite at Rannåsen in Jämtland (collected by THORSLUND), and from the Kosov Formation in Bohemia (MAREK & HAVLÍČEK, 1967).

**Remarks:** *Leptaenopoma trifidum* is readily distinguishable from contemporary leptaenoid species despite its great variability. It is in several respects similar to *Leptaena rhomboidalis* (WAHLENBERG) (as understood by POULSEN, 1943: 18–21, text-figs. 5 C, 6 B, and 7 A–E, and by KELLY, 1967: 594–595 partim, Pl. 98, figs. 1–2; non fig. 3) of late Llandoveryan age. However, the latter species is characterized by coarser rugae and by the absence of structures corresponding to the crescent-shaped ridges in the brachial interior of *L. trifidum*.

#### Genus *Titanomena* n. gen.

**Derivation of name:** From Greek *τιτανος* wide, extending, and *μηνή* crescent.

**Type species:** *Titanomena grandis* n. sp.

**Diagnosis:** Large or medium-sized leptaenids with concavo-convex or plano-convex profile and without abrupt geniculation; surface ornamentation multicostellate; deltidium massive and teeth stout; muscle-area of pedicle valve broadly oval and fairly small; cardinal process small; socket plates not denticulated; chilidium large, with a median sulcus.

**Species assigned to the new genus:** *Titanomena grandis* n. sp.

**Remarks:** Contrary to COOPER's (1956: 820) familial diagnosis, the size of the apical foramen seems to be fairly small. However, the apical foramen seems to have been smaller in many Upper Ordovician and later leptaenids than in most Middle Ordovician representatives of the family. Other characteristics, e.g. the shape of the pedicle valve muscle area and the shape of the chilidium are quite typical of the Leptaenidae and places *Titanomena* close to genera such as *Cyphomena* and *Dactylogonia*. The latter differs from *Titanomena* in being unequally parvicostellate and in its abrupt geniculation. *Cyphomena* is rather similar to *Titanomena* in the shape of the brachial valve interior, but in *Cyphomena* this structure commonly has a more distinct border between the distal trail and the central disc, a more marked convexity, and a smaller size. Even so, the differences are relatively small and it seems possible that *Titanomena* was a derivative of *Cyphomena*.

#### *Titanomena grandis* n. sp.

Pl. 6 fig. 3–6; Text-fig. 9

**Derivation of the name:** From Latin *grandis*, large.

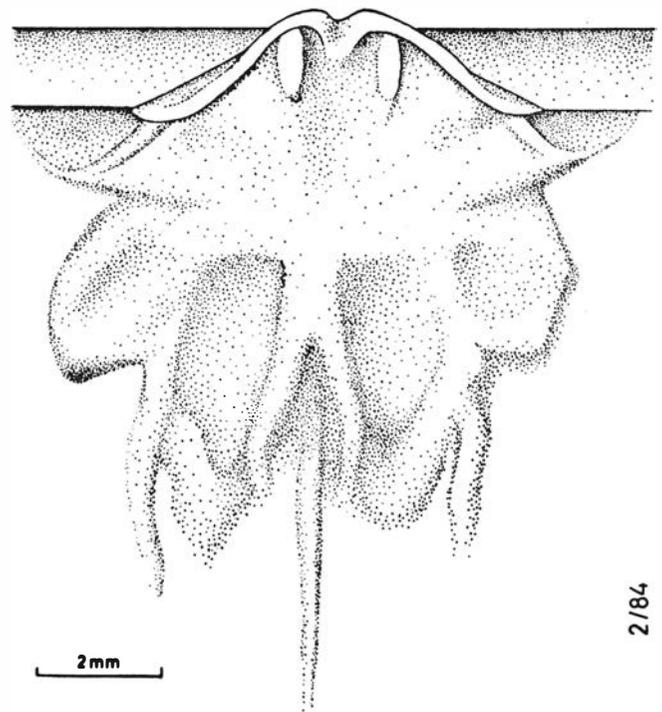
**Holotype:** LM LO 4257. A mould of a brachial valve interior, somewhat fragmentary and with signs of damage when still alive. Coll. S. L. Törnquist.

**Type stratum and type locality:** Upper division of the *Dalmanitina* Beds, Ällebergsände.

**Diagnosis:** A *Titanomena* species, the shell of which has a gentle geniculation 25–30 mm in front of the apex.

**Description:** The adult shell of *Titanomena grandis* attains a width of more than 50 mm and a length of at least 45 mm. It is plano- to concavo-convex. A great part of the brachial valve seems to be rather flat and the very gentle geniculation does not occur until 25–30 mm in front of the umbo. The cardinal angles are slightly obtuse. The ornamentation is multicostellate with rounded ribs, about 2.5 of which occur in one mm at a point 20 mm in front of the umbo. Concentric growth lines occur at uneven intervals. The brachial valve interarea is much lower than that of the pedicle valve. The deltidium is low but very thick, and obviously formed partly as a pedicle callist. The chilidium is rather high.

**Pedicle valve interior:** Traces of the costellation and the concentric structures of the exterior surface can be seen inside both valves. In the pedicle valve the muscle-scar area is rounded or elongated in outline and, except medially, the distal parts are raised above the shell floor by means of secondary shell matter. The adductor scars are situated on a broad median ridge, which does not extend as far forward as the diductor scars.



Text-fig. 9: *Titanomena grandis* n. gen. et n. sp. Holotype, LM LO 4257.

**Brachial valve interior:** With the exception of the cardinalia and the muscle-scar area, the entire surface is finely pseudo-punctate. This feature is not so obvious in the pedicle valves studied.

There is a notothyrial platform, which is fairly thick in the posterior part. The length of this platform (including the

muscle scars) relative to the length of the valve is 0.2–0.3/1, and the width relative to the width of the valve is 0.2/1. The cardinal process ascends through the platform as two fine myophore ridges, separated from each other by a median chilidial fold and a very low and short ridge that extends forward from the anterior extremity of the fold. The real posterior median ridge does not appear until further forward, where the platform is relatively low. This ridge divides in front into two branches in a typical leptaenoid manner. These paired ridges form the raised antero-medial border of the anterior muscle scars. An anterior-median ridge begins in front of the bifurcation. In its posterior part between the paired ridge branches it is fairly inconspicuous. A pair of lateral ridges originate from the angle between the posterior and the anterior muscle scars or, perhaps, from the lateral part of the anterior scars.

