



ORIGINAL ARTICLE

Pectinoidea (Mollusca: Bivalvia) from Iceland

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Abstract

The Icelandic pectinoid fauna is reviewed, based on material from the benthic survey programme BIOICE and 17 species are recorded. *Similipecten oskarssoni* is proposed as a replacement name for *Pecten groenlandicus* var. *minor* Locard, 1898 (Propeamussiidae), which is considered a valid species. Lectotypes are designated for *Pecten groenlandicus* var. *minor* and *Pecten frigidus* Jensen, 1904 (Pectinidae). *Cyclopecten ambiannulatus* Schein, 1989, *Parvamussium propinquum* (Smith, 1885), *Catillopecten eucymatus* (Dall, 1898), and *Aequipecten opercularis* (Linnaeus, 1758) were previously not known from the Icelandic fauna. All species are figured and described and distinguishing characters are discussed. The distribution in Scandinavian and North Atlantic waters is revised based on the collections in SMNH. The low frequency of juvenile specimens of *A. opercularis*, *Mimachlamys varia* and *Pecten maximus* may indicate that Scandinavian populations are the result of very occasional recruitment.

Key words: Pectinoidea, taxonomy, new species, North Atlantic, Iceland, BIOICE

Introduction

Iceland occupies a zoogeographic key position in the North Atlantic (Ekman 1935; Dahlgren et al. 2000), on the Greenland–Scotland Ridge that separates the Arctic abyssal basins from the North-Atlantic deep sea (Bouchet & Warén 1979). At the same time, the ridge forms a connection between the European and the American more shallow faunas, with Iceland and the Faroes as ‘stepping stones’. (For further references, see Gudmundsson 1998 and Dahlgren et al. 2000.) The Icelandic fauna is therefore of considerable interest for evaluating the possibilities for genetic communication between East and West Atlantic populations. The presence of a species in Iceland enhances the possibilities for genetic communication between American and European populations. The crab *Lithodes maia* occurs in the eastern and western Atlantic, and Iceland. Another well-known decapod, *Homarus*, does not occur in Iceland, and the East and West Atlantic populations have diverged to *H. gammarus* and *H. americanus* (Harding et al. 1997; Kit & Kornfield 1998).

On the other hand, Iceland is distant enough from Europe to cut off much of the genetic communication by planktonic larvae, and it is only a few decades since the snail *Hydrobia ventrosa* (found 1971, Oskarsson et al. 1977), and the bivalves *Cerastoderma edule* (found 1948), and *Mya arenaria* (found 1958, Oskarsson 1982), were naturalized there, probably spread by human activities. This suggests that the capacity of dispersal of these species is insufficient for the step to Iceland. The periwinkle *Littorina littorea* has dispersed to Iceland after the latest glaciation (Leifsdóttir & Simonarson 2001), despite seemingly favourable environmental conditions, and is the only mollusc absent in Iceland but present in both North America and northern Norway; additional support for the opinion that it was transferred to the western Atlantic by human activities. (See also Wares et al. 2002, who erroneously believed that it had occurred in Iceland during the Atlantic Stade, ca. 8000 years ago.)

Iceland is also a southern outpost of the arctic fauna, with many classical arctic species like *Yoldia limatula*, *Thracia myopsis*, several *Buccinum*, *Colus*,

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and *Boreotrophon*, although the most high-arctic species like *Portlandia arctica*, *Macoma loveni* and *Pandora glacialis* do not reach it. The arctic influence is most important along the eastern and north-eastern coasts (Thorson 1941; Madsen 1949).

Another element, the Mid-Atlantic Ridge fauna, i.e. species occurring along the ridge, sometimes only on its peaks, seems not to be represented among the pectinoids. The pectinoids of this fauna, south of Iceland, were treated by Dijkstra & Gofas (2004).

The Greenland–Scotland Ridge separates the Arctic abyssal basins from the abyssal parts of the North Atlantic. The ridge usually reaches up to a minimum depth of 300–400 m, but between the Faroes and Shetland it is transected by a pass which allows communication at a depth of ca. 750 m. Here, the current is a persistent outflow of cold (ca. -0.5 to -1.5°C), low-salinity, arctic bottom water. Such water is also to a lesser extent washing over the ridges and the Denmark Strait between Greenland and Iceland (Hansen et al. 2001). Since all the arctic abyssal species which can be carried out with the bottom currents have lecithotrophic larvae, this means that the communication between these abyssal faunas becomes unidirectional, as emphasized by Bouchet & Warén (1979).

The Icelandic pectinoid fauna was most recently listed by Ockelmann (1959) and Oskarsson (1982); the latter, however, only including the uppermost bathyal and more shallow species. Ockelmann left two species unidentified/undescribed: *Cyclopecten* sp.

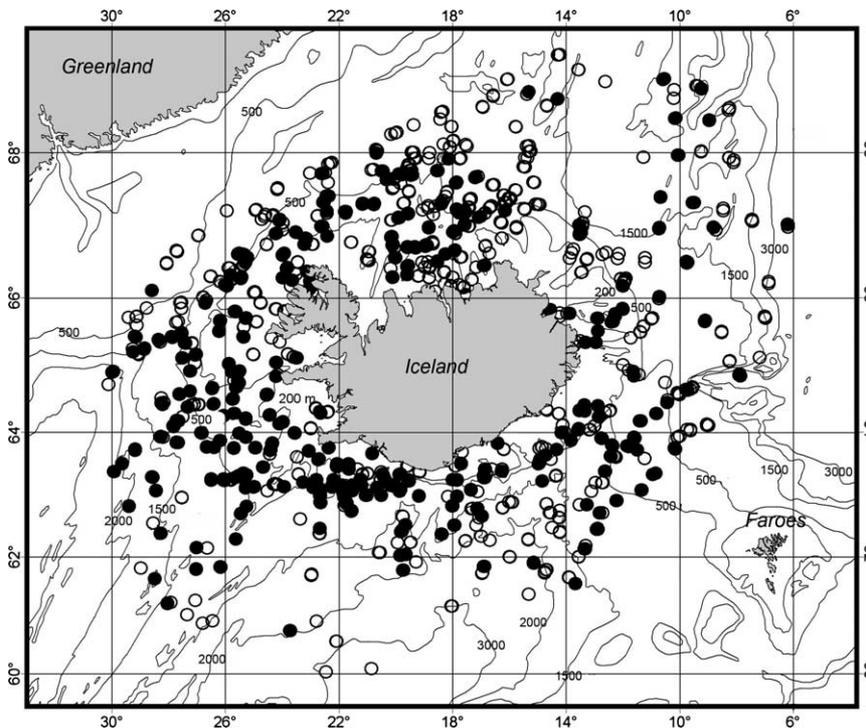
aff. *imbrifer* (here considered a synonym of *Cyclopecten hoskynsi*) and *Arctinula* sp. b (here considered a valid species, and renamed *Similipecten oskarssoni*). The access to new material from a great range of depths and localities (see Map 1) presented an opportunity to address these and other taxonomic problems within the superfamily. Together with the recent review of pectinoids from North Atlantic seamounts (Dijkstra & Gofas 2004) this gives a total coverage of the Atlantic pectinoids north of ca. 40°N ; offshore, south to ca. 30°N .

In general, the classification and terminology follow Waller (1972, 1984, 1991, 1993, 2006) and Clemam (Check List of European Marine Mollusca: www.mnhn.fr/mnhn/bimm/clemam/). Some recent suggestions in generic nomenclature have not been implemented, awaiting additional genetic support. All types listed have been examined by Dijkstra.

In order to build a better foundation for the future classification of the Pectinoidea, we have illustrated much of the variation in micro-sculpture and larval shells among the species, which has been sadly neglected previously. We have also emphasized illustrations of the poorly known species and young specimens.

Abbreviations and acronyms used in the text

BMNH, The Natural History Museum, London; HD, H.H. Dijkstra private pectinoid collection, Sneek, Netherlands; HL, Hans Larsen, Reykjavik;



Map 1. Distribution of BIOICE stations; dots mark collecting operations yielding pectinoids, circles, no pectinoids.

IMNH, Icelandic Museum of Natural History, Reykjavik; JB, Jón Bógason, Kópavogur; KBIN, Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussels; LSL, Linnean Society, London; MNHN, Muséum national d'Histoire naturelle, Paris; MOM, Musée Océanographique, Monaco; NNM, National Museum of Natural History, Naturalis, Leiden; NMW, National Museum & Gallery, Cardiff; SMNH, Swedish Museum of Natural History, Stockholm; USNM, US National Museum of Natural History, Washington, DC; ZMA, Zoological Museum, University of Amsterdam; ZMC, Zoological Museum, University of Copenhagen; ZMO, Zoological Museum, University of Oslo. Spm, pair of (joint) valves; v, valve(s); C, convexity (depth) of articulated shell; H, height (dorsal–ventral measurement); L, length (anterior–posterior measurement); Ø (used in pictures for practical reasons), largest diameter of figured specimen.

Material and methods

The samples were collected around Iceland during the BIOICE project (**B**enthic **I**nvertebrates of **I**celandic waters), from the research vessels *Bjarni Sæmundsson*, *Hákon Mosby* and *Magnus Heinason* (Gudmundsson 1998) from 1992 to 2006. Pectinoids were found in 356 samples (of a total of 1033 benthic samples) at depths between 19 and 3007 m (79 hauls more shallow than 100 m average depth and 150 hauls deeper than 1200 m; see Map 1). The sampling devices were a modified RP sled (Rothlisberg & Percy 1976; Brattegard & Fosså 1991), Sneli sled (Sneli 1998), Agassiz trawl, and triangular dredge. The RP sled is towed along the bottom and collects animals, which are stirred up by turbulence in front of the sampler. The net of the sled has 0.5 mm mesh in the cod end. The Sneli sled ploughs into the sediment and works well on soft and mixed substrates, where the more fragile RP sled cannot be towed. The samples were sieved through a series of sieves down to 0.5 mm mesh width, fixed in 4% buffered formalin and later transferred to 80% ethanol. All samples were sorted under a stereomicroscope at the Sandgerdi Marine Centre.

We have in some cases supplemented the BIOICE material with information from the large private collection of Jón Bógason, Kópavogur (JB). His material originates from collaboration with fishing boats and from his work at the Marine Research Institute, Reykjavik. Most of his collection is now in IMNH. Further information on distribution comes from Hans Larsen (HL), volunteer at the Icelandic Museum, who sorted and made the initial identifications of most molluscs from the BIOICE programme.

The BIOICE material is deposited in IMNH, with some voucher specimens in the private pectinoid reference collection of the senior author, SMNH, and at ZMA.

Propeamussiids are often difficult to work on with regular methods for shell studies. The shells are fragile and as noticed by Jensen (1912), this has given many authors an impression that the right valve is smaller than the left one. They are actually rather much the same size, but the contraction when preserved causes the margin of the right valve to break off commarginally, so neatly so it is hardly to be noticed as damage. Figures 6E and 7B show specimens where this is visible; Figure 3B shows a specimen reduced in size in this way.

The shells are also difficult to clean for examination of surface structures. Normal cleaning with diluted bleach destroys the organic matrix and causes the outer layers to peel; 3% hydrogen peroxide and a trace of sodium hydroxide was more successful. Ultrasonic cleaning can only be used with the more sturdily built shallow-water species. Soaking with a neutral detergent, weak heating (<50°) and a fine paintbrush turned out the best way for cleaning.

Dimensions of larval shells were based on measurement of its length in 1–4 specimens with SEM and additional checks under stereomicroscope with an accuracy of $\pm 10 \mu\text{m}$, but no statistics were kept.

The total list of pectinoid records on which this paper is based is available as supplementary online material at http://www.informaworld.com/mpp/uploads/dijkstraeta_supp.mat.doc. This list is the base for the distributional Maps 2–9.

All North Atlantic material of Pectinoidea in SMNH, upon which much of the information on distribution is based, is now available via the Global Biodiversity Information Facility (GBIF; <http://www.gbif.net>).

