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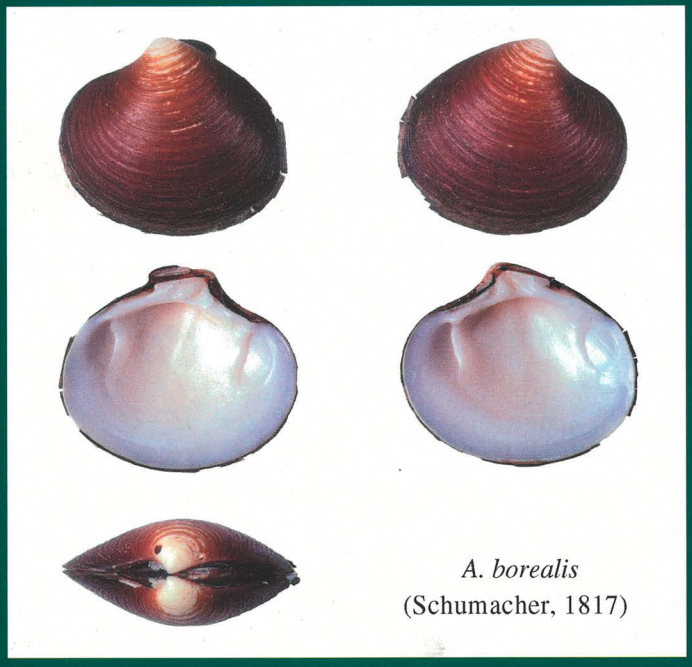
# Studies on some Arctic and Baltic *Astarte* species (Bivalvia, Mollusca)

G. Høpner Petersen



*A. borealis*
(Schumacher, 1817)

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# Abstract

Petersen, G. Høpner, 2001. Studies on some Arctic and Baltic *Astarte* species (Bivalvia, Mollusca). Meddelelser om Grønland, Bioscience 52, Copenhagen, The Danish Polar Center, 2001 71 pp.

Some species in the Arctic and Baltic *Astarte* - complexes have been described or redescribed. From the Arctic *A. borealis* - complex: *A. borealis* (Schumacher, 1817), *A. jenseni* n. sp., *A. nuuki* n. sp., *A. moerchi* n.sp., *A. sericea* Posselt 1895. From the Arctic *A. elliptica* - complex: *A. elliptica* (Brown, 1827), *A. neocrassa* n. sp., *A. longa* n. sp., *A. vaigati* n. sp. In the Baltic Sea the former "*A. borealis*"-complex has been substituted by 6 species: *A. bornholmi* n. sp., *A. silki* n. sp., *A. belti* n. sp., *A. fjordi* n. sp., *A. falsteri* n. sp., *A. nordi* n. sp. Part of the Baltic *A. elliptica* / *A. sulcata* - complex is studied: *A. elliptica* (Brown, 1827), *A. anholti* n. sp., *A. klinti* n. sp. and *A. sulcata* (da Costa 1778). A few notes on the *A. montagui* - complex and the *A. crenata* - complex have been added.

*Keywords: Astarte*, Arctic, Baltic Sea, bivalvia, mollusca, new names, new species.

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# Introduction

This paper began with the identification of *Astarte* species in quantitative samples from the Ikka fjord, Southwest Greenland. The material contains 3 distinct *Astarte* species, that preliminary were identified as "*A. borealis* s.l.", "*A. elliptica* s.l." and "*A. warhami*". However the identification of the Arctic bivalves poses several taxonomic problems. A few of them have been solved (Petersen, 1999, a, b, in press), and this paper is an attempt to solve some of the *Astarte* problems.

The Ikka fjord is a threshold fjord dominated by polar bottom water from the East Greenland current with a brackish surface layer of melt and river water in spring and summer. Furthermore, fresh water seeps up through the fjord bottom creating carbonate columns of up to 20 m in height. Neither the floating icebergs nor the deep, warmer North Atlantic water can reach the Ikka fjord due to several thresholds. The formation of the ca. 1 m thick sea ice may create a highly saline layer on the bottom during winter. The Ikka fjord with its thousands of carbonate columns is being studied by several scientists. The geology and bathymetry by Buchardt et al. (1996), (1997), (2001), Pauly (1963a,b), Seaman & Jenner (1996). Petersen et al. (1998). Thorbjørn (1996) and Thorbjørn & Petersen (in press) describe the epifauna on the ikait columns. The algae in the ikait columns are described in Kristiansen & Kristiansen (1999) and the meiofauna in Sørensen & Kristensen (2000). The quantitative grab samples are treated by Petersen (in manus).

The treatment of Baltic material was started by a note in Lubinsky (1980: 30): "The specimen of *Astarte* from Iceland, depicted as *A. borealis* by Jensen (1912, pl. 4, fig. 1a,b) is that of *A. arctica* Gray". That picture in Jensen (1912, pl. 4, fig. 1, a) was in Jensen & Spärck (1934: 83, fig. 63) used for identification of the Baltic, so called "*Astarte borealis*". In a footnote Jensen (1912: 96) referred to C.G. Joh. Petersen's identification of *A. borealis* in Danish waters, and compared the more frayed forms in the more arctic waters with the more frayed forms in the more brackish water in the Baltic Sea, and speculated on the influence of the carbonic acid content with reference to A. Krogh. This may be the explanation for this erroneous transfer of the Arctic names to the Baltic. The figures of the Faroese material of *A. sulcata* (Jensen 1912, pl. IV, fig. 3 a) and of *A. elliptica* (Jensen 1912, pl. IV, fig. 4 a) were also used for Danish material (Jensen & Spärck 1934, fig. 65 and fig. 67).

The collections at the Zoological Museum, University of Copenhagen (ZMUC) were studied, where the original materials used by Chemnitz (1784), Schumacher (1817), Mørch (1869), Posselt (1895), Petersen (1893), Jensen (1912) and Johansen (1916) are located. The collections in The Swedish Museum of Natural History (SMNH), Stockholm, were studied both by loaning the material and by personal visits.

# Material

The Arctic material located in ZMUC and SMNH for the descriptions and figures in Chemnitz (1784), Schumacher (1817), Jensen (1912), Mörch (1869), Posselt (1895) and Leche (1878) will be treated in the order given in Jensen (1912, pl. IV, fig. 1 a-f, reproduced here in Plate 1). The labels in Jensen's (1912) original material are with identifications in an unknown hand, and in Jensen's hand are added in red references to his figures. The Arctic material primarily comes from Iceland, West and East Greenland. A few samples are from Spitsbergen. Only specimens larger than ca. 20 mm are studied. A study of material and literature from the Siberian Seas, the Canadian Arctic, Northern Norway and deeper waters is omitted or incomplete.

In the old collections, sometimes more than 200 years old, descriptive information on dates, localities etc. is often limited. Sometimes the locality is just given as "Greenland", or there is simply a name of the collection or collector. However, with some historical knowledge of persons, ships, expeditions etc. most of the samples can be located, and the distributions of the species can be established. A number of identifications and names used on several generations of labels have been found. In the past, after the first studies were completed, some of the samples were aggregated to save space, while other, large samples were divided into smaller boxes in order to fit the shelves. A list of the studied samples is not given, as the number of samples cannot be accurately estimated.

The *Astarte* material from the North Atlantic area was divided into the Arctic and the Baltic, as several species from this complex are absent or rare (fossil?) along the west coast of Norway and from the Faroes. A few notes on the North Sea material are included.

The collection of Baltic bivalves in the ZMUC is large, the bulk of which was collected before 1930 in the Central and Western Baltic Sea and a few from the Kattegat region. *Astarte* species are absent from the Limfjord. Many of the stations were given with the old navigational bearings, and distance to a lighthouse or other landmarks which no longer exist or have changed name. The longitudes are sometimes referred to Copenhagen Observatory as the zero meridian. Hence I have summarised the distributions and just localised the important samples.

The Baltic Sea is inhabited by a swarm of *Astarte* species, each of them easily recognisable with a restricted distribution. The present studies in the Baltic have been limited to shells with sharp edges, smooth periostracum and larger than ca. 15 mm. The names *Astarte (Tridonta) borealis* Chemnitz + (*A. semisulcata* Leach) are erroneously recorded from the Baltic by e.g. Petersen (1893), Johansen (1916) and Jensen and Spärck (1934: 83, fig. 63). The figure of *A. borealis* in Jensen (1912 plate IV, fig. 1 a) of a specimen from Iceland was reproduced in Jensen & Spärck (1934, fig 63) for identification of the Danish

species. The figures of *A. elliptica* and *A. sulcata* from the Faroes in Jensen (1912, Pl. IV, fig. 4 a & fig. 3 a) were also reproduced in Jensen & Spärck (1934 figs. 67 & 65) for identification of these species in the Danish Seas. Jensen & Spärck (1934: 83) notes that a sharp margin is a valid character for *elliptica*, while *sulcata* sometimes may have a sharp shell margin. Tebble (1966: 70) has "crenulated margin" as a valid character for *A. sulcata* with a few exceptions in a footnote. The new species *A. anholti* in Kattegat solves this contradiction.

I can divide the material of the so-called "*Astarte borealis* - complex" from the Baltic into 6 species: *A. bornholmi* n.sp., *A. silki* n.sp., *A. belti* n. sp., *A. fjordi* n.sp., *A. falsteri* n.sp. and *A. nordi* n. sp. None of these Baltic species are identical with any of the species in the Arctic "*Astarte borealis* - complex".

A few from the *A. elliptica* complex, the *A. montagui* complex and the *A. sulcata* complex are studied, but the *A. crenata* complex is not found in the Baltic. Both *Astarte elliptica* (Brown, 1827) and *Astarte sulcata* (da Costa, 1778) occurs scattered, especially in the Kattegat region. Beside *A. anholti* n. sp. in the Kattegat the species, *A. klinti* n. sp. from the Central Baltic had also been liberally identified as *A. elliptica*, *A. montagui*, *A. sulcata* and *A. compressa*.

# Methods

In this paper only "living" material has been used. The remnants of soft parts in the illustrated shells were removed by washing sometimes with soap with protease, and where possible the soft parts were kept in alcohol.

I have used shell margin as the first entrance character in the keys. This character discriminate between the *A. borealis* complex + the *A. elliptica* complex + the *A. montagui* complex (all with sharp margin) and the *A. sulcata* complex + *A. crenata* complex (both with crenulated margin). Shell margin character was used by Smith (1881: 198), but was later abandoned due to some discussions about its validity for the juveniles. Some authors take it as an adult character only, see for instance the discussion in Jeffrey's (1881: 233-234), who argues against Smith's (1881) criticism and claim: "...International Court...decide ...what is a species... what are the limits..." and "Every naturalist has a perfect right to his own opinion".

The inside of the shells give some idea of the anatomy, but I have not tried to study the soft part. As noted by MacGinitie (1959: 168): "....*Astarte* species close so tightly that it is difficult to insert a razor blade between the valves". They are often difficult to open without damaging the valves. Ockelmann (1958) noted, that the microstructure of periostracum was of systematic value, but he did not study it further, and preliminary studies showed, that this character was not helpful for the species treated here.

The descriptions have 5 illustrations for each specimen: right valve, left valve, outside and inside, seen from umbo. The descriptions refer, when necessary, to the lunule and escutcheon seen from umbo, and to the lunule and escutcheon edges when seen from the side. The shape, the sculpture, the periostracum, the muscle scars, the mantle line and the colours are all described.

The more recent rules for nomenclature have been implemented. Several new species and names have been introduced, but for the Arctic I have not altered the old concepts of the occurring forms. I have merely extended the concepts and lifted "forma" and "varieties" to "species" level. I accept all names and descriptions as valid for a species, until otherwise proven by comparisons with the original material. Many synonymy lists are preliminary, and due to a lack of original material uncertainties cannot be resolved. I have followed the original spellings and nomenclature in the citations from old papers and labels.

# Survey of selected key literature

The published literature is the basis for the nomenclature, and the type specimens are the transfer steps to the real world. Hence, a survey of the literature used as an entrance to the *Astarte* complexes is given here.

The genus *Astarte* is well known for holding many "species" or taxonomic groups like "var.", "forma", "subspecies" etc. During the years, several malacologists have worked with *Astarte* from different areas, sometimes describing new taxa without making sure that the species were not described and sometimes using old names in a new and confusing way. The concepts of species varied and a number of names were in use. MacGinitie (1959: 164-165) described the situation very clearly: "Species in this genus... have been redescribed many times and endless varieties have been named...the only way to straighten them out would be to see the specimens...".

The collections in ZMUC and SMNH yielded several types and originals to the Arctic "*Astarte* complexes", but not all. Types for the boreal species in the *A. montagui, A. sulcata, A. elliptica, A. crenata* complexes are not seen and they are not in the collections of ZMUC and SMNH.

Probably the most complete account of the "species" and "names", that have been included into the Arctic *Astarte borealis* - complex, is given in Dall (1903: 936 + 940-941) and summarised here:

"Section *Astarte* s.s. ... inner margins crenulate when fully developed. Type, *Astarte sulcata* (da Costa)...."[Note: Dall wrongly assigned *A. sulcata* (da Costa) as the type for genus *Astarte*, see later].

"Section *Tridonta* Schumacher, 1817, type *T. borealis* Schumacher, 1817. Like *Astarte*, but the inner margins always smooth. From North American east coast: *A. arctica* (Gray, 1824): Convex and smooth form is well distinguished from *A. borealis*, destitute of concentric ribbing, dark blackish brown colour. ... = *corrugata* + *depressa* Brown, 1827, (= *cyprinoides* Daval, 1841), (= *islandica* Deshayes, 1867), (= *lactea* + *subtrigona* Sowerby, 1874). *A. borealis* Schumacher, 1817. Shell compressed, with the beaks concentrically ribbed; the rest more or less smooth. = *semisulcata* Leach, 1819, (= *veneriformis* Wood, 1828), (= *lactea* Broderip and Sowerby, 1829), (= *withami* J. Smith, 1829), (= *producta* Sowerby, 1874), the young = *richardsoni* Reeve, 1855, = *placenta* Mörch & (= *rhomboidalis* Leche, 1883)".

The names in parenthesis will not be treated further.

Jensen (1912) is a standard reference by e.g. Ockelmann (1958), MacGinitie (1959), Lubinsky (1980) for Arctic bivalves. The catalogue numbers in ZMUC for the original specimens found for Jensen (1912. Pl. IV) are given in Plate 1.

This plate IV includes the following 5 complexes:

"*A. borealis*" - complex: fig. 1a+b, c, d+e, f.

"*A. montagui*" - complex: fig. 2a, c. (2b)

"*A. sulcata*"- complex: fig. (3a, b, c)
"*A. elliptica*" - complex: fig. 4a+b, c+d, e+f, g.
"*A. crenata*" - complex : fig. (5a, b, c), d+e, (f, g), h+i, (k, l, m).

Those in parenthesis were not found. Two figures of the same specimen are given by +.

## The "*Astarte borealis* complex"

Jensen 1912 (p. 92 - 119) operates in his text with the following "names", either as synonyms or as "forms": *borealis* Chemnitz, 1784, *borealis* Schumacher, 1817, *semisulcata* Leach, 1819, *arctica* Gray, 1824, *Richardsoni* Reeve, 1855, *placenta* Mørch, 1869, *sericea* Posselt, 1895, (*producta* Sowerby, 1874).

The name in parenthesis will not be treated further. The following "names" / "species" will be discussed: *borealis, arctica, semisulcata, placenta, richardsoni, sericea, corrugata, compressa, depressa.*

From Iceland and West Greenland Jensen (1912) described two "forms":

1. Periostracum is thin, smooth, light coloured, yellowish-brown, glistening, finely fibrous towards the margin. (Pl. IV, fig. 1 a + b, reproduced here in Plate 1). See description of the original specimen ZMUC-BIV-361 = *Astarte borealis* s.s (Schumacher, 1817)

2. Periostracum is thick, frayed, dark brown, almost black, a very high form with quite narrow folds on the uppermost part of the shell (Pl. IV, fig. c, reproduced here in Plate 1). See description of original specimen ZMUC-BIV-362 = *Astarte jenseni* n. sp.

From West Greenland only, Jensen (1912) also described:
A strongly compressed form with distinct folds on the uppermost part of the shell. For this form he used the names var. *placenta* Mörch = *Astarte Richardsoni* Reeve. (Pl. IV, fig. d + e, is reproduced here in Plate 1). The validity of the name *placenta* is discussed, and two new species *A. moerchi* n.sp. and *A. nuuki* n. sp. are erected. See description of the original specimens ZMUC-BIV-360 and ZMUC-BIV-350.

From East Greenland Jensen (1912) identified:
A compressed elongated form as *Astarte sericea* Posselt, but Jensen could not separate it from the variety *placenta* Mörch. (Pl. IV, fig. 1 f, is reproduced here in Plate 1). See description of the original *A. sericea* Posselt, 1895.

## The "*Astarte montagui* - complex"

Only two originals have been located in ZMUC:

*A. Montagui* Dillwyn, forma *typica* fide Jensen (1912, pl. IV, fig. 2, a.) = (ZMUC-BIV-359: L = 13.5 mm, H = 12.7 mm, W = 7.3 mm).

*A. Montagui* Dillwyn, var. *Warhami* fide Jensen (1912, pl. IV, fig. 2 c) = (ZMUC-BIV-358: L = 21.9 mm, H = 16.5 mm, W = 9.4 mm).

Jensen (1912: 97) synonymise *A. Montagui* Dillwyn with two varieties of *A. Banksii* Leach, sensu Posselt (1895: 73, pl. 1, figs. 1-4). The original sample for *A. Banksii* Leach sensu Posselt (1895, tav.1, figs. 1-2) is deposited in ZMUC-BIV-410: L = 13.9 mm, H = 12.4 mm, W = 7.7 mm). The original sample for *A. Banksii* var. *Warhami* Hancock, sensu Posselt (1895, pl. 1, figs. 3-4) is deposited in ZMUC-BIV-409: L = 18.6 mm, H = 16.0 mm, W = 10.2 mm).

*Astarte warhami* Hancock, 1846 in the *A. montagui* complex is found in the Ikka fjord and identified as such using Hancock (1846: 336 + pl. V, fig. 15, 16). The *A. montagui* in Petersen (1978: 96) is reidentified as *A. warhami* Hancock, 1846.