**Material:** 3 brachial, 2 pedicle interiors, several exteriors, most of them fragmentary.

**Occurrence:** (2) Bestorp and (5) Ällebergsände.

Family Stropheodontidae CASTER, 1939

Genus *Leptostrophia* HALL & CLARKE, 1892

Subgenus *Eostropheodonta* WILLIAMS, 1951

***Leptostrophia (Eostropheodonta) hirnantensis***  
(M'COY, 1851)

Pl. 6 fig. 7–9; Text-fig. 10

1828 *Orthis?* *Pecten* DALMAN, Kongl. Vet. Acad. Handl. 1827: 110–111 (partim: a few specimens of *L. hirnantensis* are included in DALMAN's collection of *O.?* *pecten*).

1851 *Orthis hirnantensis*, — M'COY, Ann. Mag. Nat. Hist. 8, (2): 395–396.

1855 *Orthis hirnantensis*, — M'COY, in SEDGWICK & M'COY, British Palaeozoic rocks and fossils. 1: 219, 2: Pl. 1H, figs. 11–11c.

1871 *Orthis?* *Hirnantensis*, — DAVIDSON, Palaeontogr. Soc. 3, pt. 7: 261–262, Pl. 32, figs. 5–7 (non figs. 8–9).

1965 *Eostropheodonta hirnantensis*, — TEMPLE, Acta Palaeont. Polonica 10: 410–412, Pl. 17, figs. 1–6; Pl. 18, figs. 1–7; Pl. 19, figs. 1–5.

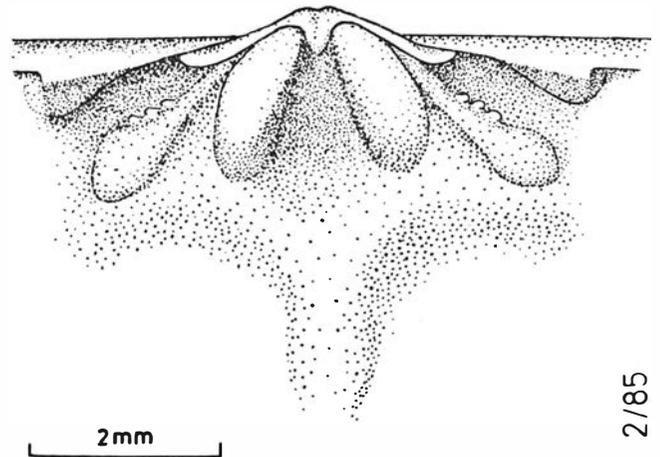
1965 *Strophodonta (Eostropheodonta) hirnantensis*, — WILLIAMS, Treatise Invertebr. Palaeont. H: H395, fig. 255, 3 d–e.

1967 *Eostropheodonta hirnantensis*, — MAREK & HAVLÍČEK, Věstník Ústř. úst. geol. 42: 282, Pl. 4, figs. 10–12.

**Description:** A species with a plano-convex or slightly concavo-convex shell that has acute cardinal angles and thus attains its greatest width along the hinge-line. The ornamentation is distinctive: the pattern is intermediate between multicostellate and unequally parvicostellate and the ribs are narrow, unusually high, and at first glance give the impression of being sharp-edged, even though they are, actually, well rounded. The pedicle-valve interarea is about  $\frac{1}{10}$  as high as the valve is long. The delthyrium is open. The brachial-valve interarea is very low. There is a fairly well-developed chilidium without a median sulcus.

**Pedicle valve interior:** The rib pattern of the exterior is clearly visible on the interior surface. In both valves the entire surface outside the muscle-scar area is coarsely pseudopunctate. The pseudopunctae are concentrated on the radiating ridges and thus appear to be arranged in more or less straight rows. In most specimens the muscle-scar area is indistinct, but in a few large specimens it can be seen that it was large, flabellate and nearly  $\frac{2}{3}$  as long as the valve. Each tooth has on its antero-medial surface a longitudinal groove.

In one specimen, this groove (it has been observed in one specimen only) has pits corresponding to the denticles on the socket plates.



Text-fig. 10: *Leptostrophia (Eostropheodonta) hirnantensis* (M'COY, 1851). Reconstruction of the cardinal region of the brachial valve, based on several specimens.

**Brachial valve interior:** The muscle scars are poorly defined. The articulating surface of the socket plate bears a row of about four small denticles. The notothyrial platform is rather inconspicuous. Anteriorly it is continuous with a short, low median ridge. In young specimens the cardinal-process knobs are short and plate-like, and diverge at about  $80^\circ$ . In adult specimens the knobs are relatively longer and the divergence is about  $65^\circ$ .

**Material:** About 125 specimens.

**Occurrence:** (1) Vrågården, (2) Bestorp, (3) Ässtorp, (5) Ällebergsände (lower division), (6–7) Mt Gisseberg, (8) Ekebacken, (10) Dimmingedalen, (12) St Virvan, (13) Stommen (lower division), (14) Skogastorp, and (28) Kullatorpsbäcken. In Wales the species is represented in the Upper Ashgillian Hirnant Beds (M'COY, 1851), and it has recently been reported from Upper Ashgillian beds in the Lake District, England, in Poland (TEMPLE, 1965) and in Bohemia (MAREK & HAVLÍČEK, 1967).

**Remarks:** The genus *Eostropheodonta* was erected by BANCROFT (1949), who considered it a distinct genus. Later WILLIAMS (1951, 1965) included *Eostropheodonta* as a subgenus in *Strophodonta* HALL, 1850. In a recent revision of the Llandovery stropheodontids from the Welsh Borderland, COCKS (1967) criticized the current subfamilial arrangement within *Stropheodontidae*. He found the arrangement inconsistent with present knowledge about the interrelationships between early stropheodontid genera. However, he did not give any alternative arrangement. *Strophodonta* was considered a strictly Devonian genus, and *Eostropheodonta* was included as a subgenus within *Leptostrophia*.