A complete set of high-resolution colour plates can be obtained from A. Warén (anders.waren@nrm.se).

Taxonomy

Superfamily Pectinoidea Rafinesque, 1815

Family Propeamussiidae Abbott, 1954

Genus Propeamussium De Gregorio, 1884

Propeamussium lucidum (Jeffreys in Thomson, 1873)
(Figures 1A,B, 2F, 3E,F, 4I,J, 8I,J)

Pleuronectia lucida Jeffreys in Thomson (1873: 464, fig. 78a [original description]).

Amussium hypomeces Dautzenberg & Fischer (1897: 195, pl. 5, figs 11 and 12). Type material: Syntypes, MOM 28 0059–63, 28 0066, 28 070, MNHN

(no register number), KBIN, Dautzenberg colln I.G. 10591, NMW Z.1955.158.02237. Type locality: The Azores, 800–1385 m depth. For additional data see Dautzenberg and Fischer (1897:140–1).

Amusium lucidum; Jensen (1912:37, pl. 2, figs 3a–c [description, distribution]).

Propeamusium centobi Schein (1989:93, pl. 8, figs 1–6). Type material: Holotype, MNHN (no register number). Type locality: North of Bay of Biscay, 47°29.6'N, 09°04.5'W, 2878 m depth.

Propeamusium lucidum; Morton & Thurston (1989:471–96, figs. 1–18 [functional morphology]); Dijkstra & Goud (2002:34, figs 1–4, 39, 40 [references, synonymy, description, distribution, discussion]).

Type material

Lectotype, BMNH 85.11.5.590, designated by Dijkstra & Gofas (2004:36), paralectotypes, USNM 62336, 62346, 62348, BMNH 77.11.28.8, BMNH 85.11.5.156.

Type locality

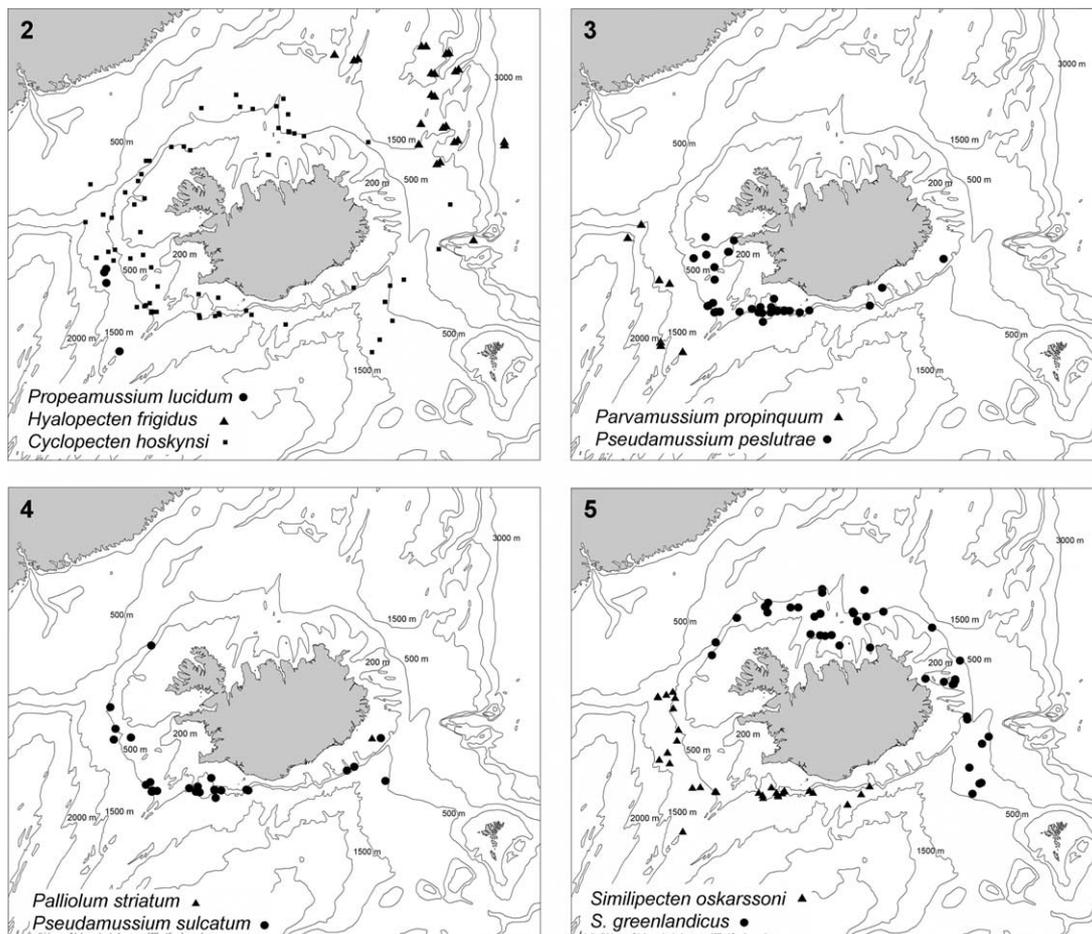
Off the British Isles, 1019 m depth. For additional data see Warén (1980:43).

Distribution

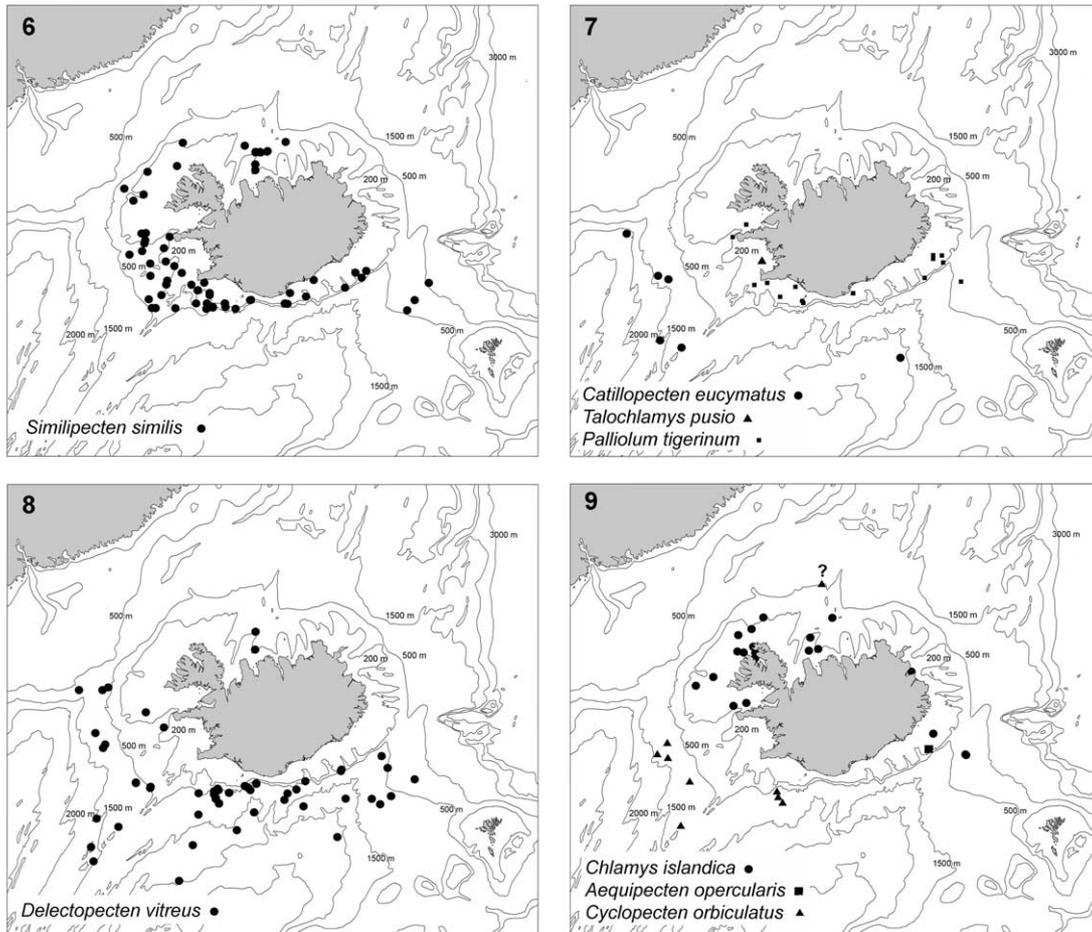
Northern to tropical eastern Atlantic (64°N–15°N), south of Greenland, southwest of Iceland and south of the Greenland–Scotland Ridge. Bathymetric range from ca. 785 m (Dijkstra & Goud 2002) to 4453 m (Morton & Thurston 1989). BIOICE material alive at four stations in 1042–1327 m (Map 2).

Description

Shell (Figures 1A,B, 3E,F) up to ca. 15 mm high, fragile, usually transparent, rarely opaque, slightly higher than long, left valve slightly more convex than right valve, equilateral (anterior and posterior end of disc of similar shape); anterior auricles larger than posterior ones. Prodissoconch (Figures 2F), length ca. 200–230 µm, white.



Maps 2–5. Distribution of pectinoids collected by BIOICE. (2) *Propeamusium lucidum*, dots; *Hyalopecten frigidus*, triangles; *Cyclopecten hoskynsi*, squares. (3) *Parvamussium propinquum*, triangles; *Pseudamusium peslutrae*, dots. (4) *Palliolium striatum*, triangles; *Pseudamusium sulcatum*, dots. (5) *Similipecten greenlandicus*, dots; *S. oskarssoni*, triangles.



Maps 6–9. Distribution of pectinoids collected by BIOICE. (6) *Similipecten similis*. (7) *Catillopecten eucymatus*, dots; *Talochlamys pusio*, triangles; *Palliolium tigrinum*, squares. (8) *Delectopecten vitreus*, dots. (9) *Chlamys islandica*, dots; *Aequipecten opercularis*, square; *Cyclopecten ambiannulatus*, triangles.

Left valve almost smooth, sometimes irregularly sculptured with weak radial and/or commarginal striae or delicate lirae (Figures 4I, 8I). Right valve with regularly spaced, commarginal lirae (Figures 4J, 8J). Anterior auricle dorsally spiny. Internal radial ribs generally 9, rarely 8 or 10, with a few rudimentary interstitial and 2 auricular ones. Byssal notch small, ctenolium (series of teeth along the edge of the shell, close to the anterior ears) lacking.

Remarks

Propeamussium lucidum seems to be scarce off Iceland (Ockelmann 1959), but rather common in the temperate and subtropical regions of the eastern Atlantic (Salas 1996; Dijkstra & Goud 2002; Dijkstra & Gofas 2004). Its supposed occurrence in the western Atlantic seems to be based on Jeffrey's old record (see below).

The BIOICE specimens are very similar to the type material. *Propeamussium lucidum* varies in sculpture on the left valve, usually very weak radial striae, sometimes with a few radial ribs anteriorly

and posteriorly. A weak reticulated sculpture is formed when both radial and commarginal striae are developed. Specimens from the temperate East Atlantic are nearly smooth (as in the types), whereas more southern specimens are weakly sculptured (*P. hypomeces* morphs: weak commarginal sculpture, and *P. centobi* morphs with weak radial sculpture or weak reticulate sculpture; based on examination of specimens in BMNH, MNHN, NNM). For discussion of geographical morphs see Dijkstra & Goud (2002) and Dijkstra & Gofas (2004).