## "The *Astarte sulcata* complex"

Jensen (1912: 105) remarked, that *A. sulcata* da Costa, 1778, p. 192 has very little variation compared with the other *Astarte* species, and figured two varieties: Jensen (1912, pl. IV, fig. 3 a,b,c, is reproduced here in Plate 1). The originals have not been located. Fig. 3a was reused in Jensen & Spärck (1934, fig. 65). Jensen (1912) considered *A. sulcata* to be a warm water form with northern limits at South West Iceland and South East Greenland. It is not found in West Greenland or in North America (Ockelmann 1958). The North East American *Astarte undata* complex has sometimes been united with the *A. sulcata* complex (see Smith 1881: 206-207) as both complexes have crenulated margin, deep concentric ridges and triangular to oval shape. Christoffer Schander identified ZMUC samples in the *A. sulcata* complex as novo species, fide labels. Both the *A. sulcata* - and *A. undata* complexes, are reported from Greenland, (Dall, 1903: 938, Jensen, 1912: 108), but they were not found in the material studied here.

## The "*Astarte elliptica* complex"

Jensen (1912) remarked that *A. elliptica* vary to a great degree and described 5 forms (= species).

1. From the Faroes is a fairly uniform form, with strongly marked folds from umbo to margin (see Jensen 1912, pl. IV, figs. 4 a,b is reproduced here in Plate 1). I accept this as the species *A. elliptica* (Brown, 1827). See descriptions later. Note, that fig. 4 a in Jensen (1912, pl. IV) of this specimen from the Faroes is reused in Jensen & Spärck 1934, fig. 67.

2. From East Greenland comes a compressed, elongated species, that is figured twice: Jensen (1912, pl. IV, figs. 4 c,d) and Posselt (1895, pl. 1, figs. 5-7). Jensen identified it as var. *depressa* Posselt 1895 (invalid name, see later). I accept this as *A. elonga* n. sp. See description later.

3. From West Greenland comes a very distinct species, (Jensen 1912, pl. IV, figs. 4 e,f). Jensen identified it as var. *crassa* Leche, 1878. I accept this as *A. neocrassa* n. sp. See description later.

From Iceland and West Greenland are two forms:

4. One has concentric ribs from umbo to the margin. *A. elliptica* Brown, 1827.

5. The other lacks folds over part of the shell (Jensen 1912, pl. IV, fig. 4 g). *A. vaigati* n. sp. See description later.

According to Jensen (1912: 111-112) a "form" of *A. elliptica* in the Arctic material has been identified as *A. borealis*: ["some specimens have folds only on the umbonal area —— are confused with less folded varieties of *Astarte borealis* Chemn. ("*A. semisulcata* Leach" etc.) — Mörch and Posselt have made mistakes —"]. This probably refers to *A. vaigati* n. sp.

## The "*Astarte crenata* complex"

The *A. crenata* complex includes: *crenata, inflata, incostata, crebricostata, subaequilatera*. Two originals from the *A. crenata* - complex were located:

*A. crenata* Gray, var. *subaequilatera* Sowerby, fide Jensen (1912, pl. IV, figs. 5 d,e) = (ZMUC-BIV-353: L = 24.3 mm, H = 18.5 mm, W = 10.6 mm).

*A. crenata* Gray, var. *inflata* Hägg, fide Jensen (1912, pl. IV, figs. 5 h,i) = (ZMUC-BIV-352: L = 14.6 mm, H = 11.6 mm, W = 7.1 mm).

These two firmly closed specimens were opened on 17 August 1999 for the first time. Both had plain margins. The consequence is, that the two originals identified and illustrated as varieties of *A. crenata* do not belong to this species. Furthermore the material mentioned in Ockelmann (1958: 91 + pl. 1, figs. 7, 21) as *A. crenata acuticostata* Jeffreys is wrong nomenclatorically, because *acuticostata* has plain margins (Smith 1881: 214). This complex is not studied further.

For the boreal *A. montagui, A. sulcata, A. elliptica and A. crenata* complexes the identifications are based on British literature, but without access to original material. The papers of Brown (1827, 1844) and Smith (1881) are important clues to the old names/species. The original material for Brown (1827, 1844) has been searched for without result (T. Schiøtte pers. comm.). The discussion and synonymy lists in Smith (1881), Dall (1903) and Jensen (1912) make it necessary to include some remarks on *A. sulcata* (da Costa, 1778).

Brown (1844) used the genus name *Crassina* and he described and figured 9 species, reproduced here in Plate 14. Note, that he does not mention any name/species from the *A. borealis* complex. He must have been aware of these older names, as he refers to his late friend Dr. Leach, who erected the name *semisulcata* in the *borealis* complex, and Brown uses Leach's name *convexiuscula* from an unpublished manuscript. Maybe Brown excluded these names because *semisulcata* was erected on Arctic material, and not British. Brown has the following 9 names/species:

1. *C. danmoniensis* Montagu, 1808: crenulated margin.
2. *C. scotica* Maton & Rackett, 1807: plain margin.
3. *C. elliptica*: Brown, 1827: plain margin.
4. *C. ovata* Brown, 1827: plain margin, incl. *Gairensis*, Nicol
5. *C. sulcata* da Costa, 1778: crenated margin.

6. *C. compressa* ? L. s.l.: plain margin?
7. *C. corrugata* Brown, 1827: plain margin
8. *C. depressa* Brown, 1827 plain margin
9. *C. striata* Brown, 1827 No remarks on margin, include var. *convexiuscula, obliqua.*

These names/species in Brown (1844) can be referred to the following complexes:

***1 + 5 Astarte sulcata* complex:** medium sized species with an oval to triangular shape, ligament rather hidden between the valves, concentric sculpture, margin crenulated: *C. danmoniensis* Montagu, 1808. + *C. sulcata* da Costa, 1778. (Note: different spellings in literature: danmoniensis, danmonia, danmoniæ, damoniensis).

Smith (1881: 207-208) synonymise *A. sulcata* da Costa, 1778 with *A. danmoniensis* Montagu, 1808 and *A. scotica* Maton & Rackett, 1807. Smith (1881: 196-197) recognize *Astarte scotica* as the type species for the genus *Astarte* Sowerby, 1816. Nevertheless, Smith declared that the older *A. sulcata* da Costa, 1778 is type for genus *Astarte*, which is nomenclatorical invalid, and the synonymy is doubtful. Both Dillwyn (1817:166-168), Maton & Rackett (1807: 81) and Montagu (1808: 44) describe *Venus scotica* with plain margins, opposed to *V. danmonia* and *sulcata*, who have crenulated margins. It is confusing as Smith (1881: 198) declared that crenulation of the margins is of importance in the discrimination of the species. *Astarte sulcata* (da Costa, 1778) was described by da Costa (1778: 192-193) as: "Pectunculus parvus dense sulcatus" and "The margins are delicately notched".

Sowerby (1818: 85) separated the genus *Astarte* from genus *Venus* and wrote: "Their edges are mostly crenulated within" and "... there are several recent British species ... of the former are *Venus Scotica* (which may be taken for the type of the Genus). ... of making a new Genus ...". (Note: see Sykes 1906 for Sowerby 1816).

**2 + 3 *Astarte elliptica* complex:** medium sized to large species, elongated ellipsoid shape, ligament rather hidden between the valves, prominent sculpture of concentric ridges and furrows from umbo to the sharp margin: *C. elliptica* Brown, 1827 + *C. ovata* Brown, 1827.

Smith (1881: 205) synonymise *C. ovata* with *C. elliptica* Brown, 1827. *C. ovata* Brown, 1827 was only illustrated in Brown (1844, pl. XXXVIII) as an addition and with some confusion with regard to figure numbers. The plate text refers *C. ovata* to figs. 12 and 13, numbers that do not occur on the plate. The two unnumbered figures on the plate are supposed to be of *C. ovata*. These two species are the only other ellipsoid specimens on that plate and Smith's synonymy is acceptable.

***6? + 7 + 8 Astarte borealis* complex:** Large species, max. length: 40 - 50 mm, prominent ligament, generally smooth surface, sharp margin: *C. corrugata*, + "*C. depressa*" ? .

Smith (1881: 202 & 217) referred *C. corrugata* as a synonym for "*A. borealis* (Chem.) Schumacher, 1817". The description (p. 96) and figure (pl. XL, fig. 24) in Brown (1844) justifies in my opinion that *C. corrugata* Brown, 1827 belongs to the *A. borealis* complex. It is large, length = 48 mm, height = 37 mm, smooth surface, sharp margin. *C. corrugata* in (pl. XL, fig. 24) has elongated, banana shaped anterior muscle scar, similar to the muscle scar seen at *Astarte nuuki* n.sp. However, it is not comparable with any of the Arctic or Baltic species described. It may be a British addition to the *A. borealis* complex.

*C. depressa* Brown, 1827 is synonymised with *A. borealis* by Smith (1881: 202). Brown had only dead and detached valves, the validity of the species and the synonymy is questionable, as the valves may be subfossil.

***9. Astarte montagui* complex:** This complex of species, smaller than ca. 15 mm include several others, see Lubinsky (1980: 32-36). They will not be studied here, nor will the smaller specimens of the larger species.

Smith (1881: 222-223) synonymise *C. compressa* s.l. with *C. montagui*, *C. striata*, *C. convexiuscula*, *C. obliqua*. However, Smith (1881: 217) also synonymise *C. compressa* sensu Montagu, 1808 and sensu Brown, 1827 (both authors have used the same specimen for their description and figures) with *A. borealis*. Only an examination of the original material can evaluate whether this is valid or not. According to the figures in Brown (1844 pl. XXXVIII, fig. 4) his *C. compressa* has elongated anterior muscle scar. The Linnean species name *compressa* should be abandoned (Dodge 1952: 125), but the name has been widely used on different Astarte species.

# Identification keys for the taxons studied

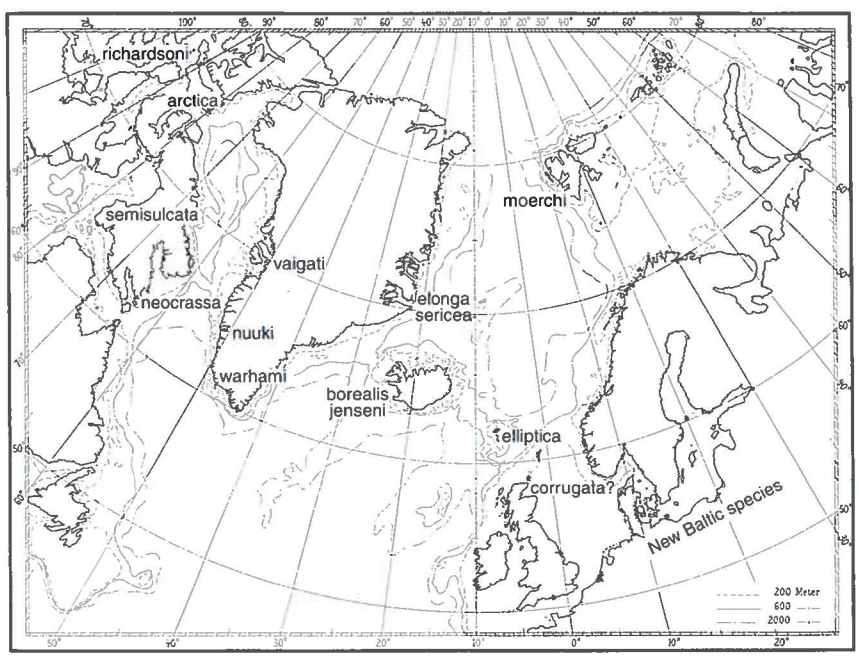
**Key to selected larger *Astarte* species, adults larger than ca. 20 mm, from Greenland, Iceland, (Spitsbergen). Siberian, Norwegian and Canadian materials not seen. The characters used have been or might be used for generic grouping.**

| | | |
|---|---|---|
| Margin sharp (Note: *A. crenata* misidentified) | 1 | |
| Margin crenulated (see Note above and p. 12) | 2 | |
| | | |
| 1: | | |
| Surface smooth, faint sculpture at umbo, | | |
| ligament clearly above umbos | 1.a | |
| Surface concentric sculptured, | | |
| ligament hidden between umbos | 1.b | |
| | | |
| 1.a: | | |
| Periostracum firm, shiny, small muscle scars | 1.a.1 | |
| Periostracum loose, dull, big muscle scars | 1.a.2 | |
| | | |
| 1.a.1: | | |
| Shape circular | *borealis* | (Iceland) |
| Shape ellipsoid, compressed | *sericea* | (E. Greenland) |
| | | |
| 1.a.2: | | |
| Anterior muscle scar elongated | *nuuki* | (W. Greenland) |
| Anterior muscle scar rounded | | |
| Shape triangular | *jenseni* | (Iceland) |
| Shape oval | *moerchi* | (Spitsbergen) |
| | | |
| 1.b: | | |
| Sculpture of prominent ribs, adults large | 1.b.1 | |
| Sculpture of fine striae, small species | 1.b.2 | |
| | | |
| 1.b.1: | | |
| Distinct costae, vanishing near margin | *vaigati* | (W. Greenland) |
| | | |
| Distinct equally spaced, concentric ribs | | |
| Shape triangular, inflated | *neocrassa* | (W. Greenland) |
| Shape ellipsoid, compressed | *elonga* | (E. Greenland) |
| Shape ellipsoid, not compressed | *elliptica* | (N. Atlantic) |

| | | |
|---|---|---|
| 1.b.2: | | |
| Shape oval, adults ca. 20 mm | *warhami* | (Arctic) |
| Shape high, triangular or nutshaped, adults smaller than ca. 15 mm. Not studied further. The complex of *montagui, banksi, striata, globosa* etc. | | (N. Atlantic) |
| 2: | | |
| Surface of prominent costae, oval-triangular shape | 2.a | |
| Surface of fine concentric lines, skew-triangular | 2.b | |
| 2.a: | | |
| Distinct costae and furrows | *sulcata* complex | (W. Europe) |
| Very prominent costae and furrows | *undata* complex | (N. America, W. Europe) |
| 2.b: | | |
| Note p. 12, wrong identifications, not studied further | *crenata* complex | (N. Atlantic) |

Note: The *Astarte* complexes with crenulated margin occur near the studied Arctic, shallow areas, but are in fact from boreal or deeper waters. They have been partly studied, as they have been mixed with the arctic, shallow water species with sharp margin. Due to incomplete investigations some species / specimens referred to in this complex have sharp margin.

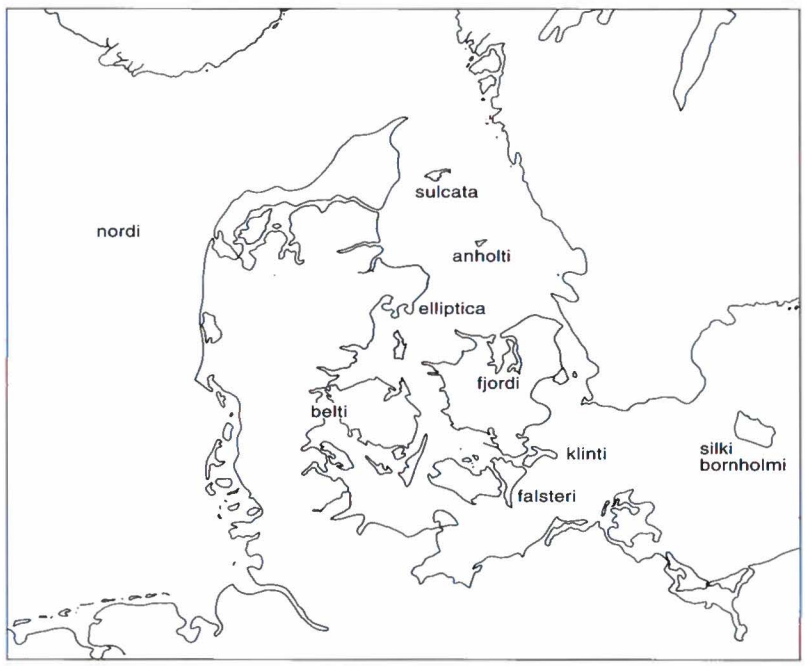
*Distribution of species and/or names in the Arctic and from Great Britain*



**Key to the Baltic - North Sea *Astarte* species, larger than ca. 15 mm. The smaller *A. montagui, banksi* etc. complex with sharp margin and smooth periostracum are not studied.**

| | | |
|---|---|---|
| Margin sharp | 1 | |
| Margin crenulated | 2 | |
| | | |
| 1 | | |
| Surface smooth, small muscle scars | 1.a | |
| Surface concentric sculptured | 1.b | |
| | | |
| 1.a | | |
| Periostracum shining | | |
| Shape high oval, umbo behind midline | *silki* | (Bornholm) |
| silky glare | | |
| Shape elongated, umbo in front of midline | | |
| oily glare | *falsteri* | (Falster) |
| Periostracum dull, shape ellipssoid, | | |
| umbo in front of midline | *bornholmi* | (Bornholm) |
| | | |
| 1.b | | |
| Sculpture of lines, ligament above umbo | 1.b.1 | |
| Sculpture of distinctly costae, | | |
| ligament hidden between umbo | 1.b.2 | |
| | | |
| 1.b.1 | | |
| Periostracum shining, fine lines, | | |
| small muscle scars | *fjordi* | (Isefjord) |
| Periostracum thick, dull, fine lines, | | |
| big muscle scars | *nordi* | (North Sea) |
| Periostracum thick, dull, coarse lines, | | |
| big muscle scars | *belti* | (Belt Sea) |
| | | |
| 1.b.2 | | |
| Shape ellipsoid, big muscle scars | *elliptica* | (Atlantic) |
| Shape triangular oval, big muscle scars | *anholti* | (Kattegat) |
| Shape nutlike, small muscle scars | *klinti* | (Baltic) |
| | | |
| 2 | | |
| Sculpture of prominent costae, triangular | | |
| roundish shape, big muscle scars | *sulcata* | (Atlantic) |

*Distribution of the species and/or names in the Baltic*



# Descriptions of some Arctic *Astarte* species

## *Astarte borealis* (Schumacher, 1817). Neotype: ZMUC-BIV-361.

**Material examined**

Jensen's original specimen of *Astarte borealis* (1912, pl. IV, fig. 1, a + b, is reproduced here in Plate 1). The text on the label with the sample reads: "Astarte borealis Ch. 6 kvml v.f.Island, 65° 32' NB, 24° 38' vL. 22 Fv. Dreschel." Added in red: "Orig pl. IV, fig. 1 a+b".

**Additional material**

Ca. 6 samples from SW Iceland, 20 - 60 m. + ca. 9 samples from SW Greenland, 30 - 40 m. + 2 samples from North and West Norway.

**Description of neotype**

Plate 2. L = 37.6 mm, H = 32.5 mm, W = 16.3 mm.