Superfamily Davidsoniacea KING, 1850

Family Meekellidae STEHLI, 1954

Subfamily Chilidiopsinae BOUCOT, 1959

[nom. transl. ex Chilidiopsidae BOUCOT, 1959]

Genus *Coolinia* BANCROFT, 1949

***Coolinia dalmani* n. sp.**

Pl. 6 fig. 10; Pl. 7 fig. 1–4

1821 *Anomites Pecten*, — WAHLENBERG, Acta Soc. Reg. Sci. Upsaliensis 8: 66 (partim: the Västergötland form of his "species").

- 1828 *Orthis? Pecten*, — DALMAN, Kongl. Vet. Acad. Handl. 1827: 110–111 (partim: the Västergötland specimens exclusive of a few specimens in Dalman's collection of *Eostropheodonta hirnantensis*), Pl. 1, figs. 6 a–d.
- 1837 *Orthis Pecten*, — HISINGER, Kongl. Vet. Acad. Handl. 1826: 70 (partim: only specimens from Västergötland localities), Pl. 20, figs. 6 a–d.
- 1921 *Schuchertella pecten*, — TROEDSSON, Lunds Univ. Årsskr. N. F., Avd. 2, 17: 7, 12.

**Derivation of name:** After J. W. Dalman, one of the early students of Swedish fossil brachiopods.

**Holotype:** LM LO 4261. Coll. J. Bergström, 1962.

**Type stratum and type locality:** Lower division of the *Dalmanitina* Beds at Stommen.

**Diagnosis:** A thin-shelled and large (maximal width exceeds 40 mm) species of *Coolinia* with a flat brachial and a nearly flat pedicle valve. Rib density exceptionally high for such a large *Coolinia* species with about 3 ribs in every mm five mm in front of umbo.

**Description:** The shell is plano-convex with very low convexity of the pedicle valve. The greatest width is along the hinge-line. The ornamentation is unequally parvicostellate with every second rib stronger than the rib between. There are 13 to 15 protegular ribs. The ribs grow coarser with distance away from the umbo. Five mm in front of the umbo there are 3 ribs in one mm; 15 mm in front of the umbo there are only 2. Fine, closely-spaced growth lines are discernible especially between the ribs. The chilidium is large and rounded. There is no deltidium. It has not been possible to discern any pseudopunctae either on flaked shell fragments or on sections perpendicular to the shell surface. However, only one specimen has been studied: specimens with preserved shell are extremely scarce.

**Pedicle valve interior:** The exterior sculpture is to some degree reflected on the interior surface of both valves. The muscle area is poorly defined anteriorly, but the diductor muscle scars seem to be separated in front of the adductor scars. Postero-laterally, the diductor scars are bordered by the well-developed dental plates. The adductor scars are broadly lanceolate. In the delthyrial cavity there is a concave, triangular pedicle callist.

**Brachial valve interior:** The muscle scars are obscure. Between and behind them there is a broad, low platform. Fulcral plates may be well developed or many be totally missing, and the socket ridges diverge from each other at angles between 40° and 90°. The angle apparently diminishes during ontogeny. In small valves the cardinal process knobs run smoothly over into the socket ridges; in large valves they are distinctly set off. The posterior surface of the myophore knob is excavated but smooth.

**Material:** About 350 specimens (fragments smaller than a third of the shell not counted).

**Occurrence:** The species is known from (5) Ällebergsände (lower division), (6–7) Mt Gisseberg, (8) Ekebacken, (12) St Virvan, (13) Stommen (lower division), (14) Skogastorp, (27) Korsbäcken (lower division), and (28) Kullatorpsbäcken.

**Remarks:** Together with other species *Coolinia dalmani* has long been known as *Anomites pecten*, *Orthis pecten* etc. and assigned to LINNAEUS. However, LINNAEUS (1758: 702) in his description referred to LISTER: "List. angl. 243. t.9 f.49.". LISTER (1678: 243) wrote about the locality as fol-

lows: "Ex fodinis carbonum Fossilis juxta Hallifax". LISTER's species is thus of Carboniferous age.

WAHLENBERG (1821: 66) was probably the first to record *A. pecten* from Swedish deposits. He reported it from Gotland (Silurian), Västergötland (Upper Ordovician) and as a variety from Fågelsång in Skåne (probably Middle Ordovician). DALMAN (1828: 110) added Borenhult in Östergötland as an Upper Ordovician locality. On the basis of present knowledge about the faunas in the actual beds it is evident that we are dealing with at least three different species (excluding *Eostropheodonta hirnantensis*, which is also included in Dalman's Västergötland collection of "*Orthis pecten*").

HISINGER (1837) was the next writer to discuss *A. pecten*, but he did not add anything substantial to the concept of the species.

LINDSTRÖM (1861: 373), writing on brachiopods from Gotland, seems to be the first to restrict the species stratigraphically and geographically.

The fact that LISTER's figure, to which LINNAEUS refers, is of a Carboniferous lamellibranch known as *Dunbarella papyracea* (J. de C. SOWERBY, 1822), was observed by WOOD in 1947. WOOD made a proposal to the International Commission on Zoological Nomenclature (ICZN) that the species name *pecten* LINNAEUS, 1758, should be applied to the Silurian brachiopod generally identified as *Schuchertella pecten* and not to the species figured by LISTER.

In the directions following on this proposal the ICZN (1950) stated that the species name *pecten* LINNAEUS, 1758, should apply to the species "commonly known as *Strophomena pecten* (LINNAEUS, 1758), i.e. the species determined as *Schellwienella pecten* (LINNAEUS, 1758) by DALMAN (J. W.), 1828, K. Svenska Vetensk. Akad. Handl., 1827: 110 pl. 1, figs. 6 a–d (as *Orthis pecten*)".