Jeffreys' (Thomson 1873:465) figures of *Pleuronectia lucida* belong to two species: the North Atlantic *P. lucidum* (Figure 78a, lv), and *Propeamussium pourtalesianum* (Dall, 1886) from the Gulf of Mexico (Figure 78b, rv). A more precise locality 'Gulf of Mexico, off Alligator Bank, 156 fms' of the latter specimen was given by Jeffreys (1876:425) and the identification by Jeffreys (in Thomson 1873) was followed by Dall (1881:117), but in 1886 Dall introduced a new species name *Amusium* (*Propeamussium*) *pourtalesianum* for Jeffreys' '*Pleuronectia lucida*' from the western Atlantic. *Propeamussium*

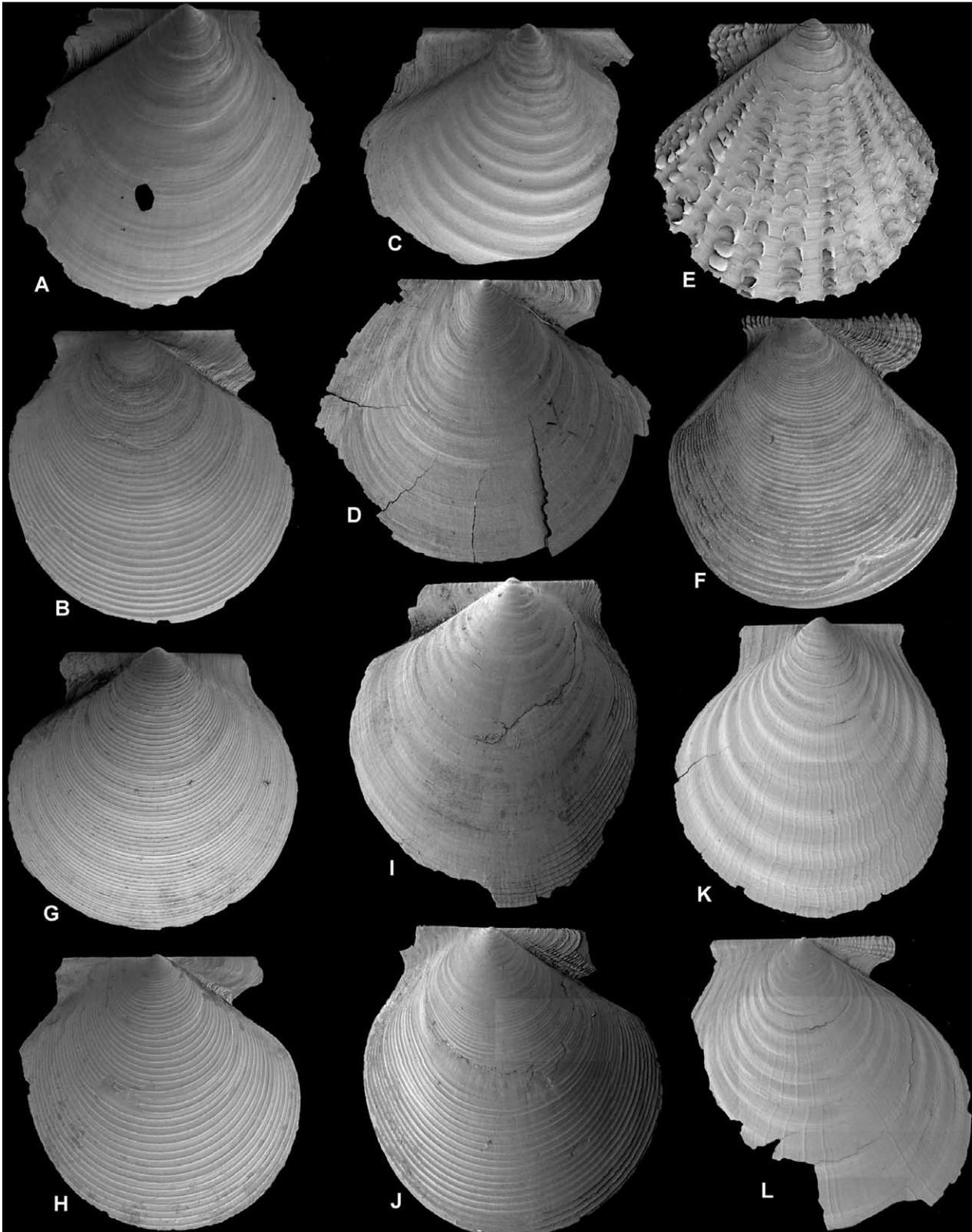


Figure 1. Thin-shelled deep-sea Pectinoidea. (A,B) *Propeamussium lucidum*, Ø 5.0 and 4.7 mm, BIOICE#2701, off western Iceland, depth 1121 m (SMNH 55517). (C,D) *Catillopecten eucymatus*, (C) Ø 4.5 mm, BIOICE#2914, off western Iceland, depth 2005 m (SMNH 55526). (D) Ø 3.6 mm, BIOICE#2707, off southwestern Iceland, depth 1407 m (SMNH 55521). (E,F) *Cyclopecten hoskynsi*, Ø 6.0 and 5.5 mm, BIOICE#2268, off southwestern Iceland, depth 450 m (SMNH 55534). (G,H) *Cyclopecten ambiannulatus*, Ø 5.2 and 4.6 mm, BIOICE#2707, off southwestern Iceland, depth 1407 m (SMNH 55519). (I,J) *Parvamussium propinquum*, Ø 9.0 mm, BIOICE#2706, off southwestern Iceland, depth 1406 m (SMNH 55512). (K,L) *Hyalopecten frigidus*, Ø 9.0 and 10 mm, BIOICE#3214, NE of Iceland, 3000–3003 m (SMNH 59237).

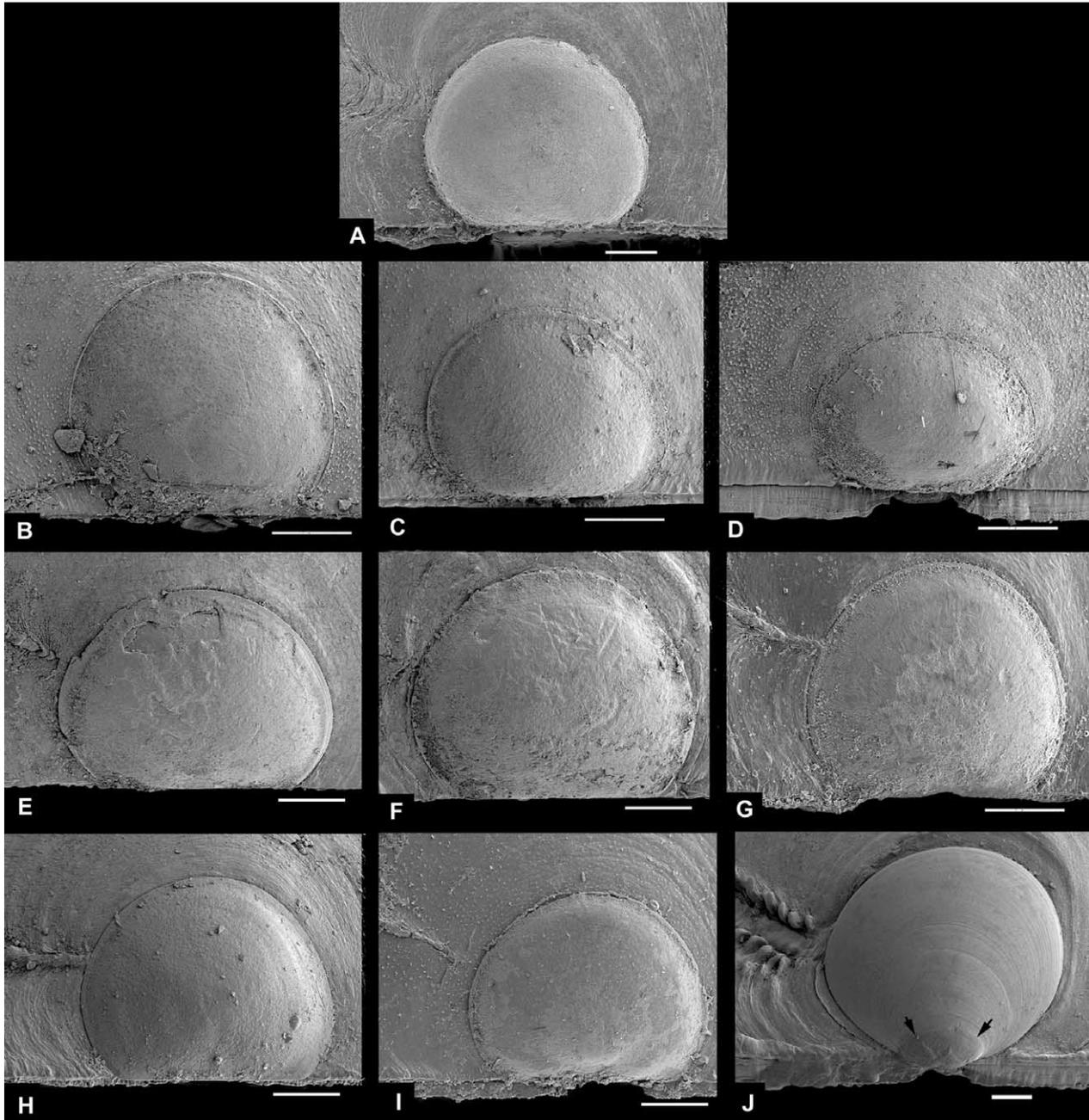


Figure 2. Larval right valves. Scale lines 50 μm . Arrows indicate demarcation of prodissoconch 1. The scale line is valid for length only; the height may differ slightly because of tilt. (A) *Hyalopecten frigidus*, BIOICE#3214, NE of Iceland, 3000–3003 m (SMNH 59237). (B) *Similipecten oskarsoni*, BIOICE#2401, off southwestern Iceland (SMNH 55525). (C) *Similipecten similis*, BIOICE#2393, off southwestern Iceland (SMNH 55515). (D) *Similipecten greenlandicus*, BIOICE#2047, off northeastern Iceland (SMNH 55520). (E) *Parvamussium propinquum*, BIOICE#2706, off southwestern Iceland (SMNH 55512). (F) *Propeamussium lucidum*, BIOICE#2701, off western Iceland (SMNH 55517). (G) *Catillopecten eucymatus*, BIOICE#2914, off western Iceland (SMNH 55526). (H) *Cyclopecten hoskynsi*, BIOICE#2268, off southwestern Iceland (SMNH 55534). (I) *Cyclopecten ambiannulatus*, BIOICE#2707, off southwestern Iceland (SMNH 55519). (J) *Delectopecten vitreus*, BIOICE#3067, off southeastern Iceland (SMNH 55531).

pourtalesianum differs from *P. lucidum* by having a more circular disc (*P. lucidum* is elongate), 10 instead of 9 internal ribs and a coloured left valve instead of a colourless or transparent one.

Several variations were described by Jeffreys (1879:562) and Locard (1898:407), but they are individual and geographic. *Amussium lucidum* var.

striata Jeffreys, 1879 was based on specimens of the same appearance as *P. centobi* with ‘distinct longitudinal striae’. We consider it a synonym of *P. lucidum*.