The shell is solid and thick, with an ellipsoid outline. Beaks are bending forward, in the midline and are not corroded. Right valve bored by small naticid.

Lunule, deep, heartshaped, lunule edge concave.

Ligament prominent, ca. 9 mm long, escutcheon ca. 20.0 mm. Escutcheon edge is straight.

Periostracum is smooth with fine concentric lines, and loosened at the edge due to the dry conservation. Periostracum is glossy, white yellow at umbo, changing through light brown to chestnut at the edge.

Inside shell colour is glossy white.

Right hinge: 1 clumsy cardinal, 2 fine anterior laterals, 1 posterior lateral.

Left hinge: 2 bifid cardinals, 1 posterior lateral.

Muscle scars are rather small. A distinct pedal muscle scar above the anterior adductor scar.

**Distribution**

Iceland - Greenland - Northern Norway

**Remarks**

This specimen (ZMUC-BIV-361) with its rather small muscle scars and concave lunule fits Schumacher's drawing of *Tridonta borealis* (1817, pl. XVII, fig. 1, a + b, reproduced here in Plate 3). The specimen is dissimilar to the old specimens from the sample of Spengler and Chemnitz, see later. The conclusion is, that the original specimen for Jensen (1912, pl. IV, fig. 1 a,b) represents *Astarte borealis* (Schumacher, 1817), and the specimen is hereby selected as neotype for the species *Astarte borealis* (Schumacher, 1817) as a result of the following studies on the old materials.

Chemnitz (1784) was for several years considered to be the author for the name *Astarte borealis*, also called "Die nordische Venus", referring to Linné: "Vermuthlich gehören die hier abgebildeten Arten von Muscheln zur Ven. boreali Linnaei". The figures of "Die nordische Venus" in Chemnitz (1784, Vol. 7: 26-28, Tab. 39, figs. 412, 413, 414) are reproduced here in Plate 4. Chemnitz (1784) has 3 specimens of *Astarte*, no. 412 (= *A. borealis* fide Jensen 1912: 92 + "lectotype" for Schumacher 1817), no. 413 (= *A. crenata* fide Jensen 1912: 92, footnote no. 1), no. 414 (= *A. sulcata* fide Jensen 1912: 92, footnote nr. 1). However, according to Chemnitz (1784: 28) no. 413 is the only one with a crenulated margin. Hence, no. 413 could be *A. sulcata-A. crenata*, and no. 414 cannot be *A. sulcata*. Linné's name *Venus borealis* refers to a species now known as *Lucinoma borealis*, see Dodge (1952: 113-114). Chemnitz's decription fits *Astarte*, e.g.: "Frische Stücke werden von einer braunen Haut bedeckt" and " Die gegeneinander gekehrten Wirbelspitzen pflegen allemahl wie abgefressen — zu sein— ob ich gleich manche hunderte derselben unter Händen gehabt" — "Die nordischen Gewässer sind das wahre Vaterland dieser Muscheln". Chemnitz's work was later declared non-binominal and hence his name is not valid.

Schumacher (1817: 49, 146-147 + plate XVII, fig. 1) described his new genus *Tridonta* and the species *Tridonta borealis* and write: "Pl. XVII, fig. 1. Chemn. 7. pag. 26, Tab. 39, fig. 412. Je ne saurais me persvader que cette coquille soit la *Venus borealis* Lin. La vrai coquille de Linnæus doit avoir des stries membraneuses relevées, irréguliéres et écartées; mais notre coquille n'est que finement striée, et c'est exactement la méme coquille de Mr. Chemnitz, qui se trouve classée dans la collection de Mr. Spengler, comme variété de la *Venus borealis* de Linnæus".

Part of the material described by Chemnitz (1784) has been traced to an old sample in the ZMUC collection, that comes close in time to the original material and containing only two specimens, ZMUC-BIV-348 (Plate 5) + ZMUC-BIV-349 (Plate 6). The labels are written in Spengler's and Mørch's hands. Chemnitz, Spengler and Schumacher worked in Copenhagen at the same time, and were probably very well acquainted with each others' collections. Spengler used to polish some of his shells and the specimens in this sample are more or less polished. The label with Spengler's hand reads: "Varietet von der Venus borealis, 143 Linné, Ohne falten, Chemn. To 7, fig. 414 und 412. Die grossen Ex: aus Island, Die kleineren von Jul. Mariæ Haab aus Grönland." The label with Mørch's hand reads: "Astarte semisulcata Leach var. A. islandica Desh. Island cfr. Sp. V. borealis var." An unknown hand has added: "38 Island". No. 38 is repeated in shells BIV-348 and in the right valve very faintly: "Island", probably in Spengler's hand. Both valves are partly polished. A third label in Japetus Steenstrup's hand: "Astarte laevis Beck. Hab Cap North". This label may refer to specimen ZMUC-BIV-349 (Plate 6) as inscribed with pencil in the right valve is written: "ved Hammerfj". The right valve is polished.

Descriptions of the two specimens in the old sample:
ZMUC-BIV-348, Plate 5: L = 40.6 mm, H = 36.1 mm, W = 19.2 mm.

Shell solid, thick, white with a yellowish touch, concentric lines, not ridges. Beaks bending forwards, almost in the midline. Ventral edge is oval to semicircular.

Periostracum rubbed or polished away, remnants are dark brown. Lunule deep, large, lunule edge is concave. Ligament prominent, but partly rubbed away. Escutcheon line almost straight.

Right hinge: 1 clumsy cardinal tooth with deep impressions on each side. One distinct anterior lateral tooth, posterior just shell edge.

Left hinge: 1 deep impression for the right cardinal surrounded by 2 smaller cardinals. Only faint laterals.

Large muscle scars, anterior kidney shaped, with a triangular pedal muscle scar just above. The posterior muscle scar is a trapezoid with the pedal muscle scar as an integrated tip.

ZMUC-BIV-349, Plate 6: L = 42.0 mm, H = 34.6 mm, W = 19.3 mm. Right valve polished. Left valves periostracum is dark brown. For further description see: ZMUC-BIV-348 above.

None of these old shells fits no. 412 in Chemnitz (1784) nor do they fit the description in Schumacher (1817). The muscle scars of these two specimens are too big to fit the drawing by Schumacher (1817) reproduced in Plate 3. As a first step in a revision it appeared necessary to select a neotype. This could stabilize the use of *borealis*, and serve as a starting point for further discussions of other species. Apparently Mørch already reidentified the specimens as *A. semisulcata* Leach var. *A. islandica* Desh. (According to Smith 1881: 218 the name *A. islandica* Deshayes is a manuscript name from 1867 and it has not been pursued further). A third unknown curator identified them as *A. laevis* Beck. Mørch (1869) did not list *A. borealis*, excluding that name (species?) from his material without further explanation. There is evidence that earlier there may have been problems with the species concept, and these old Chemnitz and Spengler specimens were not the originals as depicted in Schumacher's (1817) drawing. See also the discussion by Smith (1881: 219-220) on this matter. These two polished and somewhat worn specimens come close to *Astarte jenseni* n. sp. see later.

Lubinsky's (1980) synonymy with *Astarte arctica* (Gray, 1824) cannot be established without a study of Gray's as yet unlocated original material. Gray (1824: 243) described 2 species: *Crassina Semiculcata* Leach and *C. Arctica* Gray n.sp., however he did so without figures. His description of *Astarte arctica* could fit many *Astarte* specimens, except for the fact that Gray writes: "epidermis black, shining, finely concentrically striated". This character does not fit *Astarte borealis* (Schumacher, 1817) or any of Jensen's figured specimens. Gray's material was from the Canadian Archipelago, whereas Chemnitz',

Schumacher's and Jensen's materials were from Iceland. Apparently Gray was not able to locate *Astarte borealis* s.l. in his material, a name (species) he probably was aware of. It appears most safe to accept that the name *Astarte arctica* (Gray, 1824) covers a distinct Canadian arctic species.

## *Astarte jenseni* n. sp. Holotype. ZMUC-BIV-362.

**Material examined**

Jensen's original specimen (Jensen 1912 plate IV, fig. 1 c, is reproduced here in Plate 1). Text on the label of the specimen reads: "Astarte borealis Ch. Faxe fjord udfor Kollafjord (Vest Island), 8-11 1/2 Fv. Slik & Sten, 17-8-1901, R. Hørring" and added in red: "Orig Pl IV, fig. 1 c".

**Additional Material**

Ca. 22 samples from Iceland, 12-30 m.

**Description of holotype**

Plate 7: L = 36.3 mm, H = 31.1 mm, W = 16.0 mm.

Shell solid, high, triangular rounded shape, smooth margin. The ligament is prominent. The escutcheon edge is a little convex, the lunule edge is a little concave and these two meet under an angle of ca. 100 degrees, with the ventral edge running almost like a circle between the two edges. The beaks are in the midline, and show little corrosion.

The sculpture is concentric lines to ridges, with ca. 8 indistinct growth checks.

Periostracum is thick, fibrous on the lowest part, and not hairy or frayed. Its colour is dark brown to black, dull, as opposed to glossy.

The inside colour is light grey to white, and somewhat glossy. Right valve: 1 big, skew cardinal surrounded by anterior impression and a deeper posterior impression, bordered by a distinct cardinal starting from the beak. It has 1 anterior lateral, and no posterior lateral.

Left hinge: 2 big cardinals, the posterior bifid, start from the beaks and has a deep impression. It has 1 long thin posterior lateral, and no anterior lateral.

The muscle scars are large, the anterior is semilunar in shape, as opposed to bean shaped and has a distinct pedal muscle scar above. The posterior is a flattened oval with the pedal muscle scar as a tip.

The mantle line is rather short, due to the large muscle scars.

**Distribution**

This species seems to be distributed around Iceland.

**Remarks**

This specimen, ZMUC-BIV-362, is considerable different to the other "var" of Jensen's, so much that it deserves its own species rank. The hinge is more

substantial than that of *Astarte borealis* (Schumacher, 1817) (neotype, ZMUC-BIV-361, see above). The name is proposed as: *Astarte jenseni.*

**Etymology**
Jensen (1912, pl. IV, fig. 1 c + text p. 95-97) listed a description and a figure of this "form", ones which helped identify it as a species. His name is attached to the species.

## *Astarte nuuki* n. sp. Holotype. ZMUC-BIV-360.

(= *Astarte placenta* sensu Jensen 1912, name not available)

**Material examined**
Jensen's original specimen (1912: 96, pl. IV, fig. 1 d + e, is reproduced here in Plate 1). The label with the specimen reads: "Astarte borealis Ch. Vest-Grönland" and in red: "Orig. Pl. IV, Fig. 1 d & e."

**Additional material**
Ca. 7 samples from SW Greenland, Disko Bugt and Thule area in NW Greenland.

**Description of holotype**
Plate 8. L = 38.0 mm, H = 31.1 mm, W = 12.0 mm.

The shell is solid, ellipsoid in shape, with corroded beaks, bent forward, in front of midline. The ligament is prominent. The lunule is indistinct, with the lunule edge faintly concave, where as the escutcheon edge is straight. The shells appear to be compressed.

The sculpture is of concentric ridges on the upper third of the shells, changing to fine lines for the rest, with biocorrosion along part of one of the lines.

The periostracum is loose, frayed dark brown, non-glossy, and is lost near the margins of the shell due to dry conservation. The right hinge: It has 1 clumsy big cardinal with a tendency to bifidity, with a deep anterior impression bordered by a small anterior cardinal starting from umbo. It has 1 distinct anterior lateral, with an indistinct posterior lateral.

Left hinge: 2 smaller cardinals with bifidity which surround a deep impression. It has 1 anterior and 1 posterior small laterals.

The muscle scars are rather small with the anterior muscle scar being banana shaped, elongated by the integrated pedal muscle scar. The posterior muscle scar is a trapezoid with no distinct pedal muscle scar.

**Distribution**
This species appears to be distributed along the West Greenland coast only.

**Remarks**

Jensen (1912: 96) described this specimen as: "a strongly compressed form (var. *placenta* Mörch = *Astarte Richardsoni* Reeve) from West Greenland". In a footnote Jensen (1912: 96) referred compressed, elongated forms from East Greenland to var. *sericea* Posselt, which he lumped together with *placenta* Mörch. I consider that all three names cover three valid species. Hence a discussion of the species and the name *placenta* Mörch, 1869 is included in a following chapter.

**Etymology**

I consider the var. *placenta* of Jensen (1912) from West Greenland to be a separate species and name it *Astarte nuuki* n. sp. after Greenland's capital: Nuuk. Nuuk is situated in the middle of the West Greenland coastline.

## *Astarte moerchi* n.sp. Holotype. ZMUC-BIV-350.

(= *Astarte placenta* Mörch, 1869, name not available see below).

**Material examined**

The original specimen mentioned by Mörch (1869). The label text read: "Astarte semisulcata Leach v. placenta Moerch Spitzbergen Krøyer". This label corresponds to the text by Mörch (1869, p. 22). Only Mörch's 2 samples from Spitsbergen have been found.

**Description of holotype:**

Plate 9. L = 37.9 mm, H = 29.5 mm, B = 14.8 mm.

The shell is solid, compressed, ellipsoid in shape, with corroded beaks bent forward, in front of the midline. The lunule is narrow, distinct, and slightly concave, whereas the escutcheon is slightly convex. The ligament is prominent. The concentric ridges near the umbo change to fine lines near the margin, with corrosion along one "growth check".

The periostracum is thick, frayed, and loose at the edge due to dry conservation, it is dark brown in colour, dull in finish and has a growth of epifauna.

The inside shell colour is white yellow.

Right hinge: 1 big impression with a big, "keeled", non-bifid, cardinal behind, a smaller cardinal in front. It has 1 distinct anterior lateral, with an indistinct posterior lateral.

Left hinge: 1 big, clumsy cardinal, 1 anterior and 1 posterior lateral.

Big adductor muscle scars, the anterior is a flattened ellipsoid (non-elongated) with a very distinct pedal muscle scar above. The posterior muscle scar is a trapezoid oval with an integrated pedal muscle scar.

**Distribution**

In my material this species is only present from Spitsbergen.

**Remarks**

The two samples from Mörch (1869) were located in the collections, referred to as ZMUC-BIV-350 and ZMUC-BIV-351. Mörch (1869: 22) wrote about his species 56: *Astarte semisulcata* Leach (= *lactea*, Brod. et Sowerby, McAndrew): "Several in good condition were found among soundings from Spitzbergen Buchan". This sample is located as ZMUC-BIV-351, but is not figured. The label text in Mørch's hand reads: "Astarte semisulcata Leach, Bellsound Spitzbergen Kroyer 1839." This sample contains one 35.6 mm left valve, within this valve is written "Hammerfest", probably from N Norway. I regard this specimen as belonging to *A. borealis* (Schumacher, 1817), as defined above. It also contains 2 specimens, L = 27.0 mm, L = 21.3 mm, which I refer to *A. sericea* Posselt, 1895.

Later, under *Astarte semisulcata*, Mörch (1869: 22) adds another line: "var. *placenta* (= *Richardsoni*, Reeve, = *borealis*, Nilsson)". He refers this name to a sample "Bellsound, deux exemplaires, long 37 mm (H. Kroyer)". Within this sample (ZMUC-BIV-350) are left and right valves from a specimen measured with a modern slide ruler to L = 37.9 mm. This specimen formed the basis for *Astarte placenta* Mörch, 1869, but the name was published in synonymy of *Astarte richardsoni* (Reeve, 1855). (ICZN, 1985, article 12 B). Whether the name *placenta* Mørch is available depends, according to ICZN (1985, article 11 E), on it being used by other authors as the name of a taxon or as a senior homonym. The only pre-1961 reference to the name found (Leche 1878: 19), Dall 1903: 941, Jensen 1912: 96) make it clear that the authors in question regard it merely as the name of a morphological variation or a growth stage. This makes it necessary to propose a new name for the species.

Neither Mörch (1869) nor Reeve (1855) mention *A. borealis* in their material. The description of *Richardsoni* (Reeve 1855: 397-398, plate 33, fig. 7 a, b, reproduced here in Plate 10) neither fits *A. borealis* (ZMUC-BIV-360), as defined above, nor Mörch's *placenta* = *A. moerchi* (ZMUC-BIV-350). The materials are from widely separated areas: Reeve's (1855) is from Arctic Canada, Mörch's (1869) is from Spitsbergen and Jensen's (1912) is from West Greenland. Leche (1878: 15-21) identified from the Kara Sea a material of *Astarte* to several species and varieties and commented on the difficulties. In his table I "*A. compressa*" Lin. (fig. 2), var. "*crassa*" mihi (fig. 3 a,b) and "*A. semisulcata*" Leach var. "*placenta*" Mörch (fig. 4 a,c) are figured. Leche synonymise var. *placenta* with both *A. corrugata, forma transversa plana* and *A. Richardsoni*. The information at hand does not allow one to accept Leche's identification of the Kara Sea material from the Spitzbergen material of Mörch. Lubinsky (1980: 30-31) described "*A. borealis var. placenta*" as a high Arctic form. She gave a description of a species called *A. borealis*, but did so with photos of *Astarte borealis* (Schumacher) *placenta* (Mørch), (Lubinsky 1980: 99 and fig. 8, 9).

**Etymology**

I give the species from Spitsbergen hitherto known as *Astarte placenta* Mörch, 1869 the new name *Astarte moerchi* n. sp. I have consciously separated it from

the Canadian species *Astarte richardsoni* Reeve, 1855, which I consider to be a separate species. Reeve's material has not yet been located.

**Comparison between Mörch's *placenta* and Jensen's *placenta***

| Shell characters | *placenta* sensu Mørch ZMUC-BIV-350, Pl. 9. | *placenta* sensu Jensen ZMUC-BIV-360, Pl. 8. |
|---|---|---|
| Periostracum | brown, frayed, fine lines | black brown, frayed, ridges |
| Right hinge | 1 cardinal + 1 big anterior lateral | 1 big clumsy cardinal + 1 anterior small lateral |
| Left hinge | 1 big clumsy cardinal + small laterals | 2 cardinal, the anterior bifid + 2 small laterals |
| Anterior muscle scar | Ellipsoid, kidney shaped + faint pedal muscle scar | Elongated banana shaped + pedal muscle scar on top |
| Posterior muscle scar | Rounded rectangular | Rounded trapezoid, smaller |
| Shell shape | More oval | More rounded |
| Locality | Spitsbergen | West Greenland |
| New species name | *Astarte moerchi* n. sp. | *Astarte nuuki* n. sp. |

## *Astarte sericea* Posselt, 1895. Lectotype: ZMUC-BIV-354. Paralectotype: ZMUC-BIV-404.

**Material examined**

From the type locality: Hekla Havn, Scoresby Sund, East Greenland. The sample contains 2 specimens, 1 in good condition, L = 28.6 mm, (ZMUC-BIV-354, Lectotype, here selected), and 1 "dead", worn shell: L = 22.3 mm (ZMUC-BIV-404, paratype). The text on the label reads: "Astarte semisulcata Leach var. sericea, n. Orig. Posselt: Østgrl. Moll. 1895 Tab 1 Fig 8-12 Hekla Havn Østgrl. Exp. 1892" added in red: "Orig. Pl. IV, Fig. 1 f. (det mellemste og store Expl.)".