In 1967 BRUNTON, COCKS & DANCE figured the only specimen of *Anomia pecten* in the Linnaean Collection. It seems quite probable that this specimen has belonged to LINNAEUS and that it has been collected in Lower or Middle Silurian strata on Gotland. As has been pointed out by me (BERGSTRÖM & HAGELTORN, 1968) this Gotland species represented by the specimen in the Linnaean Collection is not conspecific with the species figured by DALMAN (1828, Pl. 1, figs. 6 a–d), as the latter without doubt is *Coolinia dalmani*. For this reason a new proposal has been sent to the ICZN in order to settle the identification problem ultimately (BERGSTRÖM 1968). It now seems safe to regard *Coolinia* a distinct genus separated from *Fardenia* LAMONT, 1935. In erecting *Chilidiopsis*, BUCOT (1959: 27) remarked that it might be a junior synonym to the poorly known genus *Coolinia* BANCROFT, 1949. New material has now made this synonymy clear (BRUNTON, COCKS & DANCE, 1967: 167).

Together with *Coolinia alterniradiata* (SHALER), *C. pecten* (LINNAEUS) and *C. subplana* (CONRAD), *C. dalmani* is one of the large *Coolinia* species, attaining a width of more than 40 mm. In this respect it differs from the smaller species *C. applanata* (SALTER), *C. applanata inaequalis* (BANCROFT), *C. roemeri* (FOERSTE) (maximal width 30 mm), *C. reedsi* (AMSDEN) (max. width 18–19 mm) and *C. comes* (MAREK & HAVLÍČEK) (largest specimen known 17 mm wide). The rib density is a fairly good aid in the identification of the different species. The approximate number of ribs in one mm, 5 mm and 15 mm respectively in front of the umbo are: *C. comes* 3.2 —; *C. dalmani* 3, 2; *C. applanata* 3,—; *C. alterniradiata* 2.2, 2.2; *C. reedsi* 2.1 —; *C. subplana* 2.1, 1.3; *C. applanata inaequalis* 2.0, 1.2; *C. pecten* 1.6, 1.1. *C. alterniradiata* seems to differ from all the others in having a constant rib density over the shell surface.

Superfamily Rhynchonellacea GRAY, 1848  
Family Ancistorhynchidae COOPER, 1956

**Emended diagnosis:** The family diagnosis should be changed to include forms with a median septum in the brachial valve.

Subfamily Plectothyrellinae n. subfam.

**Diagnosis:** Ancistorhynchids with median septum.

Genus *Plectothyrella* TEMPLE, 1965

**Emended diagnosis:** Shell biconvex and uniplicate; shell surface imbricate; costae coarse and angular; new ribs may be intercalated on the fold and in the sulcus; pedicle valve with very strong tooth plate supports; brachial valve with massive crural bases; cardinal process missing.

***Plectothyrella crassicosta*** (DALMAN, 1828)  
Pl. 7 fig. 5–8

1828 *Atrypa? crassicostis* DALMAN, Kongl. Vet. Acad. Handl. 1827: 131–132.

1837 *Atrypa? crassicostis*, — HISINGER, Lethaea Svecica ..: 76, Pl. 22, fig. 3.

1921 *Atrypa crassicostis*, — TROEDSSON, Lunds Univ. Årsskr., N. F., Avd. 2, 17: 10–12.

1921 *Platystrophia biforata*, — TROEDSSON, Lunds Univ. Årsskr., N. F., Avd. 2, 17, 9–10, 12.

1965 *Plectothyrella platystrophioides* TEMPLE, Acta Palaeont. Polon. 10: 412–415, Pl. 20, figs. 1–5; Pl. 21, figs. 1–10.

1967 *Plectothyrella platystrophioides*, — MAREK & HAVLÍČEK, Věstník Ústř. úst. geol. 42: 284, Pl. 1, figs. 14–17, 19.

**Description:** *P. crassicosta* is a relatively large, globose species with a median fold on the brachial valve and a corresponding sulcus on the pedicle valve. The greatest width and length observed are 30 and 30 mm respectively. The maximum width is mid-way between the apex and the anterior commissure. The shell surface is provided with strong ribs that are triangular in cross section. There are about 4 of these in the sulcus and 10 on the lateral flank at a point 20 mm from the apex.

**Pedicle valve interior:** The teeth are strong and provided with tooth plates that are largely hidden by secondary shell-matter. Muscle attachment was apparently confined to the area with callus growth.

**Brachial valve interior:** A distinct, narrow, median ridge extends anteriorly from the crural bases for about a third the length of the valve. In large valves two short ridges diverge from the median ridge in an antero-lateral direction. The outer socket-ridge is elongated and narrow, whereas the inner socket-ridge is short and massive. The crura emerge abruptly from the shell floor, and the crural plates are feebly developed or nonexistent.

**Material:** About 145 specimens.

**Occurrence:** (1) Vrågården, (2) Bestorp, (3) Ässtorp, (5) Allebergssände (lower division), (6–7) Mt Gisseberg, (8) Ekebacken, (10) Dimmingedal, (12) St Virvan, (13) Stommen, and (27) Korsbäcken. Outside Sweden this species is known from the Ashgill Shales in the Lake District, England, and from the uppermost Ordovician in Wales and Poland (TEMPLE, 1965). It is also known from the Kosov Formation of Bohemia (MAREK & HAVLÍČEK, 1967).

**Remarks:** *Plectothyrella crassicosta* seems to occupy a fairly isolated systematic position. *Atrypa canaliculata* DAL-

MAN, 1828, and *Aratanea monodi* SCHMIDT, 1967, are probably the most closely related species known. *P. crassicosta* differs from these species in the common presence of imbrication and in the more angular ribs.

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The photos were made by Mr. Gustav Andersson at the Institute of Palaeontology, Uppsala, with the kind permission of Dr. V.

Jansson. If not otherwise stated they were made from Plastiform casts of the specimens.

### Plate 1

Fig. 1-2: *Palaeoglossa?* sp. Plastiform not used. 1: Exterior view of a large, damaged valve. Mt Kinnekulle. Coll. G. Lilljevall. RM Br. 10698. 3/1. 2: Interior view of two valves. (28) Korsbäcken, lower division. Coll. J. Bergström, 1964. LM LO 4236. 6/1.