Schein (1989) gave a length of 170 μm for prodissoconch 2, but both our measurements (ca. 220 μm) and those in Morton & Thurston

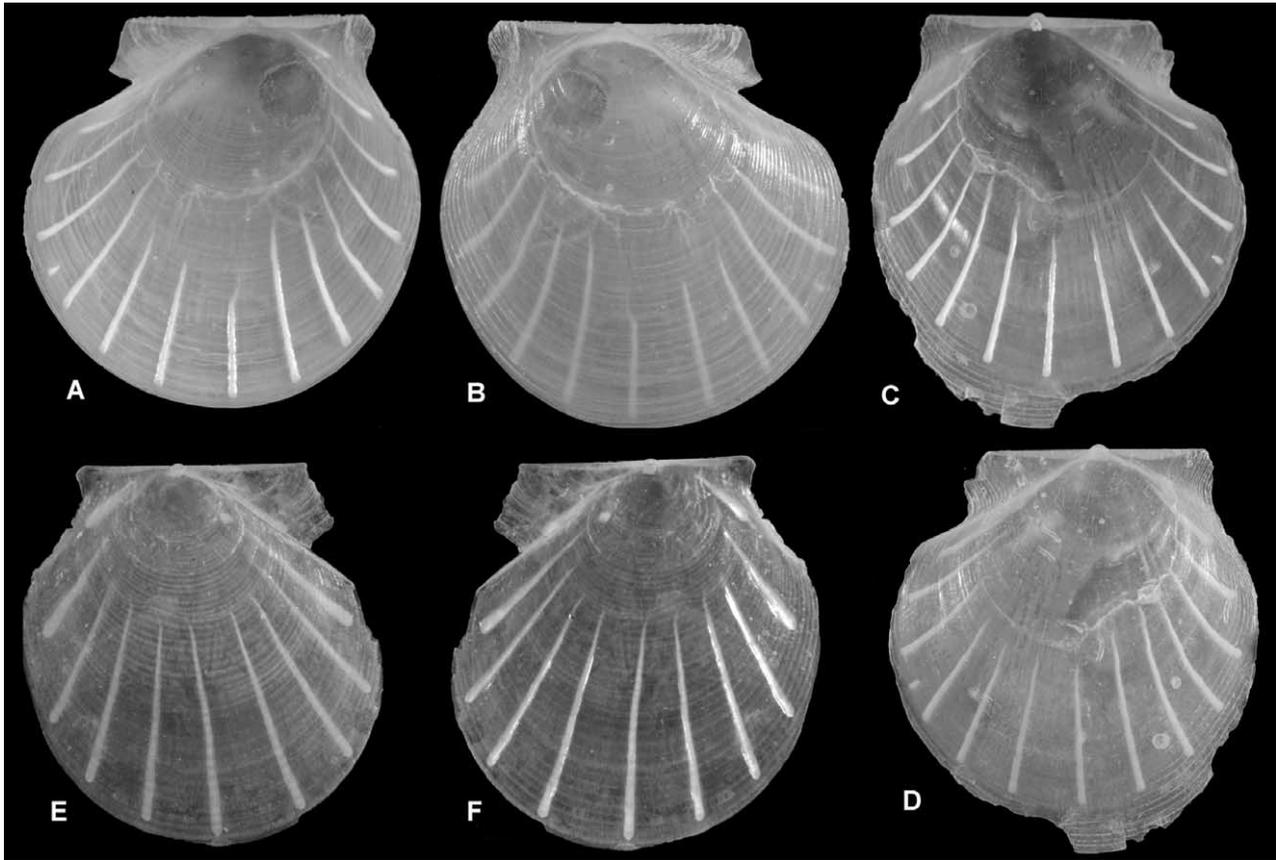


Figure 3. Internally ribbed propeamussiids (all broken at margin). (A–D) *Parvamussium propinquum*, external and internal view, \varnothing 9.0 mm, BIOICE#2706, off southwestern Iceland, depth 1406 m (SMNH 55512). (E,F) *Propeamussium lucidum*, external and internal view, \varnothing 6.1 mm, BIOICE#2701, off western Iceland, depth 1121 m (SMNH 55517).

(1989:476), 200–230 μ m, differ considerably. It is obvious that Schein's figure 11 is strongly tilted and this may explain the discrepancy.

Genus *Parvamussium* Sacco, 1897

Parvamussium propinquum (Smith, 1885)
(11,J, fig 2E, fig 3A–D, 4G,H, 8C,D)

Amussium propinquum Smith (1885:314, pl. 23, figs 7, 7a,b [original description]).

Amussium sublucidum Dautzenberg & Fischer (1897:193, pl. 5, figs 9, 10). Type material: Syntypes, MOM 28 0088, 28 0090–93, MNHN (no register number), KBIN, Dautzenberg colln I.G. 10591. Type locality not specified: The Azores, 1165–1557 m depth. For additional data see Dautzenberg & Fischer (1897:194).

Parvamussium propinquum; Dijkstra & Goud (2002):38, figs 14–20 [synonymy, description, distribution]; Dijkstra & Gofas (2004):38, figs 3A–E).

Type material

Holotype, BMNH 1887.2.9.3325.

Type locality

The Azores, 1829 m depth.

Distribution

Tropical to temperate eastern Atlantic (ca. 40°N–20°N), now extended to Iceland (ca. 65°N) with a depth range from 790 m (Dijkstra & Goud 2002) to 4060 m (Locard 1898). BIOICE material alive at 6 stations in 1295–2007 m (Map 2).

Description

Shell (Figures 11,J, 3A–D) up to ca. 7 mm high, fragile, transparent to opaque, nearly circular, somewhat longer than high, slightly drawn out posteroventrally, left valve slightly more convex than right valve; auricles small, nearly equal in size, umbonal angle ca. 125°. Prodissoconch (Figures 2E), length ca. 200 μ m, colour whitish.

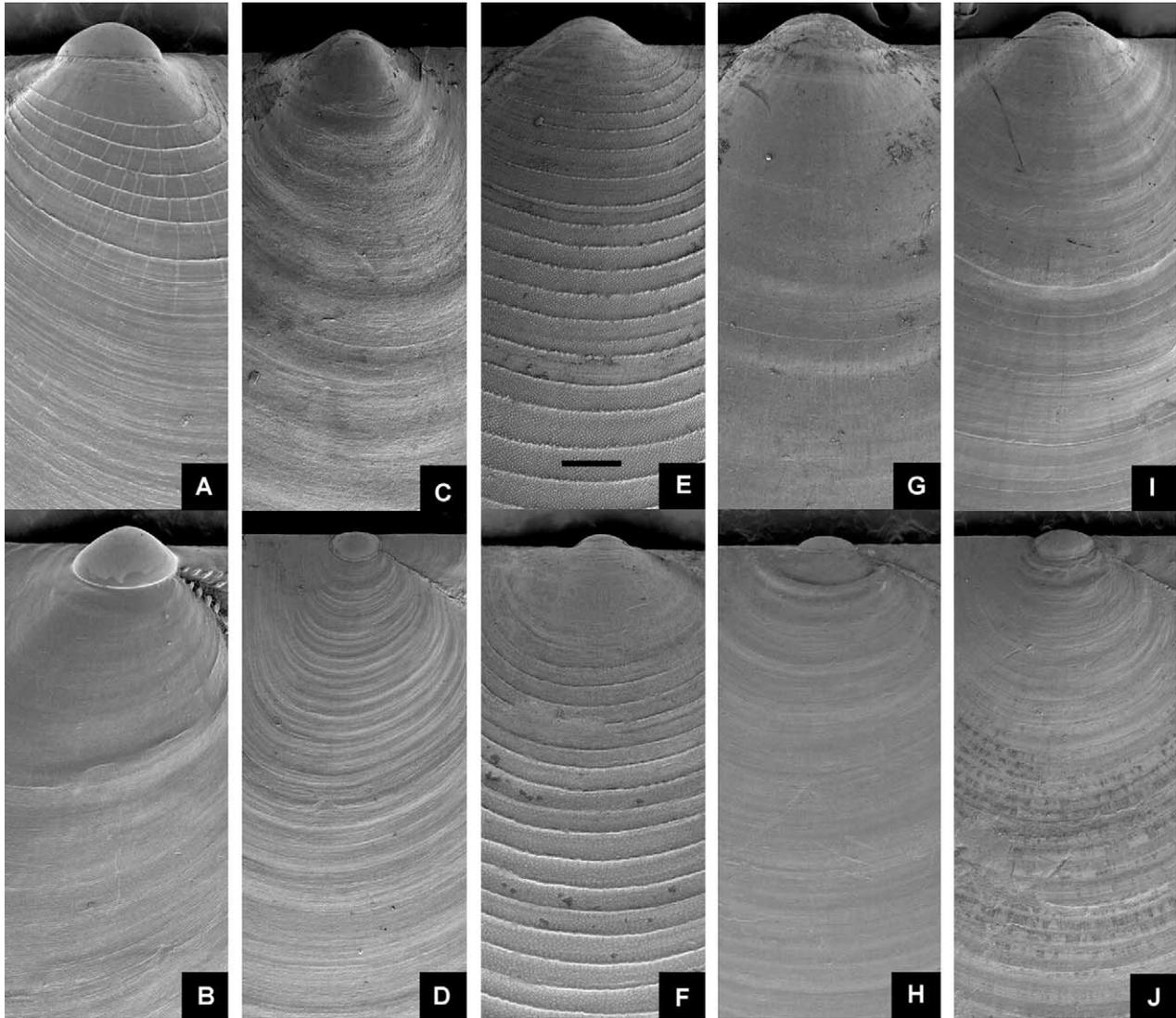


Figure 4. Umbonal area of smooth or concentrically sculptured Pectinoidea. Left valve above. All at same magnification. Scale line (see Figure E) 250 μ m. (A,B) *Delectopecten vitreus*, BIOICE#3067, off southeastern Iceland, depth 1729 m (SMNH 55531). (C,D) *Catillopecten eucymatus*, BIOICE#2707, off southwestern Iceland, depth 1407 m (SMNH 55521), (E,F) *Cyclopecten ambiannulatus*, BIOICE#2707, off southwestern Iceland, depth 1407 m (SMNH 55519). (G,H) *Parvamussium propinquum*, BIOICE#2706, off southwestern Iceland, depth 1406 m (SMNH 55512). (I,J) *Propeamussium lucidum*, BIOICE#2701, off western Iceland, depth 1121 m (SMNH 55517).

Left valve (Figures 4G, 8C) smooth at central part of disc with fine closely spaced, radial riblets and commarginal lamellae near the margin.

Right valve (Figures 4H, 8D) sculptured with regularly arranged commarginal lirae. Hinge line rather long and straight and very weakly sculptured with close-set lamellae. Inside of valve usually with 12 short and narrow radial riblets, sometimes with several rudimentary interstitial ones. Ribs commence near the central part and extend to the submarginal area. Byssal notch well-developed, ctenolium lacking.

Remarks

The Icelandic specimens have a somewhat weaker sculpture than the type material and usually lack the radial sculpture on the left valve. Adult specimens from

the Azores often have smaller, intercalated, internal riblets, which are not present in Icelandic specimens.

Parvamussium propinquum differs from *Propeamussium lucidum* in having a circular circumference (*P. lucidum* is generally higher than long), larger anterior auricles, a well-developed byssus notch (in *P. lucidum*, weak and shallow), and in having more numerous internal ribs (in *P. propinquum* 12, with several rudimentary ones commencing when half-grown; in *P. lucidum* usually only 9, developing early).