**Additional material**

11 samples from East Greenland, not found in the West Greenland or in the Iceland material. 2 samples from Spitsbergen (identified as *A. semisulcata, var.*

*placenta* by Mörch, see above). The shell identified as *A. borealis* by Schiøtte (1989, p. 18 - 19, fig. 14 A, B) was reidentified by T. Schiøtte as *A. sericea* (pers. comm.).

**Description of lectotype**

Plate 11. L = 28.6 mm, H = 21.3, W = 9.0 mm.

The shell is a thin, elongated ellipsoid, with a highly corroded umbo, in front of midline. The lunule is indistinct, with a straight edge. The ligament is thin but visible. The escutcheon is narrow, also with a straight edge, and meets lunule edge as an angle of ca. 120°. This is all due to the elongated compressed shape.

The periostracum is smooth, silky with very fine concentric lines. It is neither frayed nor loose. It has a uniform grey/brown colour throughout its surface.

The inside colour of the shell is glossy white-bluish.

The hinge is rather narrow and the cardinals are almost corroded away as a result of the corrosion from the umbo. In the right valve there is part of a larger cardinal and one distinct anterior lateral. In the left valve there are pieces of two bifid cardinals. Laterals are indistinct.

The muscle scars are oval and relatively small with a distinct pedal muscle scar above the anterior.

**Distribution**

East Greenland, Spitsbergen .

**Remarks**

The lectotype has been described and illustrated twice:

1). Posselt (1895: p. 71 and Tab. 1, fig. 8-9, reproduced here in Plate 12) described the specimen and figured the right valve and the beaks. The specimen is here selected as lectotype for *A. sericea* Posselt, 1895 (ZMUC-BIV-354). Posselt (1895: 71) described his *sericea* n. as a new var. of *A. borealis* (Chemnitz). The locality was given as: "Hekla Havn, paa Mudderbund (K.M., Østgrønlandske Exp. 1892)", corresponding to the label text. His description is (in a short English version): "—thick silky epidermis, umbo with narrow sharp foldings to the middle of the shell, from where they become broader. Shape is elongated, L = 30 mm, H = 22 mm." His figure and description match the lectotype (ZMUC-BIV-354).

2). Jensen (1912, Pl. IV, fig. 1 f, reproduced here in Plate 1) figured the left valve. The species has been described as a compressed, very elongated form (var. *sericea* Posselt) from Hekla Havn, East Greenland. In a table of measurements Jensen (1912) gave the dimension of the specimen from Hekla Havn as: L = 29 mm, H = 21.5 mm, W = 9.5 mm. This corresponds to the measurements of the specimen ZMUC-BIV-354. (L = 28.6 mm, H = 21.3, W = 9.0 mm), considering the inaccuracies in measuring. Jensen however could not distinguish this form from his "variety *placenta* Mörch".

## *Astarte elliptica* (Brown, 1827). ZMUC-BIV-357.

**Material examined**

Jensen's original specimen (1912, pl. IV, figs. 4 a + b, is reproduced here in Plate 1). The text on the label with the specimen reads: "Astarte elliptica Brown. Færöerne, Klaksvig, 10-15 Fv." and added in red: "Orig. Pl. IV, fig 4 a & b".

**Additional material**

Ca. 50 samples from the Faroes and a few samples from the outer Danish seas. Ca. 30 samples from Iceland with *Astarte elliptica* only and ca. 20 samples with both *A. elliptica* and *A. vaigati*, see later.

**Description of the specimen**

Plate 13. L = 25.8 mm, H = 19.9 mm, W = 9.6 mm.

The shell is ellipsoid, elongated. The umbo is bending forward, in front of midline, with no corrosion. The lunule is deep, with a concave edge. The ligament is small, and the escutcheon is narrow, with a straight edge.

Sculpture: ca. 20 prominent concentric ridges and furrows from the umbo to the margin, more prominent and increasing towards the margin.

The periostracum is firmly attached to the shell, is not frayed, and ranges from a yellow brown colour around the umbo to dark brown colour at the margin. The periostracum has no corrosion or external parasitism.

Inside colour: greyish-white, glossy.

Right hinge: one big central, non-bifid cardinal surrounded by deep impressions, one larger posterior cardinal and one indistinct anterior cardinal. One distinct anterior lateral with no posterior lateral.

Left hinge: 2 distinct cardinals, non-bifid, around one deep impression. No anterior lateral with one distinct posterior lateral.

Anterior muscle scar: rather large, bean shaped with a separate muscle scar above.

Posterior muscle scar: trapezoid shape with integrated pedal muscle scar.

**Remarks**

Jensen (1912: 108-113 and pl. IV, figs. 4 a-g) synonymise *A. elliptica* (Brown, 1827, pl. 18, fig. 3 = Brown 1844, p. 96, pl. 38, fig. 3, reproduced here in Plate 14) with: *A. compressa* Linné, *A. semisulcata* Leach, and *A. depressa* Posselt, 1895. However this synonymy is not valid. The name *A. compressa* Linné should be abandoned (Dodge 1952: 125). *A. compressa* sensu Brown 1827 = sensu Montagu 1808 belongs either to the *A. borealis* complex or to the *A. montagui* complex (Smith 1881: 217). *A. semisulcata* Leach is not yet localised, Leach (1819). Posselt (1895: 72 + Tab. I figs. 5,6,7, reproduced here in Plate 15) identifies the material from East Greenland as *Astarte compressa*, (Linné) var. *depressa* n. These names are not valid, as Brown 1844 has *C. compressa* sp. no. 6 + *C. depressa*, sp. nr. 8. Mørch (1869: 22-23) has *Astarte (Nicania) Warhami* Hancock with var. *depressa* from Spitsbergen.

**Legend to plates pp. 35-48**

Plate 1: The *Astarte*- complexes reprinted from Jensen (1912, pl. IV). The original specimens located are marked with their ZMUC-BIV- numbers.

Plate 2: *Astarte borealis* (Schumacher, 1817), neotype, ZMUC-BIV-361. Original specimen for Jensen (1912, pl. IV, fig. 1 a-b). L = 37.6 mm, H = 32.5 mm, W = 16.3 mm. From Iceland.

Plate 3: Drawing of *Tridonta borealis* in Schumacher 1817, pl. XVII. From the "Northern Seas". Reprinted from Schumacher 1917.

Plate 4: The 3 *Astarte* species illustrated in Chemnitz 1784, Tab. 39. From the "Northern Seas". Reprinted from Chemnitz 1784.

Plate 5: *Astarte borealis* s.l., ZMUC-BIV-348, from Chemnitz, Spengler collections. L = 40.6 mm, H = 36.1 mm, W = 19.2 mm. From the Northern Seas.

Plate 6: *Astarte borealis* s.l., ZMUC-BIV-349, from Chemnitz, Spengler collections. L = 42.0 mm, H = 34.6 mm, W = 19.3 mm. From the Northern Seas.

Plate 7: *Astarte jenseni*, n.sp., holotype, ZMUC-BIV-362, (=? *Astarte semisulcata* Leach, 1819). Original for Jensen (1912, pl. IV, fig. 1 c). L = 36.3 mm, H = 31.1 mm, W = 16.0 mm. From Iceland.

Plate 8: *Astarte nuuki* n.sp., holotype, ZMUC-BIV-360. Original specimen for *Astarte placenta*, Mörch, sensu Jensen (1912, pl., IV, figs. 1 d,e). L = 38.0 mm, H = 31.1 mm, W = 12.0 mm. From West Greenland.

Plate 9: *Astarte moerchi* n.sp., holotype, ZMUC-BIV-350. Original specimen for *Astarte placenta* Mörch, 1869, which is a nomen nudum of a replacement name for *A. richardsoni* Reeve, 1855. L = 37.9 mm, H = 29.5 mm, W = 14.8 mm. From Spitsbergen.

Plate 10: Drawing of *Astarte richardsoni* from Reeve (1855, pl. 33, fig. 7 a,b). From Arctic Canada. Reprinted from Reeve (1855).

Plate 11: *Astarte sericea* Posselt, 1895, lectotype, ZMUC-BIV-354. Original specimen for Jensen (1912, pl. IV, fig 1, f). and Posselt (1895, pl. 1. fig. 8-11). L = 28.6 mm, H = 21.3 mm, W = 9.0 mm. From East Greenland.

Plate 12: Figures of *Astarte sericea* from Posselt (1895, pl. 1. fig. 8-11). From East Greenland. Reprinted from Posselt (1895).

Plate 13: *Astarte elliptica* (Brown, 1827). Original specimen for Jensen (1912, pl. IV, figs 4 a,b). L = 25.8 mm, H = 19.9 mm, W = 9.6 mm. From the Faroes.

Plate 14: This figure is a combination of two plates: XXXVIII and XL, copied from Brown (1844). *C. corrugata* from Pl. XL, nr. 24 is inserted in pl. XXXVIII nr. 11 instead of *Cyprina vulgaris*. That pl. XXXVIII fig. 11 is *Cyprina vulgaris* is confirmed by the description of plates (Brown 1844: 143). The other numbered figures are referred as: pl. XXXVIII. nr. 1: *Crassina Danmoniensis*, nr. 2: *C. depressa*, nr. 3: *C. elliptica*, nr. 4, 5: *C. compressa*, nr. 6, 7, 8: *C. striata*, nr. 9: *C. Scotica*, nr. 10: *C. sulcata*. However two figures on pl. XXXVIII are without numbers. These two unnumbered figures are taken to represent *C. ovata* Brown, 1827 from Brown (1827, pl. 18), because Brown (1844, p.

96, species 4 = *C. ovata*) is referred to Brown (1844, pl. XXXVIII) as numbers 11 and 12. (Tom Schiøtte, pers. comm.). All species are from British Seas.

Plate 15: Reproduction of Posselt (1895, pl. 1, figs 5, 6, 7). From East Greenland.

Plate 16: *Astarte elonga* n. sp., holotype. ZMUC.BIV.356. Original specimen for Posselt (1895, pl. 1, figs 5,6) and for Jensen (1912, pl. IV, figs 4 c, d). L = 23.5 mm, H = 15.9 mm, W = 8.0 mm. From East Greenland

Plate 17: *Astarte neocrassa* n. sp., holotype. ZMUC-BIV-355. Original specimen for Jensen (1912, pl. IV, figs 4 e, f). L = 27.2 mm, H = 23.7 mm, W = 14.0 mm. From West Greenland

Plate 18: Reproduction of pl. I, fig. 3 a,b, from Leche (1878). From the Kara Sea. (See page 51).

Plate 19: *Astarte vaigati* n. sp. Holotype. ZMUC-BIV-403. Original specimen for Jensen (1912, pl. IV, fig. 4 g). L = 30.0 mm, H = 23.6 mm, W = 12.3 mm. From West Greenland.

Plate 20: *Astarte fjordi* n. sp., holotype, ZMUC-BIV-382. L = 29.4 mm, H = 26.7 mm, W = 11.9 mm. From Isefjord.

Plate 21: *Astarte belti* n. sp., holotype, ZMUC-BIV-378. L = 35.0 mm, H = 31.3 mm, W = 12.3 mm. From the Belt Sea.

Plate 22: *Astarte nordi* n. sp., holotype, ZMUC-BIV-385. L = 33.5 mm, H = 30.0 mm, W = 15.3 mm. From the North Sea.

Plate 23: *Astarte bornholmi* n. sp., holotype, ZMUC-BIV-373. L = 22.7 mm, H = 15.0 mm, W = 9.2 mm. From the Central Baltic.

Plate 24: *Astarte silki* n. sp., holotype, ZMUC-BIV-375. L = 27.5 mm, H = 26.0 mm, W = 11.1 mm. From the Central Baltic.

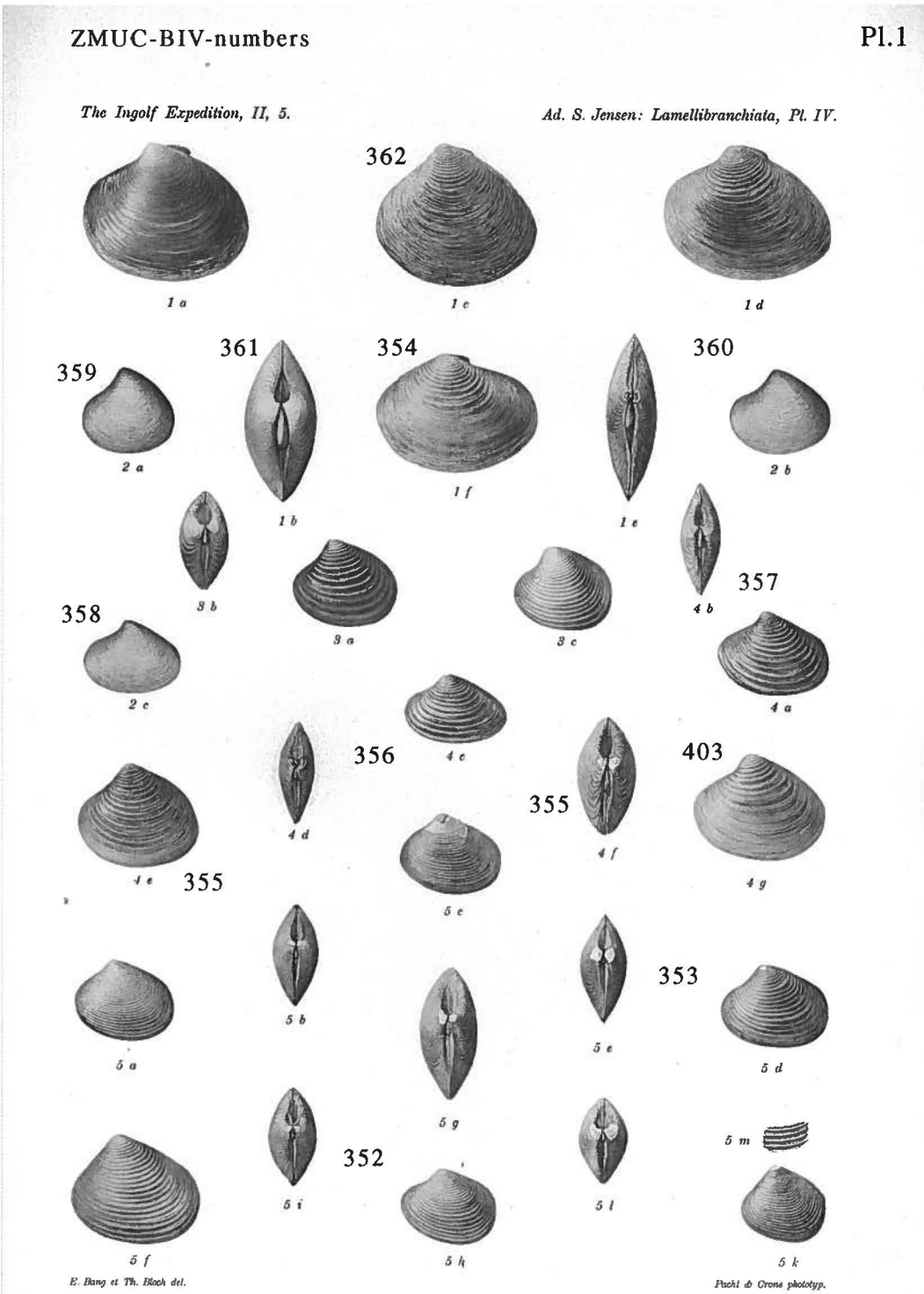
Plate 25: *Astarte falsteri* n. sp., holotype, ZMUC-BIV-384. L = 23.0 mm, H = 19.1 mm, W = 9.3 mm. From the Central Baltic.

Plate 26: *Astarte elliptica* (Brown, 1827). L = 30.8 mm, H = 22.4 mm, W = 12.2 mm. From the Kattegat.

Plate 27: *Astarte anholti* n. sp. L = 24.8 mm, H = 20.6 mm, W = 10.0 mm. From the Kattegat.

Plate 28: *Astarte klinti* n. sp. L = 15.5 mm, H = 13.6 mm, W = 7. 7 mm. From the Central Baltic.

Plate 29: *Astarte sulcata* (da Costa, 1778). L = 21.2 mm, H = 18.6 mm, W = 10.4 mm. From the Kattegat.