Fig. 3: Obolidae gen. et sp. indet. Exterior view of a crushed valve. (2) "Mösseberg/Bestorps lat.". Coll. G. Wahlenberg. UM Vg 870. 6/1.

Fig. 4-5: *Paracraniops* sp. 4: Interior of valve. (2) Bestorp. Coll. G. Troedsson. LM LO 4237. 6/1. 5: Interior of valve. (2) Bestorp. Coll. G. Troedsson. LM LO 4238. 6/1.

Fig. 6: *Philhedra* sp. A small, brachial valve. (2) "Mösseberg/Bestorps lat.". Coll. G. Wahlenberg. UM Vg 871 6/1.

Fig. 7-9: *Orbiculoidea concentrica* (WAHLENBERG, 1821). Plastiform not used. 7: Lectotype, a brachial valve interior. (2) "Mösseberg/Bestorps latar". Coll. G. Wahlenberg. UM Vg 872. 4/1. 8: A mould of a pedicle valve interior. (5) Ällebergsände. Coll. C. G. von Schmalensee, 1899. LM LO 4239. 10/1. 9: A mould of a pedicle valve interior. (5) Ällebergsände. Coll. C. G. von Schmalensee, 1899. LM LO 4240. 10/1.



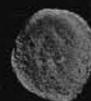
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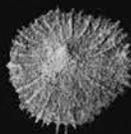
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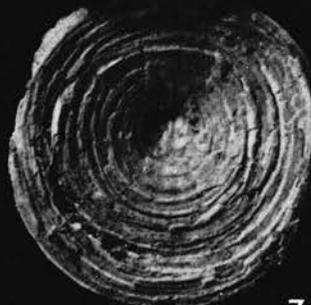
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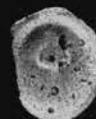
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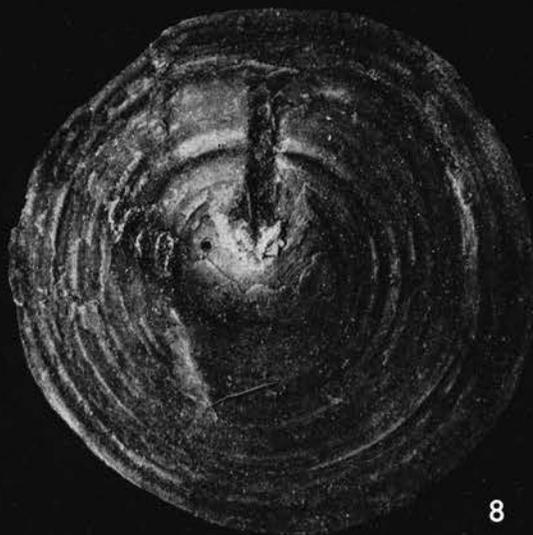
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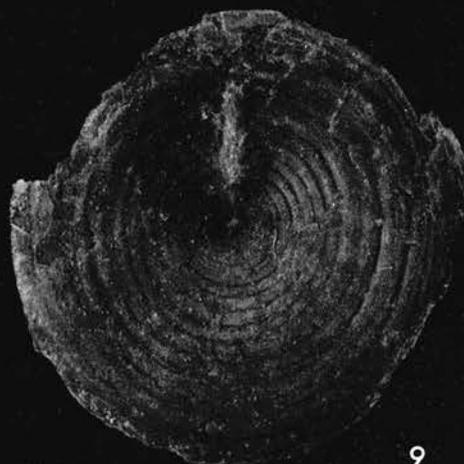
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## Plate 2

Fig. 1–4: *Giraldiella bella* n. sp. 1: Holotype, a brachial valve interior. (5) Ällebergsände, upper division. RM Br. 10933. 3/1. 2: A brachial valve interior. (5) Ällebergsände, upper division. Coll. J. W. Dalman. RM Br. 102328. 3/1. 3: Pedicle and brachial valve exteriors. (5) Ällebergsände. Coll. P. Dusén. RM Br. 10962 (counterpart to RM Br. 10960). 3/1. 4: Brachial and pedicle valve interiors. (5) Ällebergsände. Coll. P. Dusén. RM Br. 10960 (counterpart to RM Br. 10962). 3/1.

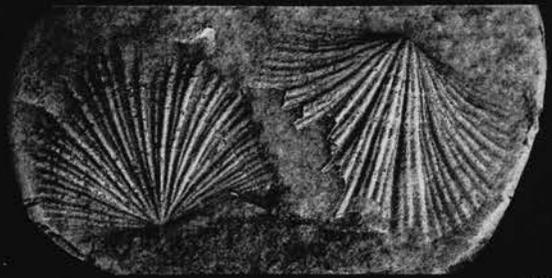
Fig. 5: *Dalmanella testudinaria* (DALMAN, 1828). A brachial valve interior. (8) Ekebacken. Coll. J. Bergström, 1964. LM LO 4241. 4/1.

Fig. 6–9: *Dalmanella pectinoides* n. sp. 6: A brachial valve interior. (5) Ällebergsände. Coll. S. L. Törnquist. LM LO 4242. 3/1. 7: A brachial valve exterior. (2) Bestorp, Coll. J. W. Dalman, 1827. RM Br. 10216. 3/1. 8: Holotype, a pedicle valve interior. (2) Mösseberg. UM Vg 873. 3/1. 9: A pedicle valve exterior. (2) “Mösseberg/Bestorp”. Coll. J. Dalman, 1827. RM Br. 10215 (counterpart to RM Br. 10213). 3/1.

Fig. 10–11: *Horderleyella fragilis* n. sp. 10: A brachial valve interior. (5) Ällebergsände. Coll. J. W. Dalman, RM Br. 102329. 3/1. 11: A pedicle valve interior. Västergötland, exact locality unknown. RM Br. 10995 (counterpart to RM Br. 10996). 3/1.