Genus *Cyclopecten* Verrill, 1897

Cyclopecten hoskynsi (Forbes, 1844)
(Figures 1E,F, 2H, 5B,C, 9C,D, 10G,H)

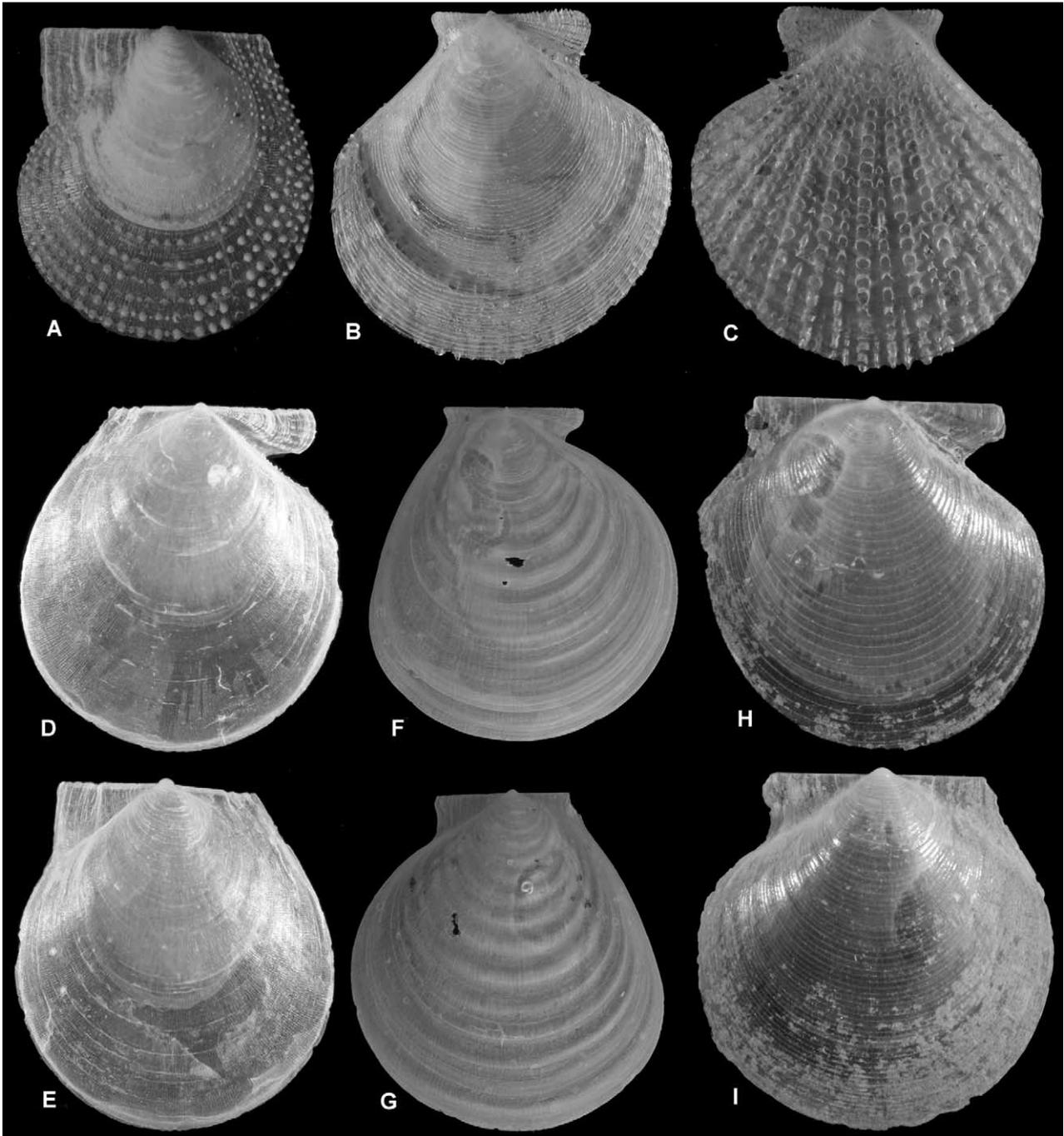


Figure 5. Pectinoidea spp. (A) *Delectopecten vitreus*, unusually strong sculpture, Ø 6.7 mm, N of Norway, 72° 10' N, 20° 37' E, depth 360–415 m (SMNH 56311). (B,C) *Cyclopecten hoskynsi*, Ø 16.1 mm, BIOICE#2758, off northern Iceland, depth 786 m (SMNH 55511). (D,E) *Delectopecten vitreus*, smooth 'abyssorum' form, Ø 8.3 mm, BIOICE#2424, off southwestern Iceland, depth 495 m (SMNH 55513). (F,G) *Hyalopecten frigidus*, Ø 22 mm, off northern Norway, 73° 28' N, 10° 00' E, depth 2346 m (SMNH 55536). (H,I) *Cyclopecten ambiannulatus*, Ø 4.3 and 5.6 mm (same specimen), BIOICE#2707, off southwestern Iceland, depth 1407 m (SMNH 55519).

Pecten hoskynsi Forbes (1844:192 [original description]).

Pecten imbrifer Lovén (1846:185). Type material: Syntypes, SMNH 1999, 2000. Type locality: Finnmarken, Norway.

Pecten mamillatus M. Sars, 1869:256 *nom. nud.* (fide Friele 1873:300).

Pecten pustulosus Verrill (1873:14). Type material: Holotype, USNM 48764. Type locality: Near St. George's Bank, mud, 274 m depth.

Pecten hoskynsi var. *major* Leche (1878:35 [not *Pecten major* Young & Bird, 1828]). Type material: Many syntypes in SMNH. Type locality: Not specified, Kara Sea, east to 65°E, 50–225 m depth

(not Leche [1883:452] = *Parvamussium alaskensis* (Dall, 1871).

Pecten lucidus Haren Noman (1881:2, pl. 1, figs 5–8 [not *Pecten lucidus* Goldfuss, 1836]). Two syntypes, NNM 99593. Type locality not specified: Barents Sea, 219–384 m depth.

Cyclopecten subimbrifer Verrill & Bush in Verrill (1897:84, 92). Type material: Syntypes, USNM 48762, 48766. Type locality: Off New England, 221–571 m depth.

Pecten imbrifer var. *lamellosa* Posselt & Jensen (1898:13, pl. 1, fig. 1f). Type material: Holotype, SMNH 3802. Type locality: Greenland, Baffin Bay, 415 m depth.

Pecten imbrifer; Jensen (1912:25, pl. 2, figs 1 and 2); (var. *major*).

Pecten imbrifer var. *minor* Jensen (1912:25 [infra-specific], fig. 2a,b [references, Icelandic distribution]).

Pecten imbrifer var. *minor*; Madsen (1949:35 [Icelandic distribution]).

Propeamussium (*Cyclopecten*) *imbriferum*; Ockelmann (1959:66, pl. 2, fig. 1 [references, distribution, biology, discussion]).

Cyclopecten hoskynsi; Soot-Ryen (1958:13 [anatomy]); Lucas (1979:16, figs [synonymy]); Smriglio & Mariottini (1990:4, 5, pl. 2, figs 3a–e); Dijkstra & Goud (2002:41, figs 13, 21–26 [references, distribution, description, discussion]).

Type material

Syntype, National Museums of Scotland, Edinburgh, reg. no. 1976.5.31904.

Type locality

Off Piscopi [= Tilos], Sporades, Greece, 366 m depth (restricted by Smaldon et al. 1976:51).

Distribution

Arctic to tropical, eastern and western Atlantic, from Svalbard and northern Greenland southwards to Massachusetts (USA) (Abbott 1974:445, as *Cyclopecten pustulosus*) in the West Atlantic and southwards to the Cape Verde Islands in the East Atlantic, in 82–2064 m (Dijkstra & Goud 2002:41; Locard 1898). BIOICE material alive at 77 stations in 125–1314 m (Map 1).

Description

Shell (Figures 1E,F, 5B,C) up to ca. 24 mm high, usually smaller, fragile, transparent to opaque, somewhat higher than long, flattened, left valve slightly more convex than right valve, anterior auricles larger

and longer than posterior ones. Prodissoconch (Figure 2H), length ca. 180 µm, colour whitish.

Left valve (Figures 9C, 10G) sculptured with broad, radially arranged vesicles and small secondary interstitial vesicles commencing in late growth stage or, usually damaged, so only curved lamellae remain, sculpture sometimes nearly absent. Commarginal lamellae usually present near ventral margin, sometimes absent. Anterior auricle with prominent commarginal lamellae and some radial rows of vesicles, posterior auricle similarly but more weakly sculptured.

Right valve (Figures 9D, 10H) with closely spaced commarginal lamellae. Auricles rather small, anterior one more prominent sculptured with small vesicles or lamellae. Internally sometimes with rudimentary riblets commencing in late growth stage and extending towards the submarginal area. Byssal notch small, ctenolium lacking.

Remarks

Arctic and northern specimens (SMNH, ZMC), have usually been identified as *Cyclopecten imbrifer*, and resemble Mediterranean *C. hoskynsi* in shape and sculpture, although larger (up to ca. 24 mm in height in high arctic areas, ca. 15 mm in northern Iceland; continuously smaller southwards, usually 6–7 mm in the Mediterranean). We cannot find any additional difference and the variation in sizes looks like a cline with BIOICE material of intermediate size. The names *Cyclopecten pustulosus* and *Cyclopecten subimbrifer* were based on specimens from the northwestern Atlantic with unusually prominent vesicles on the ribs in *pustulosus* and weak concentric lamellae and small vesicles in *subimbrifer* (see Jensen 1912 and Schiøtte 1989). Ockelmann (1959) separated four species in this group, *Cyclopecten imbrifer* (arctic), *C. subimbrifer* (West Atlantic), *C. pustulosus* (West Atlantic) and *Cyclopecten* sp. A. (from the Faroes), but also SEM examination of sculpture and larval shells from extreme localities failed to reveal any persisting differences.

Among congeneric species only those from the northern hemisphere have vesicles on the left valve. *Cyclopecten carlottensis* Bernard, 1968, known from the north-eastern Pacific, differs from *C. hoskynsi* in having coarser commarginal lamellae on the right valve and more closely set rows of pustules on the left one. Also the rows of pustules are usually more prominent than in *C. hoskynsi*. This species is morphologically very similar to the north-western Atlantic form of *C. hoskynsi* named *C. pustulosus* (now considered a synonym of *hoskynsi*). Another resembling species is *Cyclopecten davidsoni* (Dall, 1897), from Alaska, distinguishable

from *C. hoskynsi* by having a more sturdily built shell, often abruptly increasing the convexity of the valves close to the margin (flattened in *C. hoskynsi*), and by having narrower radial rows of crowded vesicles.

***Cyclopecten ambiannulatus* Schein, 1989**
(Figures 1G,H, 2I, 4E,F, 5H,I, 8E,F)

Cyclopecten ambiannulatus Schein (1989:86, pl. 4, figs 1–9, 11–12).

Type material

Holotype (livetaken) H 6.8 mm, L 6.7 mm, and 3 paratypes (livetaken), MNHN [no register number].

Type locality

North of Bay of Biscay, 4732.8' N, 835' W, 2126 m depth, alive, BIOGAS station 1, BIOGAS IV, DS 63, 01.Feb.1974.

Material examined

Iceland: BIOICE 2257, 63°15.00'N, 26°29.57'W, 1209–1212 m, clay and shell sand, 5 spm (IMNH); 2406, 62°59.40'N, 21°46.10'W, 934 m, 3 spm + 1 v (IMNH); 2410, 62°51.90'N, 21°43.30'W, 1074–1075 m, silty sand, 21 spm (IMNH/18, ZMA/3); 2412, 62°44.50'N, 21°33.80'W, 1170–1174 m, silt, 2 spm (IMNH); 2697, 64°10.40'N, 27°43.80'W, 1042 m, 11 spm + 3 v (IMNH/12, SMNH/2); 2704, 63°50.80'N, 27°42.00'W, 1295 m, 18 spm + 1 v (IMNH/17, ZMA/2); 2707, 63°55.60'N, 28°17.20'W, 1407–1408 m, silty sand, 18 spms + 1 v (SMNH/16, ZMA/3); (2740, 67°38.38'N, 20°15.80'W, 503–512 m, silt, 1 spm (IMNH); 3187, 62°09.04'N, 27°00.74'W, 1326–1327 m, 30 spm (IMNH).

Distribution

Off western Iceland (62–67°N, 20–28°W), living in 503–1408 m (Map 9). A single specimen is supposed to come from station 2740, but considering the locality, so far further north than the others, it must be considered uncertain, perhaps mislabelled.

Description

Shell (Figures 1G,H, 5H,I) up to ca. 7 mm high, fragile, transparent to opaque, circular, left valve slightly more convex than right valve, anterior auricles slightly larger and more demarcated from disc than posterior ones; umbonal angle ca. 110°;

internal ribs lacking, colour whitish. Prodissoconch (Figure 2I), length 185 µm, colour white.

Both valves (Figures 4E,F, 8E,F) sculptured with uniform and closely spaced commarginal lamellae (ca. 10 per mm on the central part of the disc), commencing in early growth stage directly below the prodissoconch boundary and extending towards the ventral margin. Granular intercalated micro-sculpture. Similar sculpture on the auricles, except anterior auricle of right valve, which is almost smooth. Posterior auricle of right valve continuous with disc, anterior auricle demarcated. Hinge line straight. Byssal notch moderately deep, byssal fasciole narrow, suture somewhat folded, ctenolium lacking.