ZMUC-BIV-numbers
Pl.1
The Ingolf Expedition, II, 5.
Ad. S. Jensen: Lamellibranchiata, Pl. IV.
362
359
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1 a
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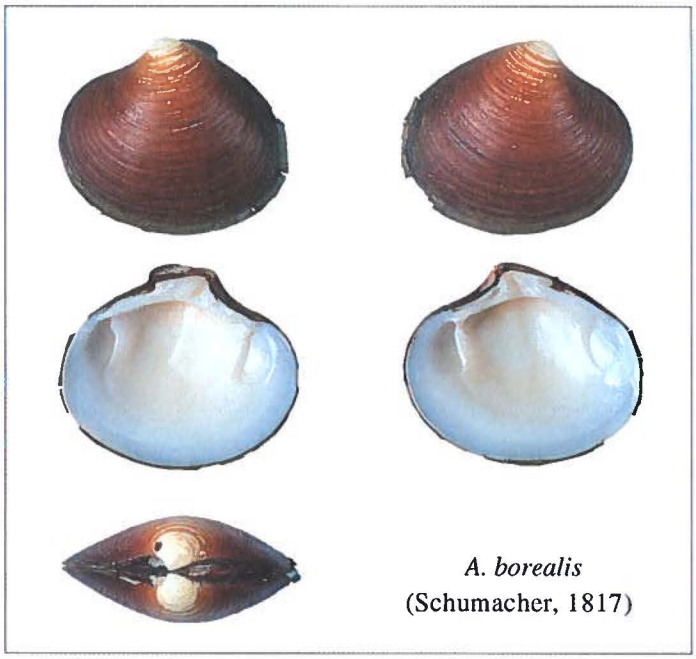
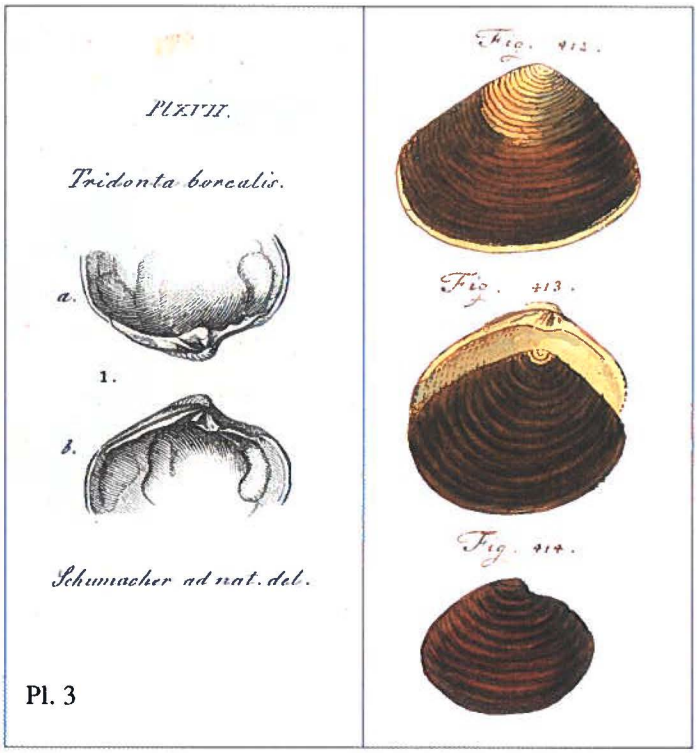


*A. borealis*
(Schumacher, 1817)

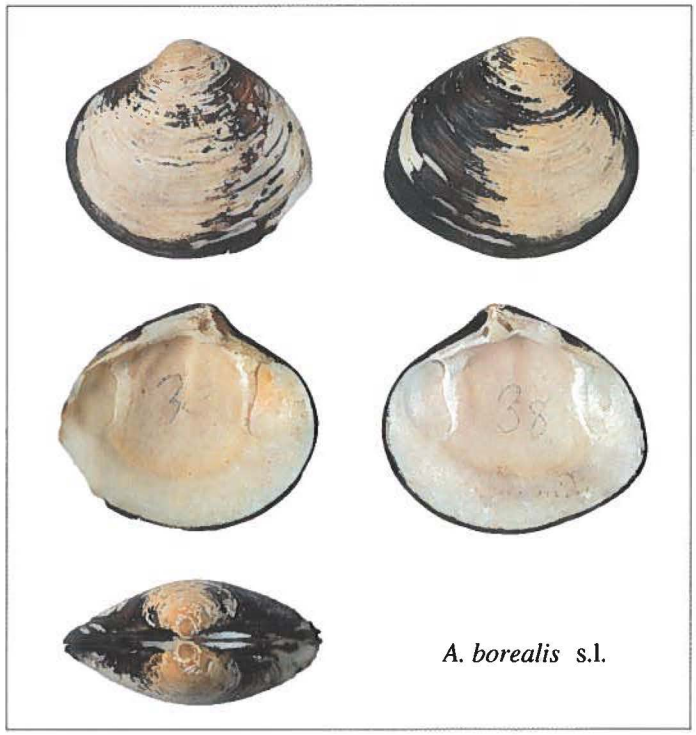
Pl. 2




Pl. 3

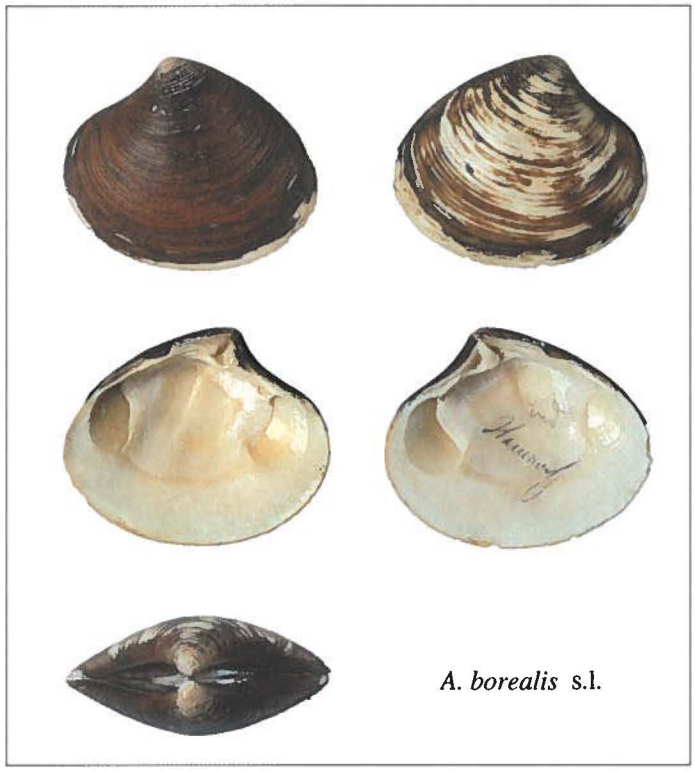
Pl. 4

Pl. 5

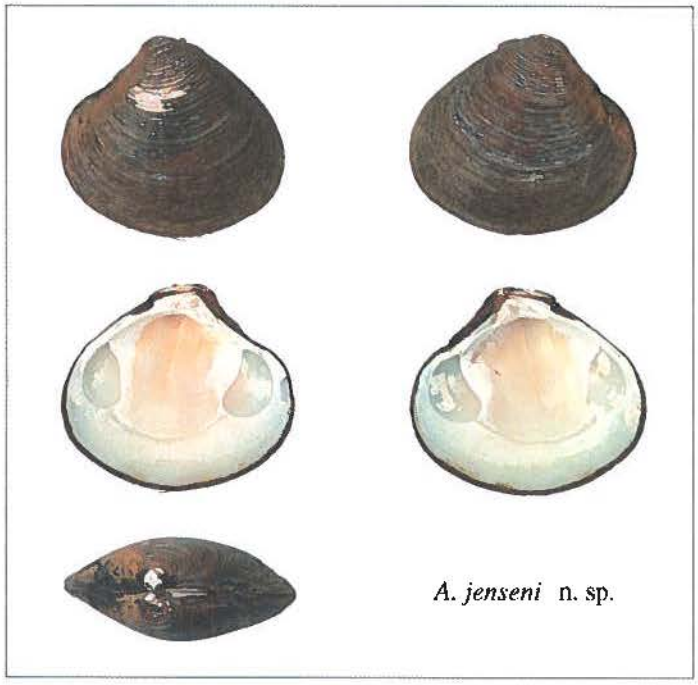


*A. borealis* s.l.

Pl. 6

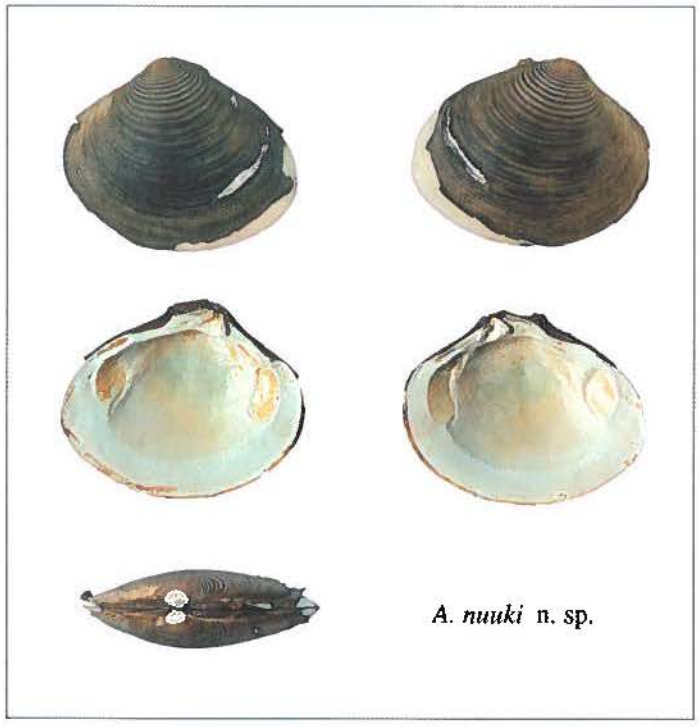


*A. borealis* s.l.



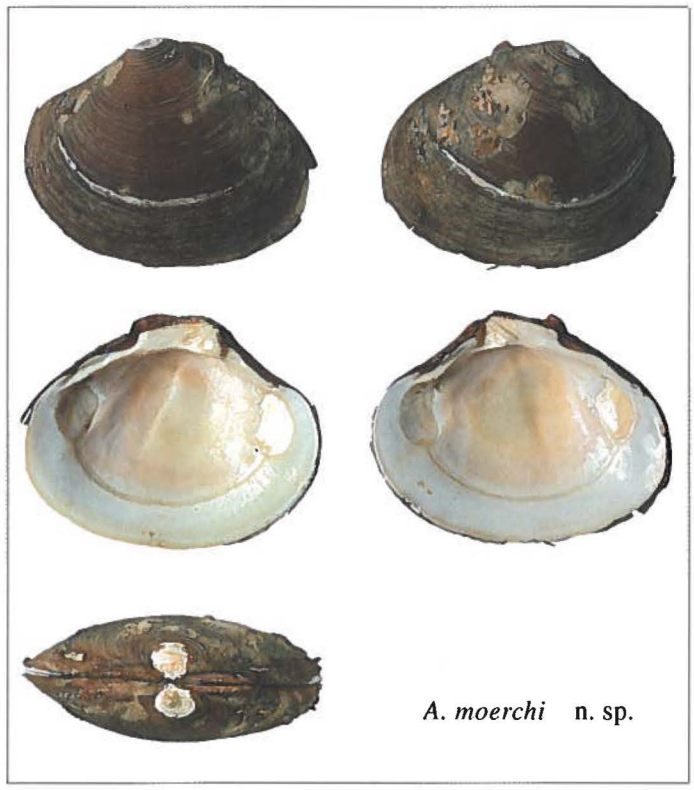
*A. jenseni* n. sp.

Pl. 7

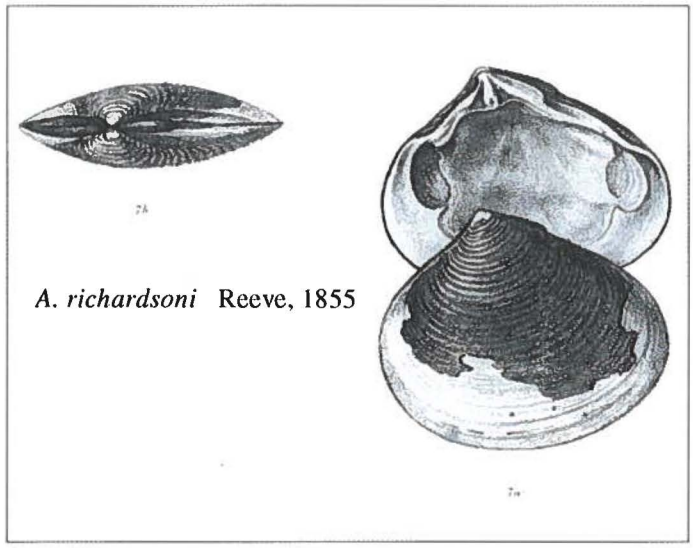


*A. nuuki* n. sp.

Pl. 8



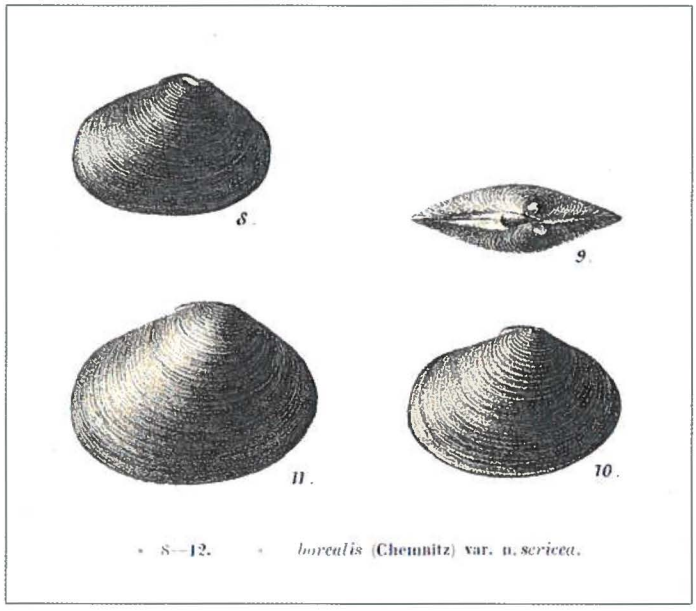

Pl. 9




Pl. 10

*A. sericea* Posselt, 1895

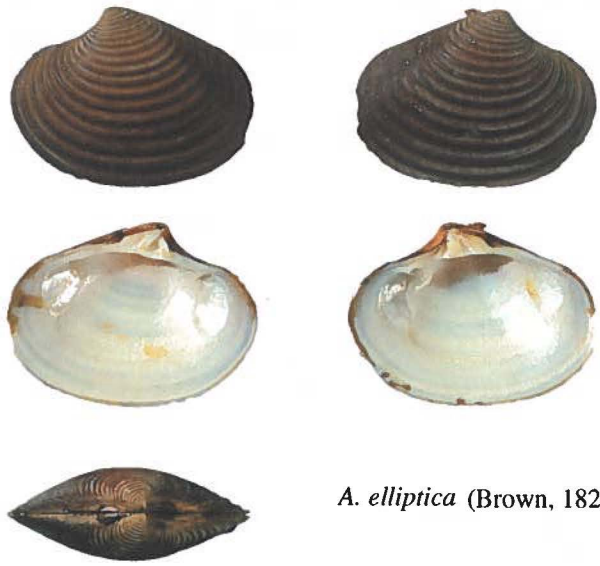
Pl. 11




8—12. *borealis* (Chemnitz) var. n. *sericea*.

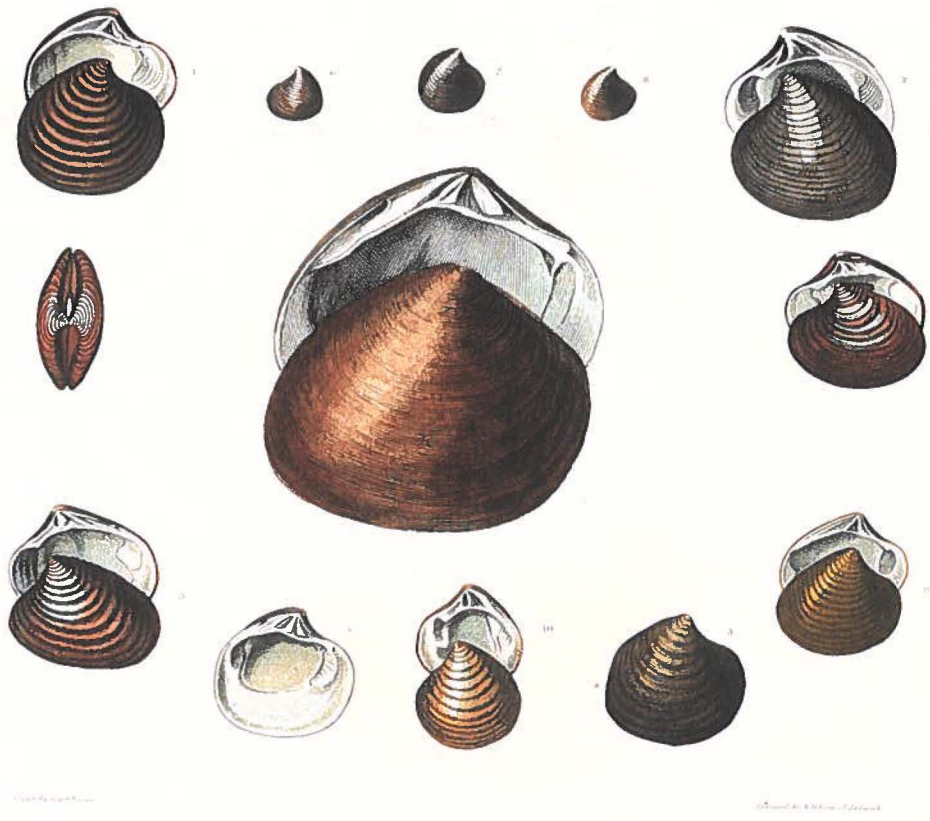
Pl. 12

Pl. 13

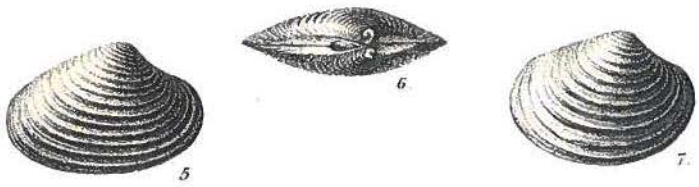


*A. elliptica* (Brown, 1827)

Pl. 14

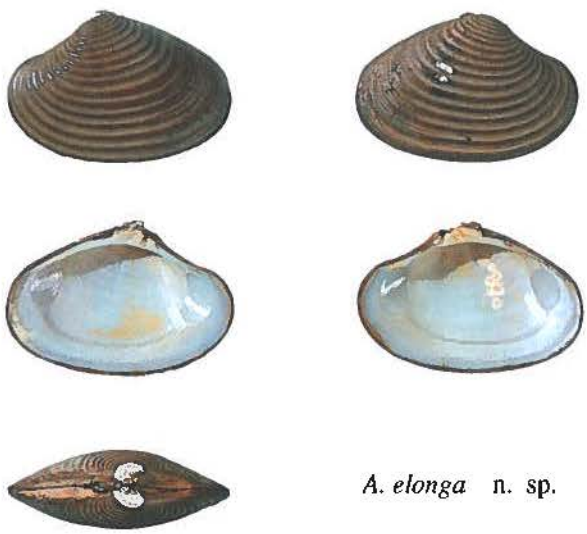


Pl. 15



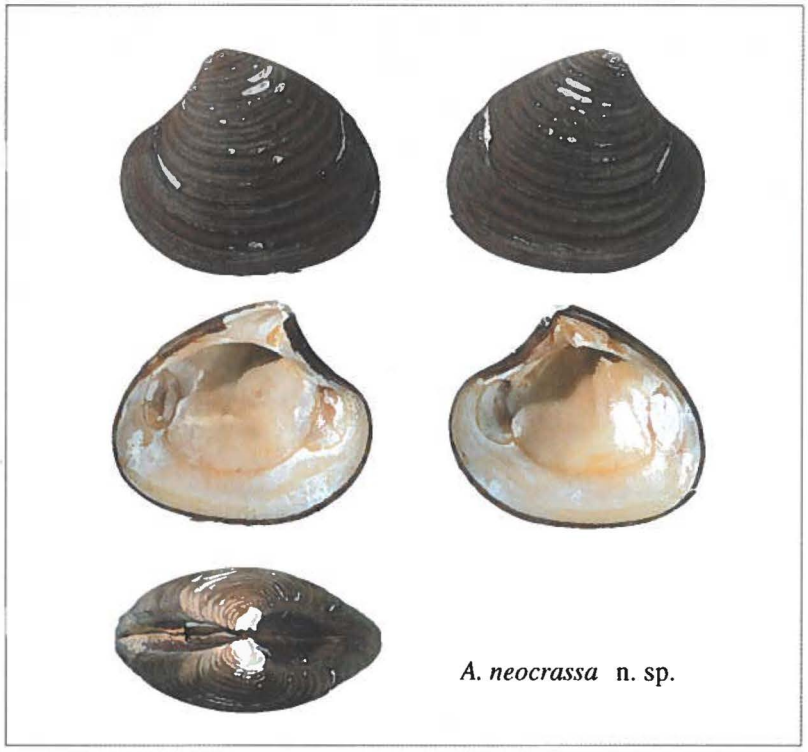

5–7. - *compressa*, (Linné) var. n. *depressa*.