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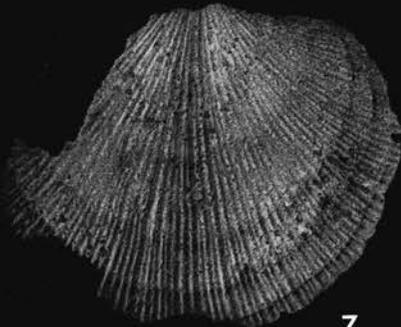
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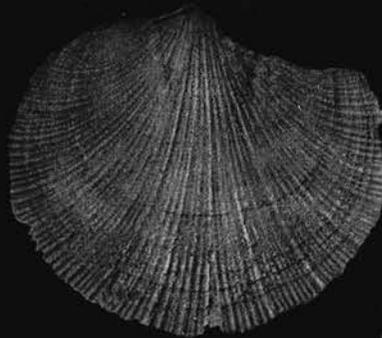
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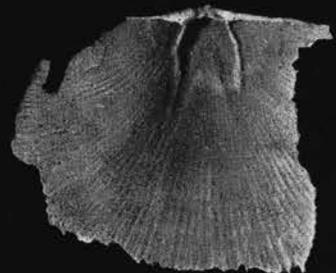
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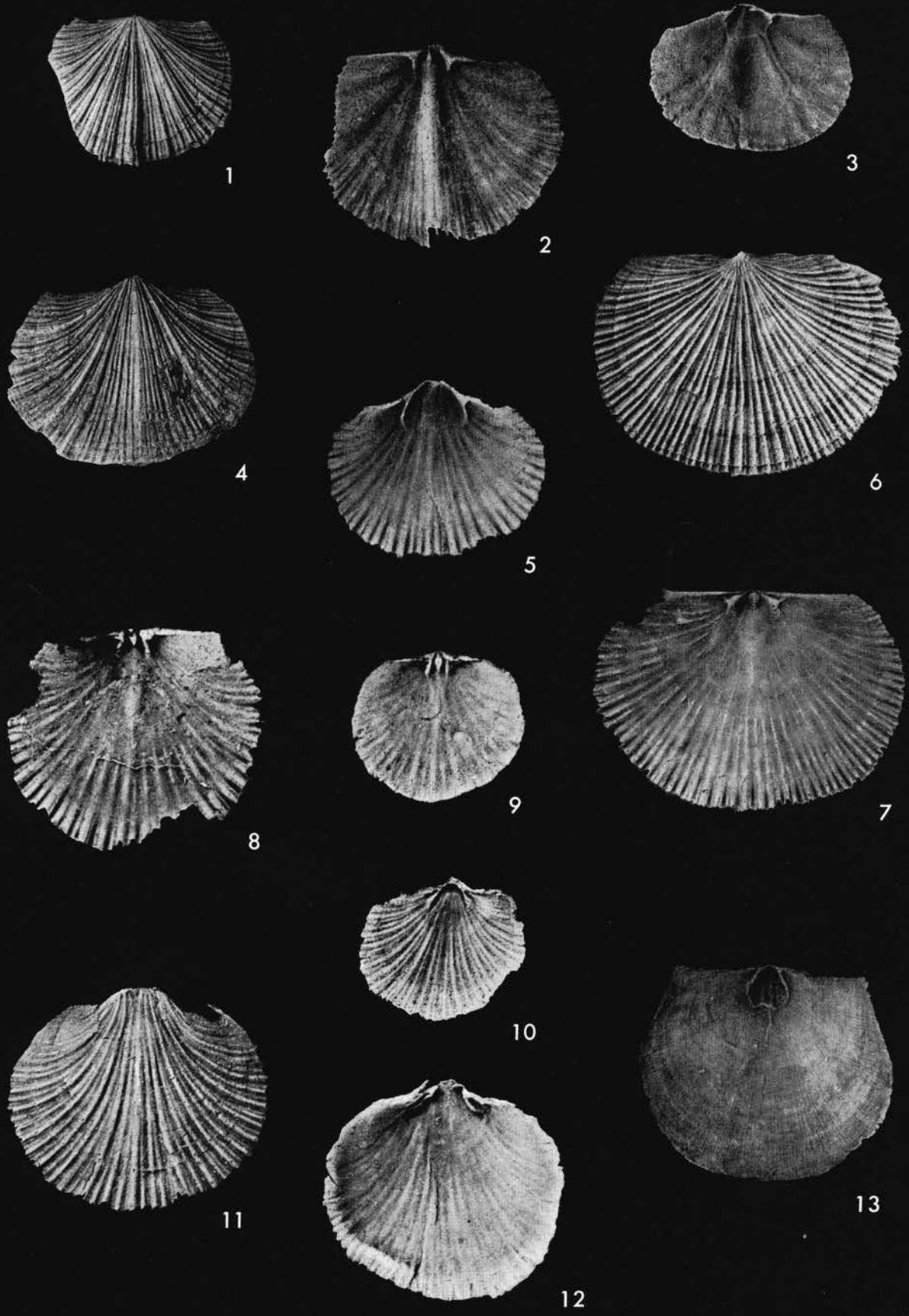
### Plate 3

Fig. 1–4: *Orderleyella fragilis* n. sp. 1: A brachial valve exterior. (5) Ällebergsände. UM Vg 874. 3/1. 2: Holotype, a brachial valve interior. (5) Ällebergsände. RM Br. 10267. 3/1. 3: A pedicle valve interior. Västergötland, exact locality unknown. RM Br. 10996 counterpart to RM Br 10995). 3/1. 4: A pedicle valve exterior. Exact locality unknown, probably Ällebergsände, upper division. RM Br. 10944. 3/1.

Fig. 5–7: *Draborthis caelebs* MAREK & HAVLÍČEK, 1967. 5: A pedicle valve interior. Locality probably (5) Ällebergsände. RM Br. 10989. 3/1. 6: A brachial valve exterior. (2) “Mösseberg/Bestorp, DALMAN 1827”. RM Br. 10201. 3/1. 7: A brachial valve interior. (2) “Mösseberg/Bestorp, DALMAN 1827”. RM Br. 10203 (counterpart to RM Br. 10201). 3/1.