Discussion

The BIOICE specimens resemble *Cyclopecten ambiannulatus* Schein, 1989, known from the temperate eastern Atlantic (44–58°N). Both species are somewhat similar in shape, size and colour, but differ in sculpture. *Cyclopecten orbiculatus* has more closely and regularly spaced commarginal lamellae on the left valve, and lacks interstitial radial sculpture. *Cyclopecten ambiannulatus* has widely spaced lamellae in young specimens and closely spaced ones with delicate interstitial radial lines in adult and subadult specimens (Schein 1989:pl. 6, figures 1–5).

Cyclopecten cincinmatus Dijkstra & Gofas, 2004, known from the Mid-Atlantic seamounts (30–34°N) differs from *C. ambiannulatus* in having much more widely spaced commarginal lamellae on the central part of the left valve (ca. 2 per mm, in *C. ambiannulatus* 8–10), and in having prominent commarginal lamellae on the anterior auricle of the left valve (in *C. ambiannulatus* very weak or lacking).

Some specimens of *Cyclopecten hoskynsi* ('var. *lamellosus*' in Jensen 1912) have prominent commarginal lamellae also on the left valve, but these are undulating, widely spaced and irregularly developed, and originate from incompletely formed vesicles. Such specimens can be distinguished from *C. ambiannulatus* by *C. hoskynsi* having very small posterior shell ears.

Genus *Similipecten* Winckworth, 1932

***Similipecten greenlandicus* (Sowerby II, 1842)**
(Figures 2D, 6A,B,D–F, 9G,H, 10A,B)

Pecten greenlandicus Sowerby II (1842:57, pl. 13, fig. 40 [original description]).

Pecten groenlandicus [sic]; Jensen (1912:30 [references, Icelandic distribution]); Madsen (1949:36 [references, Icelandic distribution]).

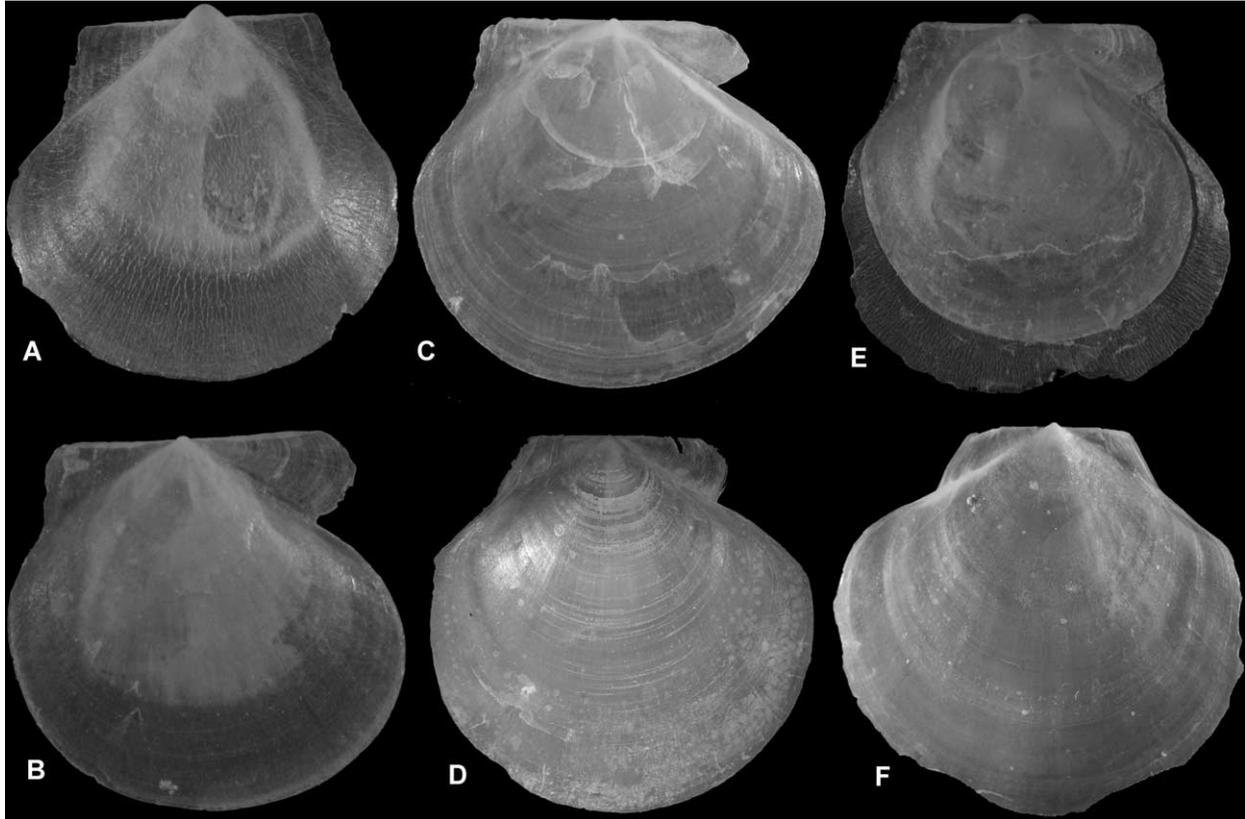


Figure 6. *Similipecten* spp. (A,B, E) *S. greenlandicus*, BIOICE#2047, off northeastern Iceland, depth 272 m (SMNH 55520). (A) Left valve, Ø 4.8 mm. (B) Right valve, Ø 4.2 mm (of same specimen). (E) Complete specimen, showing the partly and concentrically broken right valve contained in the left one. (C) *S. similis*, Ø 6.2 mm, BIOICE#2393, off southwestern Iceland, depth 291 m (SMNH 55515). (D,F) *S. greenlandicus*, Ø 30 mm, Svalbard, Vest Spitsbergen, depth 38–55 m (SMNH 55510).

Propeamussium (Arctimula) groenlandicum [sic]; Ockelmann (1959:68, pl. 2, fig. 2 [references, distribution, biology]).

Cyclopecten (Delectopecten) greenlandicus; Grau (1959:53, pl. 20 [references, description]).

Delectopecten greenlandicus; Lubinsky (1980:28, pl. 5, fig. 7 [distribution]).

Similipecten greenlandicus; Knudsen (1985:104 [distribution]).

Arctimula greenlandica; Richling (2000:46, text fig. 49 [distribution]).

Type material

Not found; not in The Hancock Museum at Newcastle upon Tyne (UK) (L. Jessop, personal communication) or in BMNH.

Type locality

Greenland.

Distribution

Arctic region except the Chukchi Sea (north of Bering Sea); in the North Atlantic southwest to

the Gulf of St. Lawrence (Clarke 1974; Lubinsky 1980) southeast to northern Norway (Lofoten), south-eastern Iceland and the Faeroes (Madsen 1949; Petersen 1968). Living in 4 to ca. 600 m, on fine sediments. Some very deep records (2000 m in Knudsen 1985; Richling 2000) probably originate from ice drift. BIOICE material alive at 55 stations in 107–1048 m, only two records below 600 m (Map 5).

Description

Shell (Figures 6A,B,D–F) up to ca. 30 mm high, fragile, almost circular (adult specimens slightly longer than high), weakly convex, left valve somewhat more convex than right valve, equilateral, anterior auricles larger than posterior ones, both nearly equal in length, umbonal angle ca. 120°, Greyish semitransparent, internal ribs lacking. Prodissoconch (Figure 2D), length 160–170 µm, colour white.

Left valve (Figures 9G, 10G) with delicate anti-marginal, micro-sculpture of irregularly branching and anastomosing raised lines and commarginal growth lines near ventral margin. Auricles with

growth lines and slightly raised laterally, anterior auricle more demarcated from disc than posterior one.

Right (Figures 9H, 10H) valve smooth with commarginal growth lines. Anterior auricle with closely spaced growth lines and strongly demarcated from disc, anterior margin curved, posterior auricle continuous with disc. Byssal notch small, byssal fasciole narrow, ctenolium lacking.

Remarks

High arctic specimens are much larger, up to 32.5 mm in height in Svalbard (Knipowitsch 1901) and 35 mm in East Greenland (Ockelmann 1959), than specimens from Iceland and northern Norway (up to 12 mm in height), but they cannot otherwise be separated.

Jeffreys (1879:560) considered certain small, smooth specimens from off western Europe to be young *S. greenlandicus*; Locard (1898:399) introduced a varietal name (var. *minor*); and Jensen (1912:32) considered such specimens as a 'dwarf-form'. Ockelmann (1959:72) had the opinion that the arctic and more southern specimens differed anatomically. Moreover, arctic and West European specimens differ in sculpture of the left valve, which in *S. greenlandicus* has an antimarginal micro-sculpture of irregular raised lines, while southern specimens have a much weaker sculpture, restricted to the umbo and visible mainly in well preserved specimens. The almost smooth specimens are here considered a distinct species and renamed *Similipecten oskarssoni*.

***Similipecten oskarssoni* nom. nov.**
(Figures 2B, 7B–F, 9E,F, 10E,F)

Pecten groenlandicus; Jeffreys (1879:560 [not *P. greenlandicus* Sowerby]).

Pecten groenlandicus var. *minor* Locard (1898:399 [original description]).

Propeamussium sp. b Ockelmann (1959:72).

Similipecten similis (Laskey); Schein (1989:96 [pro parte]).

Type material

Lectotype of *Pecten groenlandicus* var. *minor* (spm: H 6.2, L 6.5, C 1.6 mm), 5 paralectotypes (3 spm + 2 v) in MNHN [no register number], here designated.

Type locality

Bay of Biscay, 647–1190 m depth.

Etymology

Named after Ingimar Óskarsson (1892–1981), honorary doctor at the Icelandic University, and an initiator of high level amateur natural history in Iceland.

Distribution

Western and south-western Iceland to the Bay of Biscay, probably also off West Africa but the paralectotypes supposed to originate from such localities, have unclear locality data or are lost. BIOICE material alive at 33 stations in 291–1408 m, on fine sediments (Map 5).

Description

Shell (Figures 7B–F) up to ca. 10 mm high, fragile, transparent, weakly convex, equivalve, nearly circular (somewhat longer than high), equivalve and equilateral, anterior auricles slightly longer than posterior ones and somewhat more demarcated from disc, umbonal angle ca. 120°, internal ribs lacking. Prodissoconch (Figure 2B), length 175 µm, colour white.

Both valves smooth (Figures 9E,F, 10E,F), except the umbonal area of the left valve, which has a sculpture similar to *S. greenlandicus*, but more delicate (Figure 10E). Posterior auricle more continuous with disc than anterior one. Anterior auricle of right valve larger and more curved laterally than anterior one of left valve. Byssal notch moderately small, byssal fasciole very weak, ctenolium lacking.

Remarks

The type material of *Pecten groenlandicus* var. *minor* consists of two lots, one labelled 'Talisman 1883, dragage 34', from 112 m depth off northwestern Morocco. A second lot consists of 3 spm and 4 v from 'Travailleur 1880, dragages 2, 7, 90, 12, 14, 16 and 20', from the Bay of Biscay, in 697–1190 m. A third lot with a single specimen and the same station numbers has obviously been separated later from this and glued to a piece of cardboard. Two lots listed by Locard (1898) are missing. The specimen from dragage 34 seems to be mislabelled, already by or before Locard, since the depth is much smaller than expected. We have therefore selected a specimen from the mixed lot as lectotype. A restriction of the type locality, more detailed than Bay of Biscay, does not seem necessary. All specimens in identifiable condition belong to *S. oskarssoni* and the characteristic, irregular lines can be seen on the umbo of the left valve.