Pl. 16



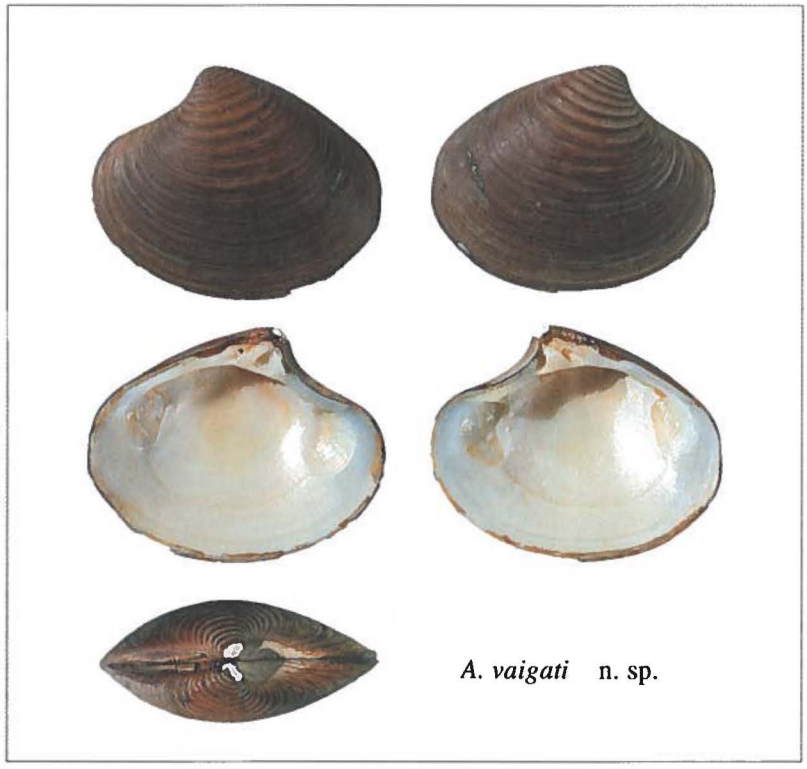
*A. elonga* n. sp.

Pl. 17



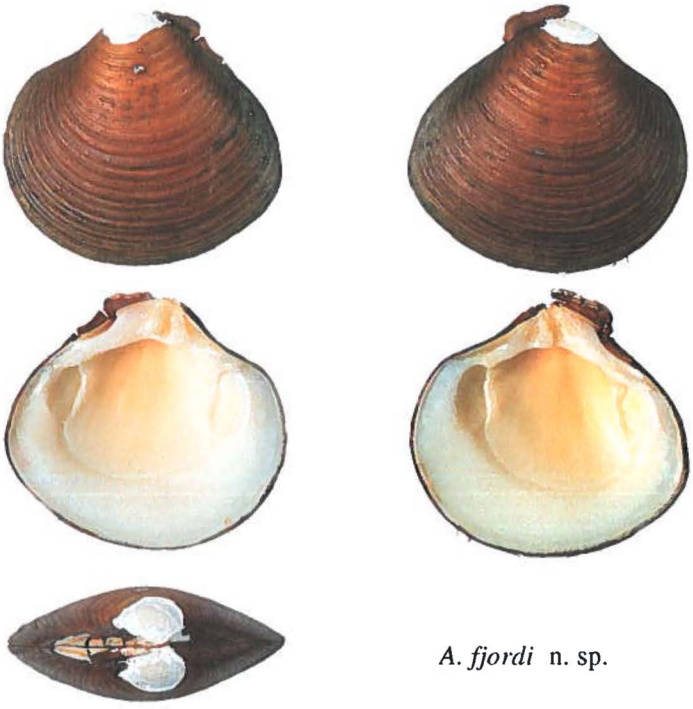
*A. neocrassa* n. sp.

Pl. 19



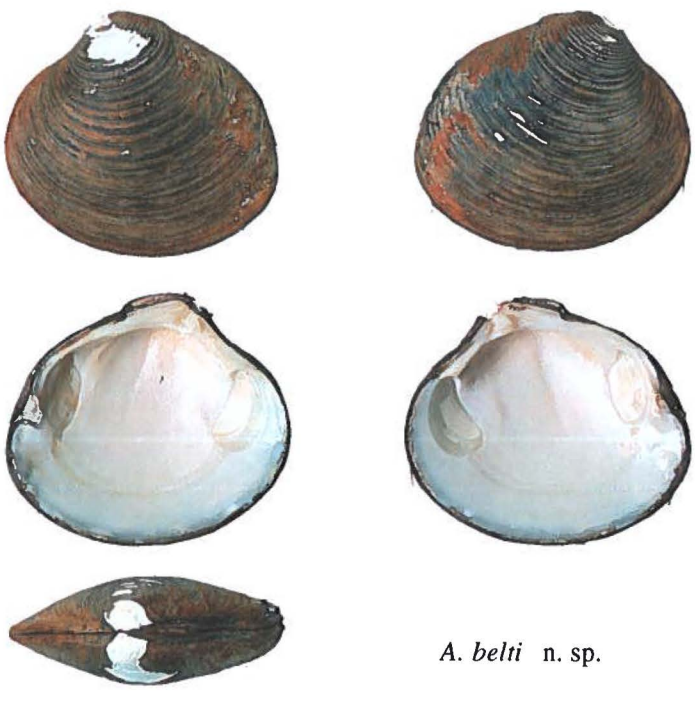
*A. vaigati* n. sp.

Pl. 20



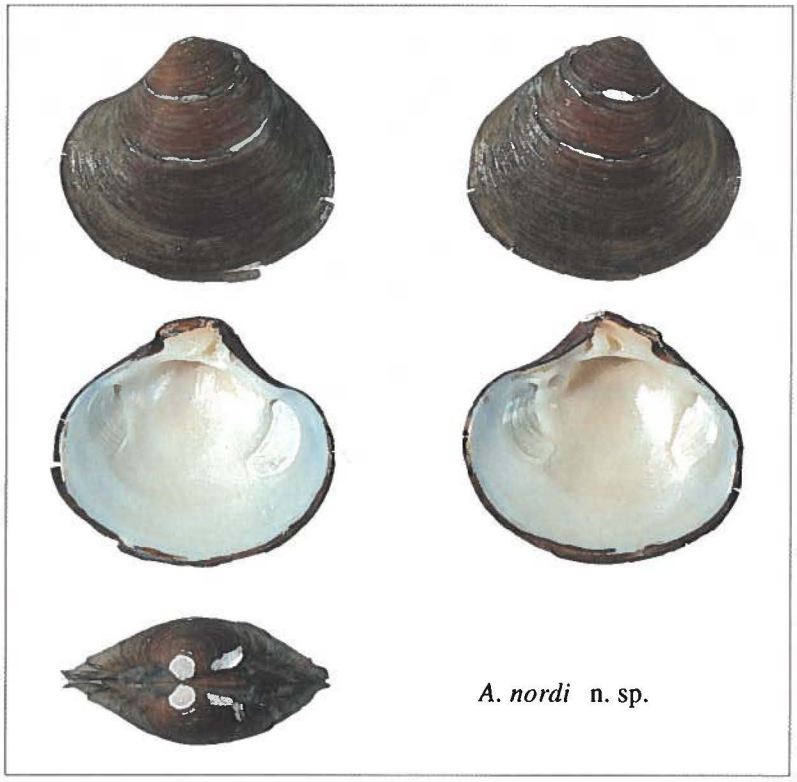
*A. fjordi* n. sp.

Pl. 21



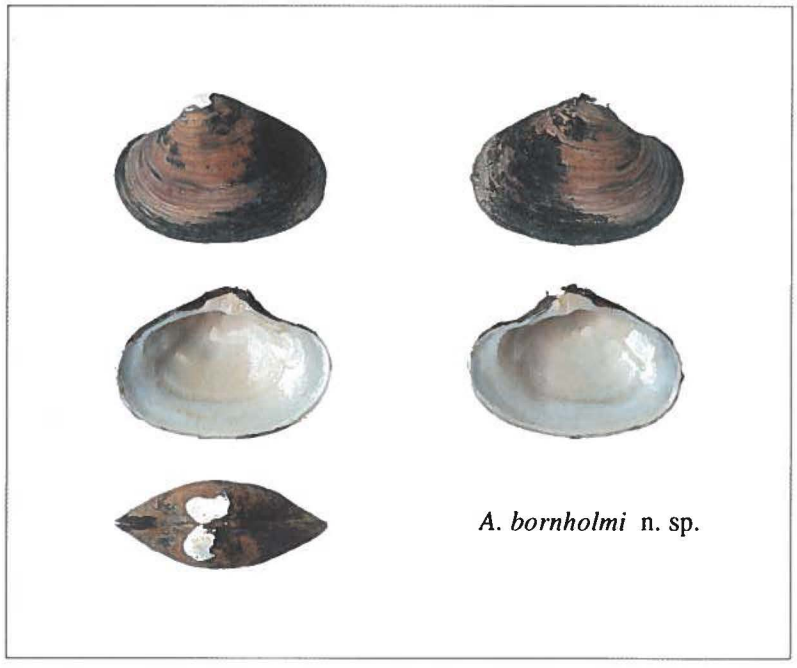
*A. belti* n. sp.

Pl. 22



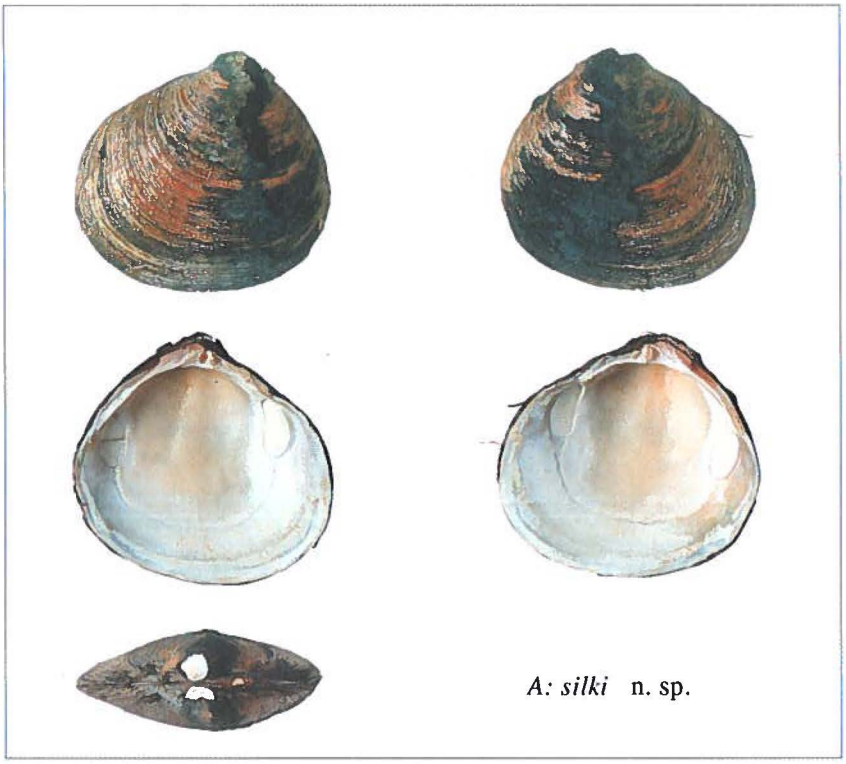
*A. nordi* n. sp.

Pl. 23



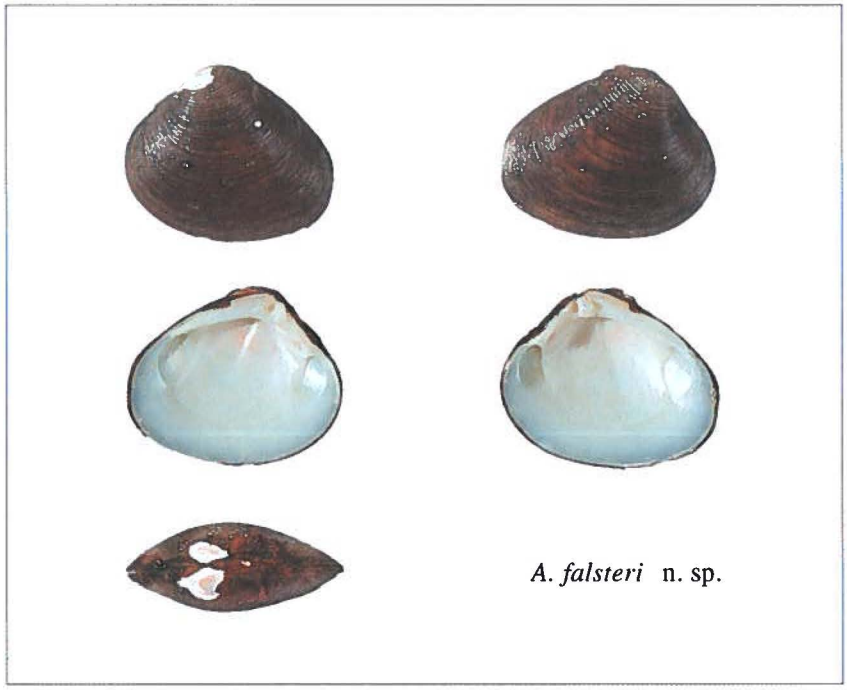
*A. bornholmi* n. sp.

Pl. 24



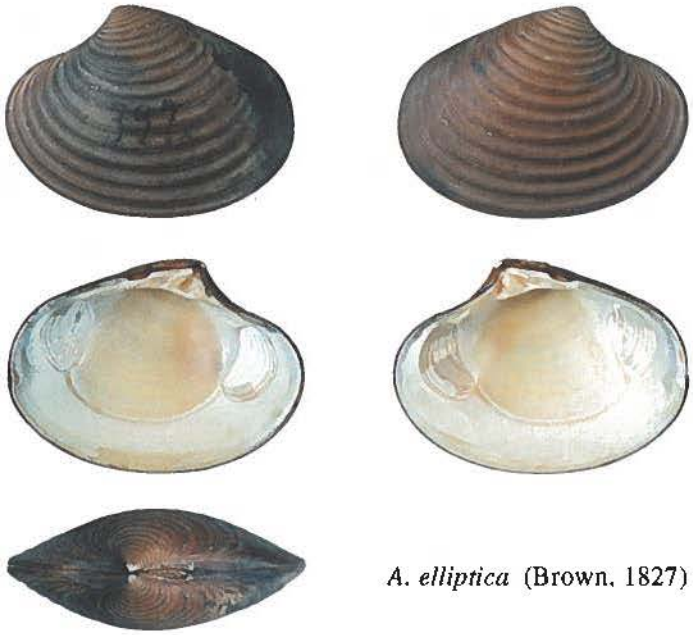
*A: silki* n. sp.

Pl. 25



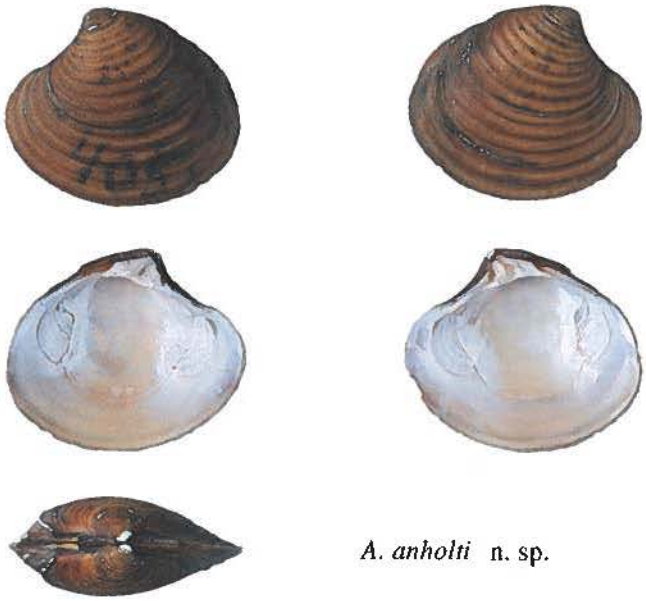
*A. falsteri* n. sp.

Pl. 26



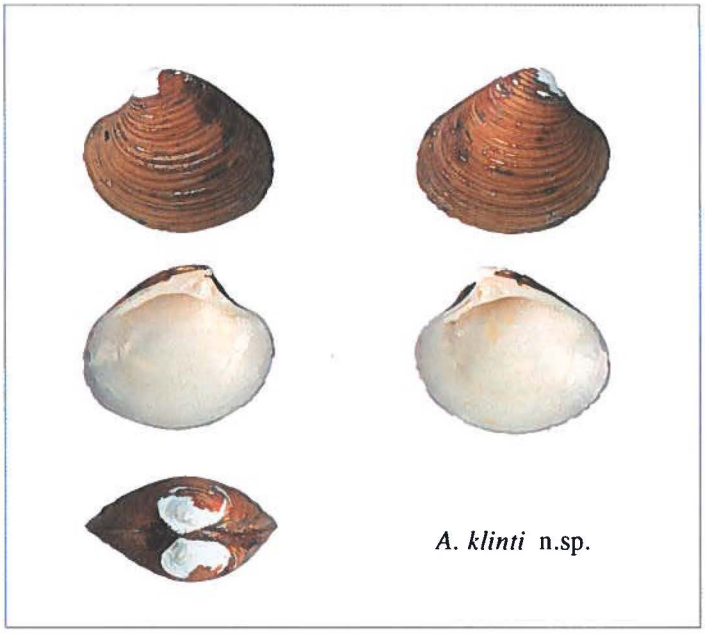
*A. elliptica* (Brown, 1827)

Pl. 27



*A. anholti* n. sp.