Fig. 8–12: *Drabovia westrogothica* n. sp. 8: A brachial valve interior. (5) Ällebergsände (?). RM Br. 10991. 4/1. 9: Holotype, a brachial valve interior. (13) Stommen. Coll. J. Bergström, 1961. LM LO 4243. 3/1. 10: A pedicle valve interior. Mösseberg (probably Bestorp). Coll. P. T. Cleve. UM Vg 875. 3/1. 11: A pedicle valve exterior. Mösseberg (probably Bestorp). Coll. P. T. Cleve, 1865. UM Vg 876. 3/1. 12: A pedicle valve interior. (5) Ällebergsände. Coll. P. Dusén. RM Br. 10963. 3/1.

Fig. 13: *Hirnantia sagittifera* (M'COY, 1851). A pedicle valve interior. Mösseberg (probably Bestorp). UM Vg 859 (bp. 2021). 1/1.



#### Plate 4

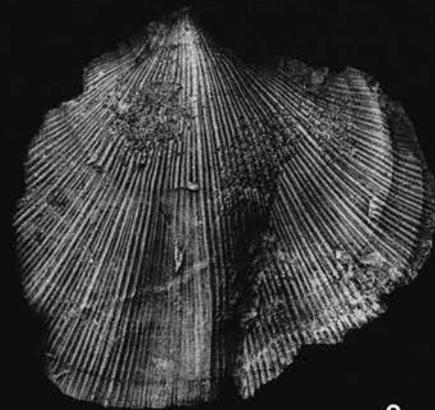
Fig. 1–2: *Hirnantia sagittifera* (M'COY, 1851). 1: A brachial valve interior. (5) Ällebergsände. Coll. S. L. Törnquist. LM LO 4244. 2/1. 2: A pedicle valve exterior. (5) Ällebergsände. Coll. P. T. Cleve, 1865. UM Vg 877. 2/1.

Fig. 3–6: *Kinnella kielanae* (TEMPLE, 1965). 3: A brachial valve interior and a pedicle valve exterior. (5) Ällebergsände. Coll. G. Troedsson, 1915. LM LO 4245. 5/1. 4: A brachial valve interior. (7) "Gisseberget Trädgården". Coll. Elsa Warburg, 1910. UM Vg 878. 10/1. 5: A pedicle valve interior. (5) Ällebergsände, lower division. Coll. J. W. Dalman. RM Br. 102330. 4.5/1. 6: External view of two pedicle valves. (5) Ällebergsände. Coll. G. Troedsson, 1915. LM LO 4246. 4.5/1.

Fig. 7–8: *Cliftonia psittacina* (WAHLENBERG, 1821). Lectotype, posterior and anterior views of conjoined valves. Dalarna, Osmondsberget, Boda Limestone. Coll. G. Wahlenberg. UM D. 1175. 3/1.



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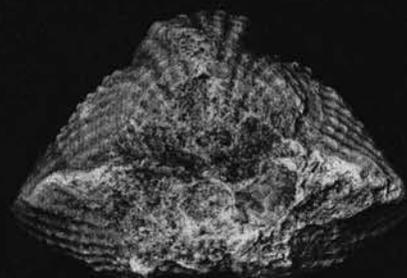
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## Plate 5

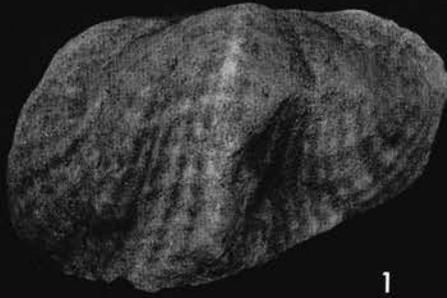
Fig. 1–2: *Cliftonia psittacina* (WAHLENBERG, 1821). 1: Complete specimen. (5) Ällebergsände. Coll. J. W. Dalman, 1827. RM Br. 10525. 3/1. 2: A pedicle valve interior. “Fårdalaberg”. Coll. J. W. Dalman, 1827. RM Br. 10519. 3/1.

Fig. 3–6: *Aphanomena schmalenseei* n. sp. 3: Holotype, a brachial valve interior. (5) Ällebergsände. Coll. G. Troedsson, 1915. LM LO 4248. 1.5/1. 4: A brachial valve interior. (5) Ällebergsände. Coll. P. T. Cleve, 1865. UM Vg 879. 1/1. 5: A brachial valve exterior. (13) Stommen. Coll. J. Bergström, 1961. LM LO 42 49. 2/1. 6: A pedicle valve interior. Locality unknown. UM Vg 880.

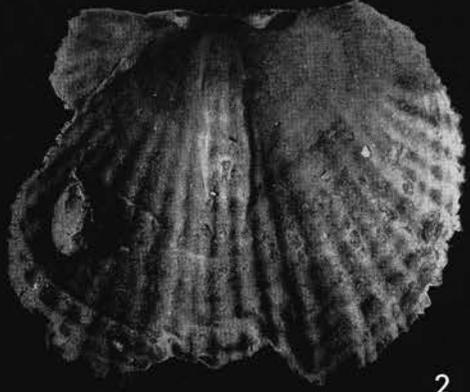
Fig. 7: *Kjerulfina?* sp. Plastiform not used. A pedicle valve exterior. (29) Kullatorp boring core at 35.04 m UM Vg 881. 4/1.

Fig. 8–9: *Leptaena rugosa* DALMAN, 1828. 8: A brachial valve exterior. (5) Ällebergsände. Coll. S. L. Törnquist. LM LO 4250 (counterpart to LM LO 4251). 2/1. 9: A brachial valve interior. (5) Ällebergsände. Coll. S. L. Törnquist. LM LO 4251 (counterpart to LM LO 4250). 2/1.

Fig. 10–11: *Leptaenopoma trifidum* MAREK & HAVLÍČEK, 1967. 10: A brachial valve interior. (5) Ällebergsände. Coll. B. Bohlin, 1959. LM LO 4253. 2/1. 11: A pedicle valve interior. (5) Ällebergsände. RM Br. 10267. 2/1.