Similipecten oskarssoni can be confused with *S. greenlandicus* of similar size. Both species occur in

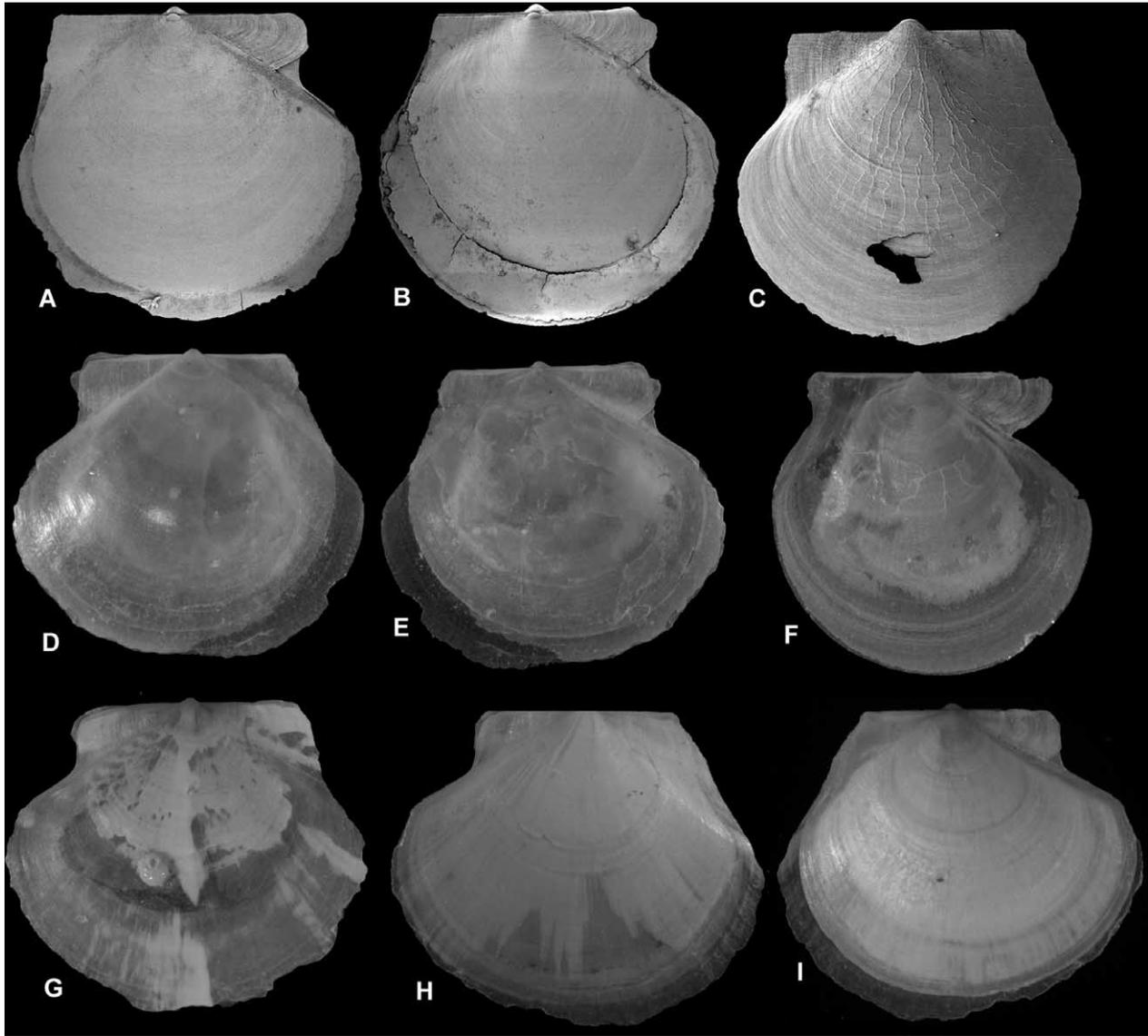


Figure 7. *Similipecten* spp. (A) *Similipecten similis*, Ø 3.6 mm, BIOICE#2393, off southwestern Iceland, depth 291 m (SMNH 55515). (B–F) *S. oskarssoni*, (B,C) Ø 3.75 and 2.3 mm, BIOICE#2401, off southwestern Iceland, depth 520 m (SMNH 55525). (D–F), (D) left side; (E) right side of same specimen, Ø 5.1 mm; (F) right side, not broken, Ø 5.7 mm, BIOICE#2401, off southwestern Iceland, depth 520 m (SMNH 55518). (G–I) *S. similis*, (G,H) left side, varying colour pattern, Ø 7.1 and 7.9 mm; (I) right side of H; BIOICE#2710, off western Iceland, depth 220 m (SMNH 55516).

Iceland and live in similar habitats, but with no overlap in distribution (Map 5). *Similipecten oskarssoni* has only a few irregular radial lines on the umbo of the left valve, visible at $50\times$ with a good stereomicroscope, whereas *S. greenlandicus* has a similar but much coarser micro-sculpture and *S. similis* is smooth (Figures 7G,H, 9I). For further differences see Table I. Schein (1989:96) regarded this species as a ‘forme incolore’ of *Similipecten similis*.

According to the IZCN (1999:50, art. 45.6.4) the name *Pecten groenlandicus* var. *minor* Locard, 1898 may be considered subspecific, but the subspecies name is preoccupied by *Pecten maximus* var. *minor* Locard, 1888. Therefore the epithet is replaced with

Similipecten oskarssoni nom. nov. (ICZN, 1999:63, art. 60.3).

***Similipecten similis* (Laskey, 1811)**
(Figures 2C, 6C, 7A,G–I, 9L,J, 10C,D)

Pecten similis Laskey (1811:387, pl. 8, fig. 8 [original description]); Jensen (1912:29 [Icelandic distribution]); Madsen (1949:36 [Icelandic distribution]). *Similipecten similis*; Lucas (1979:3, figs [synonymy]); Dijkstra & Goud (2002:44, figs 33–38 [synonymy, description, distribution]); Dijkstra & Gofas (2004:53, fig. 14A–E).

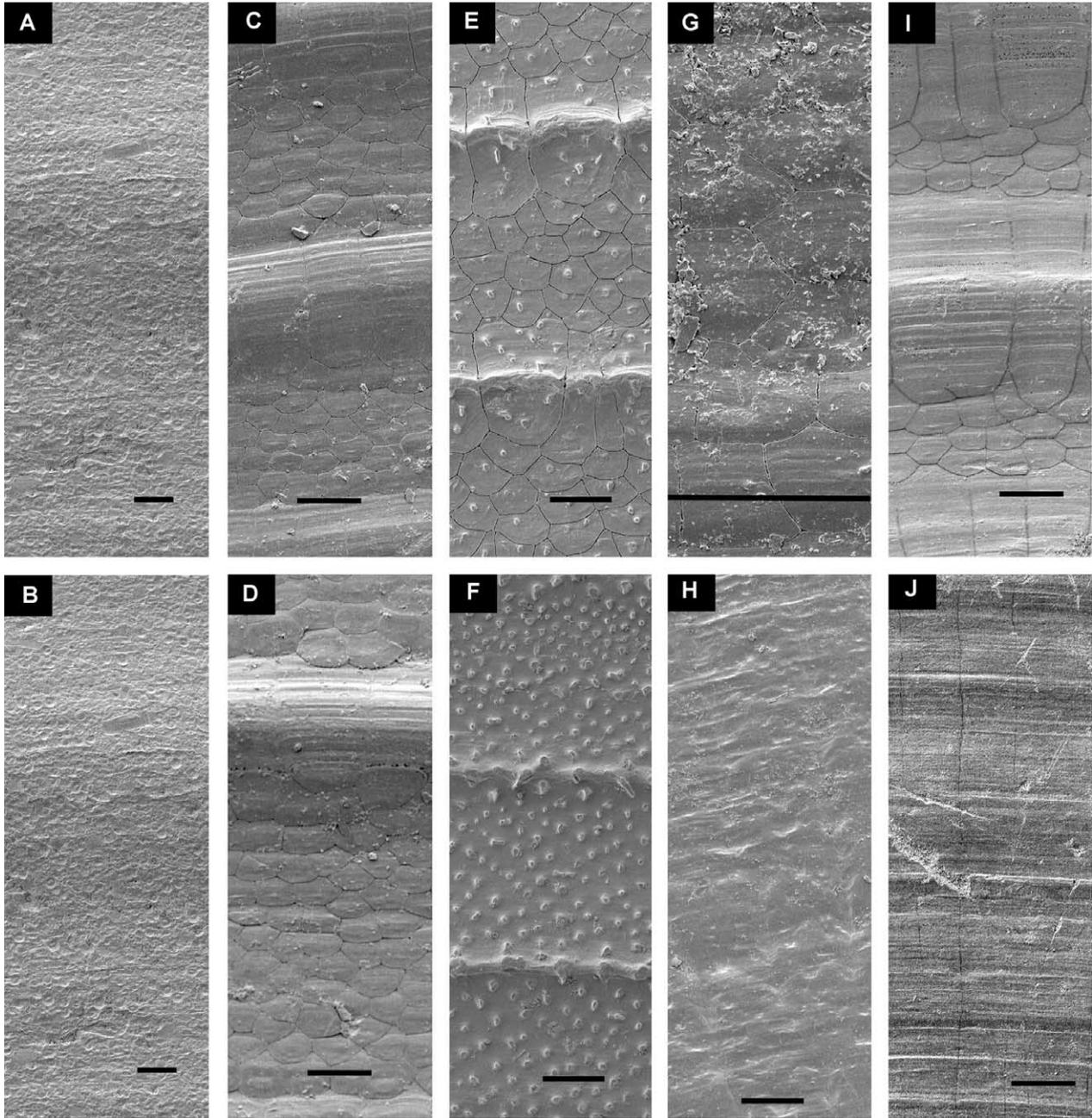


Figure 8. Detail of sculpture, mid-shell of half-grown specimens. Left valve above. Scale lines 25 µm. (A,B) *Catillopecten eucymatus*, BIOICE#2914, off western Iceland, depth 2005 m (SMNH 55526). (C,D) *Parvamussium propinquum*, BIOICE#2706, off southwestern Iceland, depth 1406 m (SMNH 55512). (E,F) *Cyclopecten ambiannulatus*, BIOICE#2707, off southwestern Iceland, depth 1407 m (SMNH 55519). (G,H) *Delectopecten vitreus*, BIOICE#3067, off southeastern Iceland, depth 1729 m (SMNH 55531). (I,J) *Propeamussium lucidum*, BIOICE#2701, off western Iceland, depth 1121 m (SMNH 55517).

Type material

Not searched for by the present authors. Types of Laskey are supposed to be in the Hunterian Museum, Glasgow.

Type locality

Firth of Forth, Scotland.

Distribution

North-eastern Atlantic (70°N–15°N), bathymetric range usually 25–500 m, living on fine silt to sand. A long-lived and frequently cited record from 3.6 m (Forbes & Hanley 1849:293) represents an exception. In Scandinavia it occurs more shallow, from ca. 25–50 m (SMNH). Found at 76 BIOICE stations in 104–1000 m, usually more shallow than 300 m (Map 6).