Pl. 28



*A. klinti* n.sp.

Pl. 29

*A. sulcata*
(da Costa, 1778)

## *Astarte elonga* n. sp. Holotype. ZMUC-BIV-356

**Material examined**

The original specimen for Posselt (1895, tav.1, figs. 5 - 6, is reproduced here in Plate 15) and Jensen (1912, pl. IV, figs. 4, c - d, is reproduced here in Plate 1). The text on the label with the specimen reads: "Astarte compressa L. var. oblonga." (later changed to) "depressa" (and again later to) "elliptica Brown." "Orig. Posselt: Østgrl. Moll. Tab. 1. Fig 5 - 7, Hekla Havn, Østgrl. Exp. 1892." Added in red: "Orig. Pl. IV, Fig. 4 c & d".

This sample contains 2 specimens: Holotype: ZMUC-BIV-356.

+ Paratype.

**Additional material**

5 samples from East Greenland north of 66°N. One sample has been given the preliminary label name "var. longissima", which has been later changed to "depressa".

**Description of holotype**

Plate 16. L = 23.5, H = 15.9, W = 8.0 mm.

Shape: very elongated, ellipsoid. with a corroded umbo in front of mid-line. The lunule is rather long, with a concave edge. The ligament is small, the escutcheon is narrow, with an almost straight edge.

Sculpture: Ca. 20 prominent concentric ridges and furrows from the umbo to the margin, with no increasing in strength, remaining the same "quality" throughout the shell.

Periostracum: firmly attached to the shell, with a grey brown colour throughout the shell. The shell shows a few small spots of external parasitism or corrosion.

Inside colour: greyish white, with several yellow spots which indicate internal parasitism. The hinge is rather small and weak.

Right hinge: 1 bigger central cardinal surrounded by 2 impressions and 2 distinct, but small cardinals. It has 1 distinct posterior lateral and no posterior lateral.

Left Hinge: 2 cardinals, posterior with tendency to bifidity and only traces of laterals.

Anterior muscle scar: Semilunar with a rather large separate and distinct pedal muscle scar.

Posterior muscle scar: Trapezoid in shape with a near integrated pedal muscle scar.

Paratype: L = 22.0 mm, H = 16.2 mm, W = 7.5 mm.

**Remarks**

Posselt (1895: 72-73) describes his *A. compressa* var. *depressa* n. as elongated, compressed with sharp ribs that disappear against the posterior part.

He notes the length as 23 mm and the height as 16 mm for a larger specimen. This correspond with his figs. 5 (right valve) and 6 (umbo) of the holotype. His fig. 7 is probably from the paratype. The figures are reproduced here in Plate 15. The measurements from his figures and calculated reduction give, that the specimen in fig. 5 and 6 is ca. 23 mm long, and that the specimen in fig. 7 is ca. 21 mm long.

Jensen (1912: 112) gave measurements for two specimens from Hekla Havn: L = 23.5 mm, H = 16 mm, W = 8 mm + L = 22.5. H = 16.5, W = 7.75 mm. Jensen's figs. 4 c-d are measured as 23.5 mm, which correspond to the holotype and his measurements of the larger specimen from Hekla Havn. His second measurement corresponds to the paratype. Jensen's figures are reproduced here in Plate 1. I accept that the material, descriptions and figures represent a good species. However, Posselt's names are invalid, and Jensen's synonymy is doubtful, hence I have given this species the new name *Astarte elonga* n. sp.

**Etymology**

Posselt's material from Hekla Havn, East Greenland was identified by several unknown old malacologists by the label names: "var. longissima" and "var. oblonga" and finally ending with the name "var. depressa". The initial label names are partly reused with the name "elonga", because a name with reference to the locality "Hekla Havn" may give a wrong reference to Iceland, and the other old names are occupied.

## *Astarte neocrassa* n. sp. Holotype. ZMUC-BIV-355.

**Material examined**

Jensen's original specimen (1912, pl. IV, figs. 4 e + f, reproduced here in Plate 1). The text on the label with the specimen reads: "Astarte elliptica Brown var. Leche [ off. 3]. Vest-Grönland". Added in red: "Orig. Pl. IV, Fig. 4 e & f."

**Additional material**

4 samples from West Greenland, which are generally more corroded than the type specimen.

**Description of holotype**

Plate 17. L = 27.2 mm, H = 23,7 mm, W = 14.0 mm.

Shell: roundish, triangular shape with the umbo approximately in the middle. Lunule: large, broad, deep, with a concave edge. The ligament is small, and the escutcheon is narrow, with a convex edge.

Sculpture: ca. 25 concentric prominent ridges and furrows, becoming more flat towards the margin.

Periostracum: corroded or attacked in spots, loosened near the margin, and dull, grey dark brown in colour.

Hinge: partly broken, probably during the opening of the shells. Description supplied from other material.

Right hinge: 3 cardinals, 1 distinct anterior lateral, with no posterior lateral.

Left hinge: 2 cardinals, with no obvious laterals.

Anterior muscle scar: Strong, deep and semilunar with a rather large pedal muscle scar separated above.

Posterior muscle scar: A large rounded square shape, with a rather large but not separate pedal muscle scar.

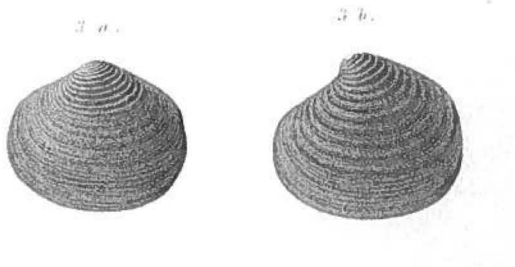
**Remarks**

Leche's (1878: 19 + plate 1, fig. 3 b, reproduced below) description of the fossil specimen fits Jensen's specimen, as does the other material from West Greenland. Leche's figure of a recent specimen (plate 1, fig. 3 a) does not fit. Leche's material is fossil from the Kara Sea and he also referred the name *crassa* to fossil material. This identification has since been verified by me comparing it with original, mainly fossil, material from the Kara Sea, housed in SMNH. The shells are corroded and parasited.

**Etymology**

According to the procedure (Petersen 1999a), when fossil names are used on living species, the West Greenland living material is accepted as a species with the new name *Astarte neocrassa* n. sp.

*Plate 18. Reproduction of plate I, fig. 3 a,b, from Leche (1878). From the Kara Sea.*



## *Astarte vaigati* n. sp. Holotype ZMUC-BIV-403

**Material examined**

Jensen's original specimen (1912, fig. 4 g, reproduced here in Plate 1). Of the two labels with the sample the latest text reads: "Astarte elliptica Brown, Sarquaq (Waigatet) Vestgrönland. Trausted 1892". The older label text reads: "Astarte semisulcata Leach" (later changed to) "compressa Linné". Added in red: "Orig. Pl. IV, fig. 4 g".

**Additional material**

Ca. 20 samples from West Greenland often with 2 or 3 other species and in samples from Iceland together with *A. elliptica*.

**Description of holotype**

Plate 19. L = 30.0 mm, H = 23.6 mm W = 12.3 mm.

Shape: elongated and rounded, but not a real ellipsoid. The umbo in front of the midline is a little corroded. Lunule is prominent and deep, with a concave edge. The ligament is small, and the escutcheon is indistinctive, with a convex curved to straight edge.

Sculpture: Distinct concentric ridges and furrows from the umbo and ca. 1/3 down to the margin, gradually disappearing and changing to an almost smooth surface on the outer 1/3 part of the shell.

The periostracum is rather firmly attached, but loosened at the edge due to conservation. The colour is brown changing to yellow around the anterior part.

The inside colour is grey, with yellowish parts.

Right hinge: 1 big, non-bifid, central cardinal surrounded by 2 impressions, an indistinct anterior cardinal and a sharp posterior cardinal. It has 1 prominent anterior lateral and no posterior lateral.

Left hinge: 1 central impression surrounded by 2 keel-like cardinals, no anterior lateral and 1 indistinct posterior lateral.

Anterior muscle scar: semilunar to bean shaped with a separate pedal muscle scar.

Posterior muscle scar: A rounded square shape with integrated pedal muscle scar.

**Remarks**

This species refers to some "forms" of *A. elliptica* that erroneously were identified as *A. borealis* according to Jensen (1912: 111-112: ["some specimens have folds only on the umbonal area ... are confused with less folded varieties of *Astarte borealis* Chemn. ("*A. semisulcata* Leach" etc) ... Mörch and Posselt have made mistakes ..."]).

**Etymology**

The species is found in samples along the West Greenland coast, north and south of the strait "Vaigat", connecting Davids Strait and Disko Bay.

# Descriptions of some Baltic *Astarte* species

## *Astarte fjordi* n. sp. Holotype. ZMUC-BIV-382. Paratype. ZMUC-BIV-383.

**Material examined**

The holotype and paratypes from the sample: " 21-5-1909 Isefjorden ved Balonen 4 Fv. Astarte borealis Chem." (in English: "21-5-1909, Isefjord at Balonen 4 fathoms. Astarte borealis Chem.") Note: The locality "Balonen" refers to a former naval shooting mark in Vestre Løb, West of Orø.

**Additional material**

A few samples from the Isefjord area and from the southern Kattegat.

**Description of holotype**

Plate 20. L = 29.4 mm, H = 26.7 mm, W = 11.9 mm.

The shell is solid, with a sharp edge. The beaks are corroded, approximately situated in the midline. The ventral line is almost circular.

Sculpture: concentric lines, rather smooth. The lunule is distinct with a concave edge. The ligament is very prominent, and the escutcheon line is straight. The umbo is at the tip of a ca. 90° angle between the lunule and the escutcheon lines

Periostracum: tight, not frayed or loose, and yellowish-brown to dark brown in colour.

Inside shell colour: yellowish, white, glossy, with a strongly build hinge.

Right hinge: 1 big, but neat, bifid cardinal surrounded by deep impressions bordered by bifid cardinals. 1 big distinct anterior lateral, and 1 small but distinct posterior lateral.

Left hinge: 1 big impression between 2 big bifid cardinals, with indistinct laterals.

There are rather small, oval muscle scars with a distinct pedal muscle scar above the anterior muscle scar.

The pallial line is rather distant from shell edge, closest to the posterior end.

**Paratype**

ZMUC-BIV-383 is from the same sample as ZMUC-BIV-382. L = 19.0 mm, H = 16.1 mm, W = 7.6 mm.

**Etymology**

The name refers to its occurrence in the Isefjord.

## *Astarte belti* n. sp. Holotype. ZMUC-BIV-378. Paratypes: ZMUC-BIV-379 + ZMUC-BIV-380.

**Material examined**

The holotype and paratypes are in separate samples. The rest of the material with the soft parts and shells are all from sample ZMUC-BIV-377. The locality inscribed on the label reads: "Udfor Rudbæksmøllegaard, 13-15 m, syd for Strib, Lille Bælt, 27-5-1916, Leg: P.L. Kramp." (in English: "Off Rudbæksmøllegaard, 13-15 m south of Strib, Little Belt ...")

**Additional material**

21 samples from the Little Belt, 16 samples from the Great Belt and 10 samples from the Kattegat area.

**Description of holotype**

Plate 21. L = 35.0 mm, H = 31.3 mm, W = 12.3 mm.

The shell is solid and thick with a sharp ventral edge. The umbo, in front of midline, is heavily corroded.

Sculpture: concentric lines merge into indistinct ridges. The lunule is small, but distinct, with a concave lunule edge. The ligament is distinct and the ligament edge is straight, while the escutcheon is indistinct. The posterior end is shortened and corroded, probably due to parasitism. The ventral line, from the stump posterior end to the concave lunule line, is rounded, almost circular.

Periostracum: black to dark brown in colour, with lighter brown hardened sediment around the posterior and anterior ends. Corrosion (biocorrosion?) appears along small parts of some of the concentric lines.

The inside of shell is predominantly white, but has some bluish, brownish, whitish blisters caused? by parasitism.

The hinge is strongly built.

Right valve: 1 big, clumsy cardinal with a tendency to bifidity. This cardinal is surrounded by deep impressions and is bordered by 2 smaller cardinals, all of which radiate from the umbo. It has 1 distinct anterior lateral and 1 indistinct posterior lateral (= shell edge?).

Left valve: 2 cardinals with a tendency to bifidity with a deep impression between. It has 1 indistinct anterior and 1 indistinct posterior lateral.

Muscle scars: The anterior is large, oval to pear shaped with a distinct pedal muscle scar above. The posterior is large, trapezoid in shape, deformed by parasitism.

The pallial line runs parallel to the ventral edge.

Paratypes: ZMUC-BIV-379: L = 28.8 mm, H = 26.7 mm, W = 12.6 mm. ZMUC-BIV-380: L= 25.0 mm, H = 22.0 mm, W = 10.3 mm.

**Distribution**
Around the island Fyn. The depth is recorded from ca. 10 m to ca. 50 m. In the large material collected east of Femern *A. belti* is not found.

**Remarks**
There are 16 samples with 100% parasitism and 5 samples without any obvious parasitism in the Little Belt area. The majority of the samples without serious parasitism, however, come from the Great Belt and Kattegat areas. A comparable parasitism is found in a few *A. elliptica* from both the Arctic and the Baltic material.

**Etymology**
The name refers to its distribution, restricted to the Belt sea.

## *Astarte nordi* n. sp. Holotype. ZMUC-BIV-385.

**Material examined**
Sample: "83 Sml V.N.V. for Bovbjerg Fyr. 56 m. 8-10-1930. Dana st. 4304" (in English: 83 nautical miles WNW of Bovbjerg Lighthouse. 56 meters. 8 October 1930. Dana st. 4304).

**Additional material**
1 valve from: "56° 49' N, 6° 51' E, 34 m, 1-10-22. Dana st. 2853". And 1 sample from app. the same position in 1952.

**Description of holotype**
Plate 22. L = 33.5 mm, H = 30.0 mm, W = 15.3 mm.

The shell is rounded with the beaks approximately in the midline, and has corroded beaks. The lunule is large and distinct, and the edge concave. The ligament is distinct, the escutcheon is visible, with an approximately straight escutcheon line. The margin from escutcheon to lunule edge is almost circular. Sculpture of fine concentric lines, with 2 of the lines being corroded.

The periostracum is light chestnut-brown to brown in colour with a dull finish. The periostracum is not frayed or loosened in any way.

The shell edge is sharp and the inside shell colour is yellowish white.

Right hinge: 1 big clumsy box shaped cardinal surrounded by 2 deep impressions with a small thin anterior cardinal and a narrow posterior cardinal. It has 1 big anterior lateral and 1 indistinct posterior lateral.

Left hinge: 1 deep impression bordered by 2 smaller cardinals with a tendency to bifidity and small indistinct laterals.

The muscle scars are rather large, and the anterior is an elongated kidney-shape with a distinct pedal muscle scar above. The posterior is an ellipsoid with the pedal muscle scar as a tip.

The mantle line is closer to the shell edge at the posterior part.

**Distribution**
The species appears in the large North Sea material located in only 3 samples, all of which come from the same locality: ca. 57° N, 7° E, but collected in 3 different years: 1922, 1930, 1952.

**Remarks**
Note the possible similarity with the species *Astarte corrugata* (Brown, 1827).

**Etymology**
The name refers to its occurrence in the North Sea.

## *Astarte bornholmi* n. sp. Holotype. ZMUC-BIV-373.

**Material examined**
The holotype comes from the same sample as *Astarte silki* n. sp. "S E of Due Odde, 54° 53, 5' N - 15° 16' E. 16-6-1923, Dana st 3114, 72 m". This sample, apart from the dry shells of type specimen (ZMUC-BIV-373) and type specimen of *A. silky* (ZMUC-BIV-375) is kept in 3 samples as: 1. Dry valves from opened specimens: ZMUC-BIV-374. 2. The corresponding soft parts incl. the soft parts from the type specimen + small unopened specimens: ZMUC-BIV-374. 3. Dry, dead shells: ZMUC-BIV-376.

**Additional material**
9 samples from around Bornholm that appear in depths of between ca. 40 and 93 m.

**Description of holotype**
Plate 23. L= 22.7 mm, H= 15.0 mm, W= 9.2 mm.

The shell is solid and ellipsoid in shape. The umbo is in front of midline. The ventral line is flattened and the shell edge is sharp. The lunule is indistinct, whereas the lunule edge is distinct and concave. The ligament is small, and the escutcheon line is straight.

The periostracum is partly covered by a black hardened sediment. It is dull light brown in colour with concentric lines merging into small ridges.

Inside: White in colour with a weak hinge.

Right hinge: 2 small flat, indistinct cardinals with 1 anterior and 1 posterior indistinct laterals or ridges.

Left hinge: no real cardinals, only a flat calcareous part with two impressions. It has 1 anterior and 1 posterior small but distinct lateral.

The anterior muscle scar is small and bean shaped, while the posterior muscle scar is small and circular. There is no distinct pedal muscle scar and the mantle line is parallel with the shell edge.

**Distribution**
The Baltic around Bornholm.

**Etymology**
The name refers to its distribution around the island Bornholm.

## *Astarte silki* n. sp. Holotype. ZMUC-BIV-375.

**Material examined**
The holotype is from the same sample as *A. bornholmi* n. sp. "S E of Due Odde, 54° 53' 5 N - 15° 16' E. 16-6-1923, Dana st 3114, 72 m". This sample is, apart from the dry shells of type specimen of *A. bornholmi* (ZMUC-BIV-273) and type specimen of *A. silki* (ZMUC-BIV-375), kept in 3 samples as: 1. Dry valves from opened specimens: ZMUC-BIV-374. 2.The corresponding soft parts incl. the soft parts from the type specimen and the small unopened specimens: ZMUC-BIV-374. 3. Dry, dead shells: ZMUC-BIV-376.

**Additional material**
6 samples from around Bornholm that appear in depths from between ca. 30 and 93 m.

**Description of holotype**
Plate 24. L= 27.5 mm, H= 26.0 mm, B= 11.1 mm.

The shell is solid. The umbo is corroded and positioned behind the midline. It is a rounded triangular high form. The lunule is small, but distinct with an almost straight edge. The ligament is small and the escutcheon line is curved outwards (convex).