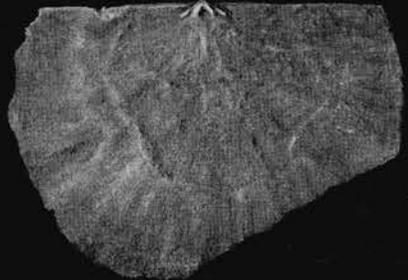
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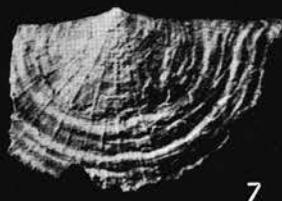
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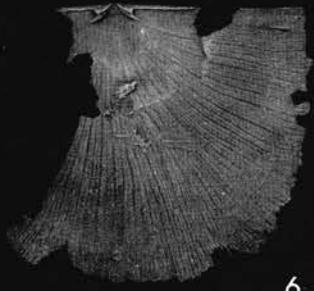
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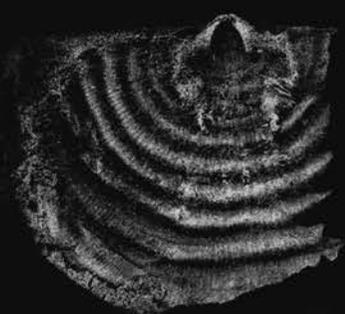
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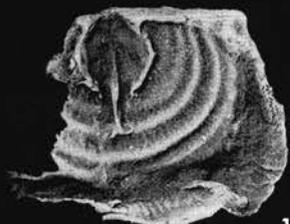
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### Plate 6

Fig. 1–2: *Leptaenopoma trifidum* MAREK & HAVLÍČEK, 1967. 1: A brachial valve exterior. (5) Ällebergsände. Coll. C. G. von Schmalensee, 1899. LM LO 4254. 2/1. 2: A pedicle valve exterior. (5) Ällebergsände. Coll. B. Bohlin, 1959. LM LO 4255. 2/1.

Fig. 3–6: *Titanomena grandis* n. gen. et n. sp. 3: A pedicle valve exterior. (5) Ällebergsände. Coll. J. Bergström, 1962. LM LO 4256. 1/1. 4: Holotype, a brachial valve interior. The specimen has been severely damaged when still in life. (5) Ällebergsände. Coll. S. L. Törnquist. LM LO 4257. 1.5/1. 5: A pedicle valve interior. Västergötland, exact locality unknown (probably Ällebergsände, upper division). RM Br. 10944. 1/1. 6: A brachial valve exterior. (5) Ällebergsände, probably upper division. RM Br. 10929. 1.5/1.

Fig. 7–9: *Eostropheodonta birnantensis* (M'COY, 1851). 7: A pedicle valve interior. (13) Stommen. Coll. Walmsedt. UM Vg 882. 3/1. 8: A brachial valve interior. (5) Ällebergsände, lower division. Coll. J. BERGSTRÖM, 1963. LM LO 4258. 3/1. 9: A brachial valve exterior. (5) Ällebergsände. LM LO 4259. 3/1.

Fig. 10: *Coolinia dalmani* n. sp. A brachial valve exterior and a fragment of a pedicle valve exterior. (5) Ällebergsände. Coll. P. T. Cleve, 1865. UM Vg 883. 1.5/1.



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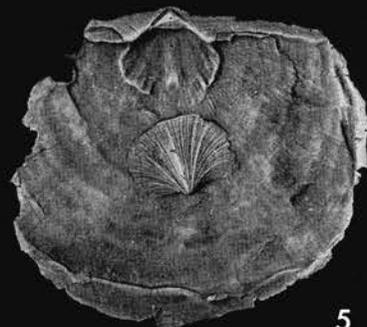
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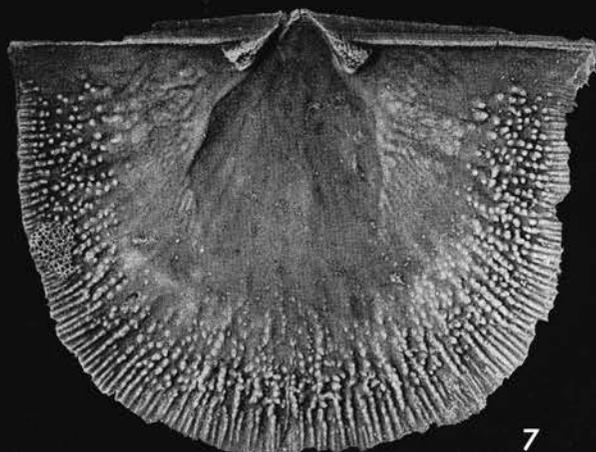
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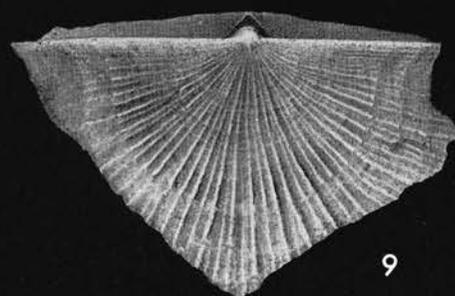
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### Plate 7

Fig. 1–4: *Coolinia dalmani* n. sp. 1: A brachial valve interior. (5) Ällebergsände. Coll. J. Bergström, 1963. LM LO 4260. 4/1. 2: Holotype, a brachial valve interior. (13) Stommen. Coll. J. Bergström, 1962. LM LO 4261. 2/1. 3: A pedicle valve exterior. (5) Ällebergsände. Coll. Elsa Warburg, 1940. UM Vg 884. 1.5/1. 4: A pedicle valve interior. (5) Ällebergsände. Coll. S. L. Törnquist. LM LO 4262. 4/1.

Fig. 5–8: *Plectothyrella crassicosta* (DALMAN, 1828). 5: A pedicle valve interior. (2) Bestorp. Coll. G. Troedsson. LM LO 4263. 3/1. 6: A pedicle valve interior (with *Cliftonia psittacina*). (2) Bestorp. Coll. I. Wallerius. LM LO 4264. 3/1. 7: Exterior of the same pedicle valve. (2) Bestorp. Coll. I. Wallerius. LM LO 4265. 2/1. 8: Umbonal part of a brachial valve interior. (2) Bestorp, southern crevace. Coll. J. Bergström, 1962. LM LO 4266. 4/1.