The periostracum dark brown in colour with a silky glare. It has concentric fine lines, and the periostracum is covered with a black, hardened sediment.

Inside shell: white - light yellow in colour.

Right hinge: 1 big cardinal + 2 smaller cardinals, all radiating from the umbo. It has 1 distinct anterior lateral and 1 indistinct posterior lateral.

Left hinge: It has 2 cardinals, 1 anterior lateral and 1 posterior lateral, both of which are indistinct.

Anterior muscle scar: rather small and bean shaped. The posterior muscle scar is rather small and almost circular. Note: healed scratch across the left scar.

The mantle line is rather distinct from the shell edge, situated closer to the posterior shell edge.

**Distribution**
The Baltic Sea around Bornholm.

**Etymology**
The name refers to its silky periostracum.

## *Astarte falsteri* n. sp. Holotype. ZMUC-BIV-384.

**Material examined**
The sample: "S.f.Falster. 54° 25' N - 12° 10' Ø, 21 m, 18-4-1925. Dana st. 3374".

**Additional material**
Ca. 20 samples appear in depths of between ca. 20 and 70 m in the area from between Femern to Bornholm.

**Description of holotype**
Plate 25. L = 23.0 mm, H = 19.1 mm, W = 9.3 mm.

The shell is a triangulated and elongated oval skew with the anterior end more rounded than the posterior end. The beaks are corroded, and well in front of the midline. The lunule is indistinct, while the lunule edge is straight. The ligament is not prominent, and the escutcheon is narrow, but distinct. The escutcheon edge is straight and meets lunule edge under an angle of ca. 90°.

Sculpture: fine concentric ridges, with a sharp shell edge.

The periostracum is thick, not frayed or loosened, and dark brown in colour with an oily glare.

The inside is white in colour.

Right hinge: 1 big clumsy cardinal surrounded by deep impressions bordered by 2 thin cardinals with a cleft running along the top edge of the cardinal. It has 1 anterior lateral and 1 indistinct posterior lateral.

Left hinge: A deep impression bordered by 2 smaller cardinals with a cleft along the top. It has 1 indistinct anterior + 1 distinct posterior lateral.

The muscle scars are rather small. The anterior is oval-kidney shaped and has a distinct pedal muscle scar separated by a small crest. The posterior muscle scar is rounded rectangular and has the pedal muscle scar integrated as a handle.

The mantle line is parallel to the shell edge.

**Distribution**
The Baltic Sea between Falster and Bornholm.

**Etymology**
The name refers to its distribution south and east of the island Falster.

## *Astarte elliptica* (Brown, 1827). ZMUC-BIV-405

**Material studied**
A specimen selected from a sample from Kattegat. The text on label with the sample reads: "Schultz Grunds Fyrskib i V, 2 kvml. Sten. 30 - 34 m. 26-6-1886, "Hauch" st. 397. Kattegat".

**Additional material**
Ca. 10 samples scattered in the Danish seas.

**Description of the specimen**
Plate 26. L = 30.8 mm, H = 22.4 mm, W = 12.2 mm.

The shell is elliptic in shape with the umbo in front of the midline, showing no corrosion. Sculpture: ca. 20 concentric ridges of relatively equal size from the umbo to the margin. It has a well developed lunule with a concave lunule line.

The ligament is small and narrow, and ligament line is straight.

The periostracum is firmly attached and with no corrosion, and is light brown in colour.

The inside of shell is white to yellow in colour and shows traces of parasitism around the posterior part. The margin is sharp.

Right hinge: One big cardinal surrounded by two impressions and by two small, thin cardinals, of which none are bifid or clefted. No posterior lateral, but has one distinct anterior lateral.

Left hinge: two cardinals, no laterals.

Anterior muscle scar: oval half-moon shaped, with distinct pedal muscle scar.

Posterior muscle scar: squared to oval with integrated pedal muscle scar.

**Distribution**
Massachusetts, Labrador, Greenland, Kara Sea, White Sea, Faroes, Northern British Isles. (Tebble 1966: 71).

**Remarks**
This specimen has been selected from the Kattegat material for comparison with the other species co-occurring in the area. The species from this area will not be studied further.

## *Astarte anholti* n. sp. Holotype. ZMUC-BIV-406.

**Material studied**

A specimen from the Kattegat. The text on the label with the sample reads: "Lysegrundens nordl. Vager i N.V. t. N, 20 kvml. 22 m. 28-6-1886, "Hauch" st. 405".

**Additional material**

Ca. 30 samples distributed from the Kattegat to the Baltic around Darsser Ort.

**Description of holotype**

Plate 27. L = 24.8 mm, H = 20.6 mm, W = 10.0 mm.

The shape is oval to triangular with a tendency to truncate at the posterior end, with traces of parasitism. The umbo is in front of the midline, and has traces of corrosion.

Sculpture: ca. 20 prominent concentric ridges, appearing small just around the umbo, but otherwise of the same quality to the margin. The lunule is distinct, while the lunule edge is distinctly concave. The ligament is small and hidden between the valves, and the ligament edge is a convex curve.

The periostracum is firmly attached, but has a small amount of corrosion along 2 growth lines and is chestnut brown in colour. Inside shell: Yellowish-white in colour and rather glossy with a sharp margin.

Right hinge: 1 clumsy cardinal with tendency to bifidity, surrounded by 2 impressions, delimited by 2 distinct cardinals. It has 1 anterior lateral and no posterior lateral.

Left hinge: 1 deep impression surrounded by 2 nice cardinals both of which have a tendency to bifidity. It has no laterals.

Anterior muscle scar: elongated and bean shaped, it has a rather large oval pedal muscle scar above.

Posterior muscle scar: rather large with an oval edge against the margin and a triangular corned pointing to the umbo. The pedal muscle scar acts as a tip or a handle.

**Remarks**

This species occurs in the Kattegat region together with both *A. elliptica* (Brown, 1827) and *A. sulcata* (da Costa, 1778). It resembles both species, and has been identified as such. It has never been described and this may be the explanation for the confusion in both Jensen & Spärck (1934) and Tebble (1966) in their identifications of *A. sulcata*.

**Etymology**

The species is named after the island Anholt, situated in the supposed centre of its distribution in the Kattegat.

## *Astarte klinti* n. sp. Holotype ZMUC-BIV-408

**Material studied**

A specimen from the Baltic. The text on the label with the sample reads: "55° 08' N. 13° 13' Ø. 38 m. Dredge. S.V.t.S. of Smygehug Fyr. 22-6-1923. V. Østersø. Leg. "Dana" st. 3132. Det. A.C. Johansen".

**Additional material**

Ca. 15 samples in the Baltic from the island of Møen to around Bornholm.

**Description of the holotype**

Plate 28. L = 15.5 mm, H = 13.6 mm, W = 7.7 mm.

The shape is triangular/oval, non truncated, with the umbo in front of the midline, and signs of corrosion.

Sculpture: concentric lines that become less distinct towards the margin.

The lunule is rather deep and rounded, and the lunule edge is somewhat concave. The ligament is small and hidden in the escutcheon, and the escutcheon line is almost straight.

The periostracum is brown in colour and rather loosely attached to the shell.

The inside of the shell is white and glossy in colour and with a sharp margin.

Right hinge: 1 clumsy cardinal surrounded by 2 rather small impressions delimited by 2 small markings as cardinals. It has 1 distinct anterior lateral and no posterior lateral.

Left hinge: 1 rather small impression surrounded by 2 small cardinals and has no laterals.

Anterior muscle scars: rather small, oval with a distinct pedal muscle scar above. The right valves anterior lateral points outwards between the two muscle scars.

Posterior muscle scar: rather small, triangular/oval with a distinct pedal muscle scar above.

**Distribution**

In the Baltic between Femern and Bornholm.

**Remarks**

This species was previously in the old and first sorting given the name of both *A. elliptica* or *A. compressa*. It can be separated from both *A. elliptica* s.s. and *A. anholti* n. sp., but it may be associated with the *A. montagui* - complex. When found in the Baltic *A. montagui* complex occurs with the name and/or species *A. banksi* s.l.. The *A. montagui* s.s. from Kattegat is easily distinguishable against the above mentioned species by way of its high triangular shape. The *A. montagui* complex will not be studied further.

**Etymology**
Several of the old bearings are to the prominent cliff of Møen, in Danish Møns Klint. The species is named from "Klint".

## *Astarte sulcata* (da Costa, 1778). ZMUC-BIV-407

**Material studied**
A specimen from the Kattegat: The text on the label of the sample reads: "ca. 8 sm SE of Syrodde (Læsø), 31-40 m, 5-7-1990, leg. K.W. Ockelmann".

**Additional material**
There is a large amount of material from the North Atlantic, with a few samples from the Kattegat region. There are no samples from the Belt Sea nor from the Baltic.

**Description of the specimen**
Plate 29. L = 21.2 mm, H = 18.6 mm, W = 10.4 mm.

Shape: triangular / oval. The umbo is situated in the midline, and shows little corrosion. The posterior end is somewhat truncated, which may in some specimens be caused by parasitism. However this specimen has no obvious parasitism.

Sculpture: ca. 25 concentric, rather small ridges of equal quality from the umbo to the margin.

The lunule is undeveloped, and the lunule line is concave. The ligament is small and hidden between the valves. The ligament edge is convex curved and gently glides into the rounded posterior end.

The peristracum is firmly attached to the shell, light brown in colour, with black spots on the posterior end, probably from the sediment.

The inside of the shell is white and dull, and finish with a crenulated margin.

Right hinge: 1 large, triangular, flat, non bifid cardinal, surrounded by 2 impressions, the shell edges and no real laterals.

Left Hinge: 1 large impression surrounded by 2 rather large and clumsy cardinals, with no real laterals.

Anterior muscle scar: A rather large oval with a distinct triangular pedal muscle scar above.

Posterior muscle scar: A rather large oval trapezoid with an almost indistinct mark of the pedal muscle scar.

**Distribution**
S.E. Greenland, Barents Sea, N.W. Africa, Mediterranean. (Tebble 1966: 70)

**Remarks**

This specimen from Kattegat is described and figured for comparison with the other species treated. It fits the specimen from the Denmark Strait, figured in Jensen (1912, Pl. IV, fig. 3 c), but not the specimen from the Faroes figured in Jensen (1912, Pl. IV, fig. 3 a, reproduced here in Plate 1). This fig. 3 a in Jensen (1912, pl. IV) of a specimen from 300 m depth at the Faroes was reused in Jensen & Spärck (1934, fig. 65) for the identification of the Danish population.

# Discussion

It was a surprise, that a supposedly simple identification of the bivalves from Ikka Fjord, SW Greenland required the study of the *Astarte* s.l. complexes. I have to apologise for setting up several new names/species, but for the Arctic material, I have merely lifted the old concepts of forms and varieties to species level. Furthermore I had to use some stricter nomenclature rules. Only some of the names and species are cleared up here. For the Arctic species further studies on the names/species *A. arctica* (Gray, 1824) and *A. semisulcata* (Leach, 1819 a, b, c) and their original material are required. Studies on the Siberian and Canadian material are needed, but have to be left to future studies. This paper is not intended to be a revision of the *Astarte* species, but may have clarified a section of the complex.

It was an unpleasant surprise to discover, that benthic bivalves from the Baltic could be easily separated into several new species, probably more than I have recognised here. However, the Western and Central Baltic Sea has been a kind of "no man's sea" ever since World War II . Benthic investigations were restricted for political and military reasons, and even today several areas are inaccessible. Mustard gas and ammunition were dumped at several places causing accidents to fishermen fishing in the area. As a result the theories and concepts about species developed before World War II have survived undisputed. New studies of benthic materials with modern quantitative, biochemical, ecological or other methods are required.

There is no doubt that the Arctic *Astarte borealis* complex does not enter the Baltic Sea. Furthermore, the Baltic complex can be divided into more species. It is also reasonable to suppose, that the Arctic complex consists of more species, than has previously been named and observed. The connections between the Baltic and the Arctic populations are not known. The *Astarte borealis* s.l. were not found in the Faroes (Petersen 1968) or in the Central North Sea (Petersen 1977). It is reported from the Tromsø region to be a common arctic species (see Soot-Ryen, 1924: 62), but may be rare (fossil?) or absent from West Norway. Tebble (1966: 72-73, plate 7, d) reports, that *A. borealis* has been collected in the northern North Sea, but not close to the British Isles, but his plate is not sufficient evidence for identification. Smith (1881: 202 & 217) synonymised *A. borealis* (Ch.) (Sch). with *C. corrugata* Brown, 1827, which may be an endemic British species of this complex.

The *A. elliptica* complex, the *A. sulcata* complex and the *A. montagui* complex enter the Baltic Sea with known and new species, and require further studies. The *A. crenata* complex appears not to have come near the Baltic Sea. The type species *A. scotica* for genus *Astarte* is not known.

It is widely accepted, that the Arctic has fewer species than the Tropics. However, this is not a general rule, as several taxonomic and ecological groups have evolved many more species in the Arctic than they have in the

Tropics. There is a fast speciation and high biodiversity in certain Arctic groups, e.g. benthic and icebiota depending groups, (see Petersen 1984a: 124). Lubinsky (1980: 29) noted: "Although *Astarte* is one of the oldest living bivalves, the northern fauna contains some species that probably originated as late as the Pleistocene period".

The species here are described on morphological characters. Their distribution in the Arctic and the distribution of the new species in the Baltic are shown in the maps pp. 20 and 22. However, it is often said that such species may be ecological clines. Generally I can discriminate between the species by their morphology and relate them to their distribution patterns. In a few cases where I have little or no material at hand (e.g. *borealis* sensu Tebble 1966) is it difficult to discriminate between the species, but I am inclined to believe, that more material will confirm the species concept. As long as "morphospecies" reflect "ecospecies", all deductions from fossils to climatic changes, evolution or palaeoenvironment must be based on well defined and well studied "morphospecies".

The observed parasitism and/or biocorrosion is a special problem. Only the species *Astarte belti* n.sp. shows a level of parasitism, that can distort the shell which in turn gives the impression of a new morphospecies. Maybe this species is a vector for an unknown parasite, in most of the other materials studied a similar parasitism is rare, see Petersen (1984b). The corrosion is taken as a biological dependant "biocorrosion", that only attacks living specimens, which may be due to parasites on the shells surface and/or to the living specimens' activities in the bottom. There may also be chemical reactions, that sometimes cause corrosion and sometimes deposition of sediment on the shell.

The Baltic is just a small part of the circumpolar waters, which include Hudson Bay, the White Sea, the Azov Sea, the Northern Caspian Sea and the several North Pacific Seas. The Baltic has all the features of an Arctic fjord: formed by glaciers, icebound in the innermost part every winter, receiving large rivers, influx of warmer bottom water, surface layer of brackish melt water etc. The Baltic is merely the southernmost and largest of such fjords, where Arctic and southern species meet. For many years the Arctic species in the Baltic were considered to be "relict" species (Rasmussen 1973, p. 277), that have survived from earlier periods. However, the Baltic went though various stages: the Baltic Ice lake, the *Yoldia* sea, the *Ancylus* lake, the *Littorina* sea, and all eradicated the previous ecosystems (Björck 1995). This makes it difficult to see how Arctic species could survive as "relicts", and even develop species endemic to the Baltic. These old questions have recently been somewhat elucidated for the *Coregonus* group (Svärdson 1998) and the speciations in the Quarternary.

The Baltic was also the first area where the so called "brackish water paradox" was demonstrated (Johansen 1916, Remane 1934). This paradox is: "There are very many species in marine waters, rather many species in limnic

waters, but in the transitional brackish waters are a minimum of species. The salinity in brackish waters is approximately the same as in the blood fluid in vertebrates".

The species here presented in the *Astarte* complexes may be examples of fast speciation into both Arctic and brackish waters. Their non-pelagic development may promote speciation. The first Baltic immigrants may have been fast to develop species endemic to the Baltic. Examples of possible southern immigrants or new species are *Cerastobyssum hauniense* Petersen & Russell 1971 and *Littorina tenebrosa* Montagu, see Rasmussen 1973, p. 241.

However, was there enough time or enough isolated areas to permit the evolution of Arctic and brackish water species? Can the immigration and/or speciation be traced in the rather young geological layers? Would future geologists call the present day Baltic a boreal freshwater lake after *Theodoxus fluviatilis* or would they call it a subarctic marine sea after *Macoma balthica*? The questions on the life history, evolution, palaeogeography etc. of these important benthic species could be targets for the many laboratories on the borders of the Baltic and Arctic seas. Hopefully, the species presented here may be an inspiration for future works related to these problems.

# Acknowledgements

My dear colleague, Kurt W. Ockelmann warned me against a study of the *Astarte* species, because he knew the problems. I should have listened to him! However, Tom Schiøtte, Zoological Museum, University of Copenhagen, experienced problems with his material from NE Greenland, and persuaded me to go through the material. He has been a valuable help with both taxonomy and nomenclature. Geert Brovad, Zoological Museum, University of Copenhagen kindly took the photographs. Anders Warén, Swedish Museum for Natural History, Stockholm, was very helpful in finding original material. Jon Arne Sneli, Trondhjem Biologiske Stasjon, was a very valuable referee. Jørgen Hylleberg, Aarhus University, was a good discussion partner on the bivalve species concept. Jan Marcin Weslawski, Inst. Oceanology, PAS, Poland, gave important advice regarding the Baltic material. Sven Funder, Geological Museum, University of Copenhagen, did not like all the species (neither do I) and explained to me about the history of the Baltic. An anonymous referee suggested that all the problems should be solved by biochemical methods, but failed to indicate the sources for the money, manpower and the solutions for the old species concept. They have all added to my occupation over a long period, for which I am most grateful.

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This book is one of the numerous publications from the 1995-1996 expeditions to the arctic Ikkafjord, SW Greenland.

A few genera evolved a large number of arctic species during late Tertiary. This is also true for certain bivalve genera, and the identification of the bivalve species from the quantitative material from Ikkafjord involved studies on material from the earliest scientific expeditions to the Arctic regions. The species concepts and their names date back to the eighteenth and nineteenth centuries, when also the ideas on ice ages and glaciation took form. These ideas have been supported by studies on recent and fossil bivalves.

The neotype of *Astarte borealis* (Schumacher, 1817) from Iceland, shown on the front page, was located in the collection of the Zoological Museum, Copenhagen. Illustrations of this species have been used for identifications of both Canadian and Baltic bivalves with some confusions as results. Part of the *Astarte* species is cleared up here, but much is left to future studies.


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