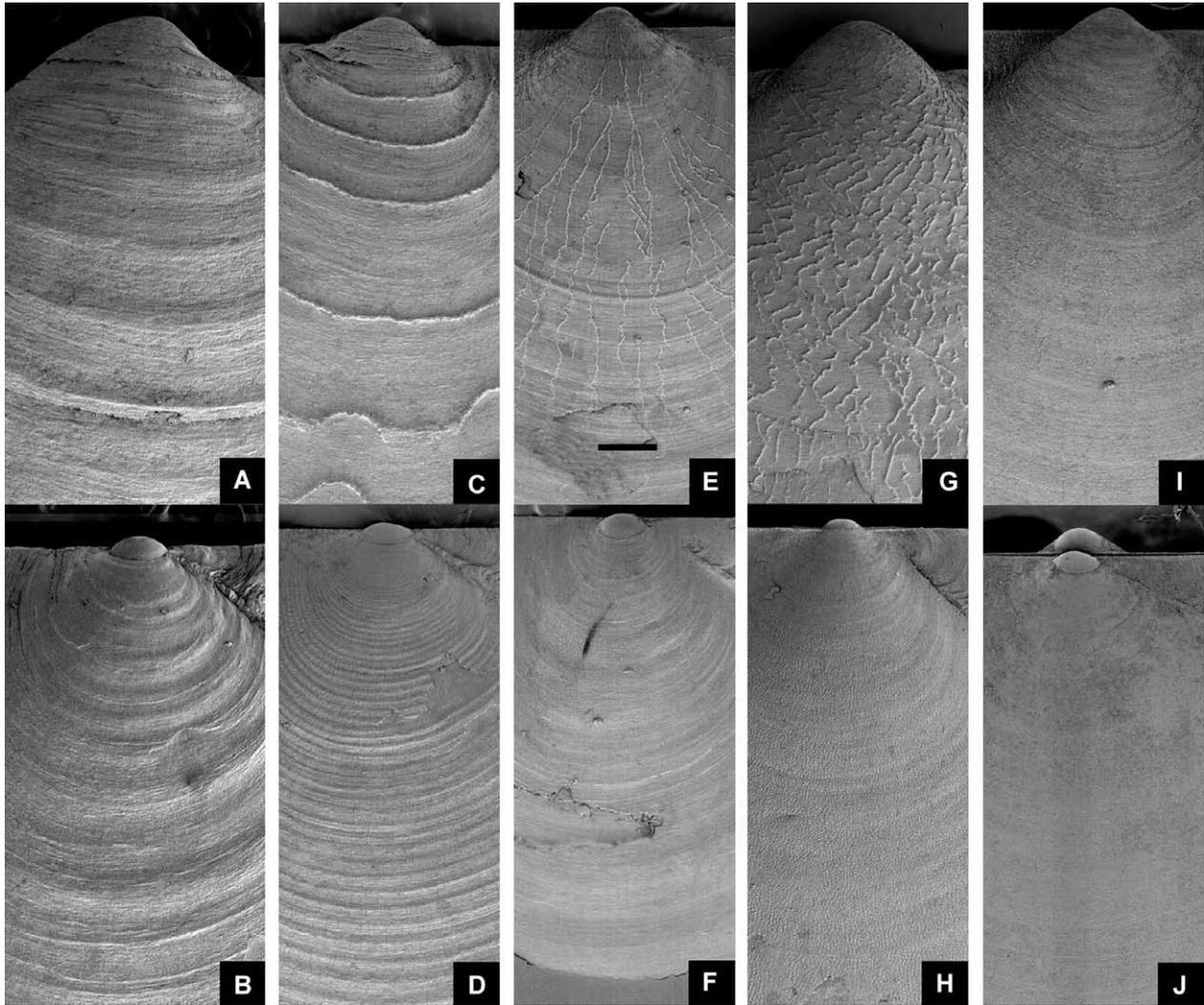


Figure 9. Umbonal area of smooth or radially sculptured Pectinoidea. Left valve above. All at same magnification. Scale line (see Figure E) 250 μ m. (A,B) *Hyalopecten frigidus*, BIOICE#3214, NE of Iceland, depth 3000–3003 m (SMNH 59237). (C,D) *Cyclopecten hoskynsi*, BIOICE#2268, off southwestern Iceland, depth 450 m (SMNH 55534). (E,F) *Similipecten oskarssoni*, BIOICE#2401, off southwestern Iceland, depth 520 m (SMNH 55525). (G,H) *Similipecten greenlandicus*, BIOICE#2047, off northeastern Iceland, depth 272 m (SMNH 55520). (I,J) *Similipecten similis*, BIOICE#2393, off southwestern Iceland, depth 291 m (SMNH 55515).

Description

Shell (Figures 6C, 7A,G–I) up to ca. 7 mm high, weakly convex, right valve slightly more convex than left one, semi-opaque, slightly longer than high; posterior auricles larger and longer than anterior ones; umbonal angle ca. 120. Colour strongly variable whitish, mottled with red and yellowish brown. Prodissoconch (Figure 2C), length 145 μ m, colour white.

Both valves smooth (Figures 9I,J, 10C,D), sometimes weakly sculptured with delicate growth lines. Anterior auricles weakly sculptured with closely spaced commarginal lirae or lamellae; posterior auricles nearly smooth. Hinge line straight, except near the antero-dorsal margin where it is somewhat curved. No internal riblets, except two small

auricular ones (sometimes nearly lacking). Byssal notch small, byssal fasciole very narrow or nearly absent, ctenolium lacking.

Remarks

Juvenile specimens of *Similipecten oskarssoni* could be confused with *S. similis*, but the sculpture of the umbo of the left valve in *oskarssoni* is visible already at a size of 2 mm. For further differences see Table I.

Genus *Catillopecten* Iredale, 1939

Catillopecten eucymatus (Dall, 1898)
(Figures 1C, D, 2G, 4C,D, 8A,B)

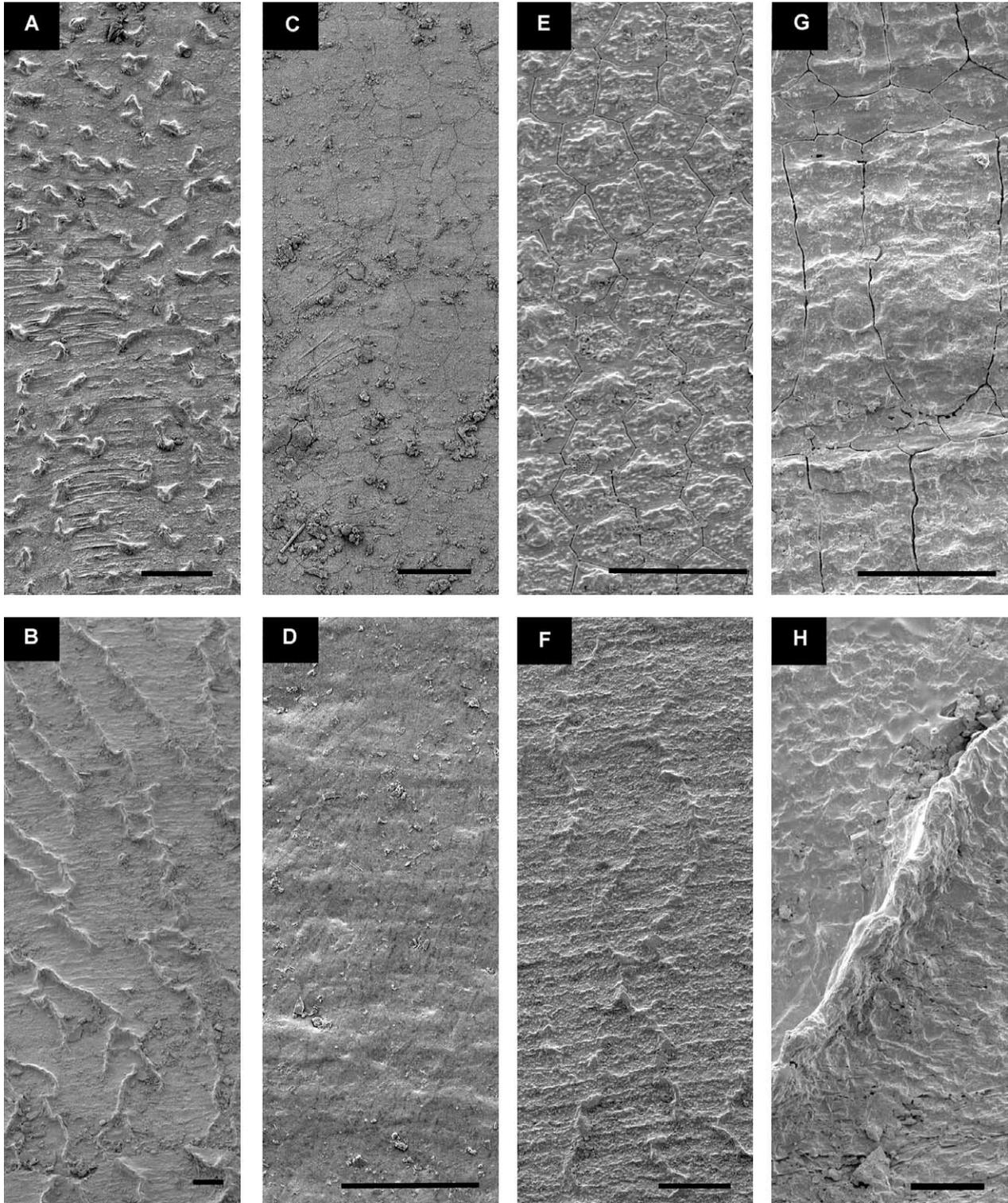


Figure 10. Detail of sculpture, mid-shell of half-grown specimens, A–D, Left valve above, E–H, right valve above. Scale lines 25 μm . (A,B) *Similipecten greenlandicus*, BIOICE#2096, off northern Iceland, depth 300 m (SMNH 56408). (C,D) *Similipecten similis*, BIOICE#2393, off southwestern Iceland, depth 291 m (SMNH 55515). (E,F) *Similipecten oskarsoni*, BIOICE#2401, off southwestern Iceland, depth 520 m (SMNH 55525). (G,H) *Cyclopecten hoskynsi*, BIOICE#2268, off southwestern Iceland, depth 450 m (SMNH 55534).

Pecten fragilis Verrill (1897:81 [not Jeffreys 1876]).
Pecten eucymatus Dall (1898:754 [based on *Pecten fragilis* Verrill 1897, not Jeffreys, 1876]).

Bathypecten eucymatus; Schein (1989:81, pl. 4, figs 1–8, pl. 5, figs 1, 3, 5 [synonymy, description, distribution]).

Table I. Morphologic characters of *Similipecten* spp.

Character/Species	<i>S. oskarssoni</i>	<i>S. similis</i>	<i>S. greenlandicus</i>
Shell	Very fragile	More sturdy	Very fragile
Size height	10 mm	7 mm	10–30 mm
Convexity	Valves flattened	Valves more inflated	Valves flattened
Anterior auricle rv	Less declined	More declined	Less declined
Sculpture of disc lv	Restricted to umbo	Weak commarginal	Weak antimarginal
Sculpture anterior auricle lv	Lacking	Commarginal lamellae	Only growth lines
Shell structure	Glossy, greyish transparent	Semi-opaque, coloured	Dull, greyish semi-transparent

Catillopecten eucymatus; Dijkstra & Gofas (2004:55, fig. 15A–F [references, description, distribution]).

Type material

Syntypes, USNM 35566.

Type locality

Western Atlantic, North Carolina, off Cape Hatteras, 1542 m depth.

Distribution

Northern and temperate western and eastern Atlantic, from off southern Iceland to Cape Hatteras (North Carolina, USA), the Azores, and southwest of Ireland into the Bay of Biscay, living in bathyal to abyssal depths on soft sediments. Depth range 1057–4829 m (Verrill 1897:81; Schein 1989:81). Found at 5 BIOICE stations in 1295–2007 m (Map 7).

Catillopecten eucymatus is new to the Icelandic fauna.

Description

Shell (Figures 1C,D), up to ca. 10 mm high, fragile, translucent, unusually flat, left valve slightly more convex than right valve, circular, almost equilateral, auricles nearly equal in size, anterior auricles somewhat demarcated from disc and posterior auricles continuous with disc, umbonal angle ca. 110°, colour whitish, internal ribs lacking. Prodissoconch (Figure 2G), length 175–180 µm, colour white.

Both valves (Figures 4C,D, 8A,B) smooth with no trace of macro- and micro-sculpture; commarginally undulated, especially central part of left valve; right valve less so. Delicate irregularly spaced, commarginal lamellae on auricles of left valve, somewhat more prominent on anterior one. Commarginal growth lines and very fine commarginal lamellae near ventral margin of right valve. Anterior auricle of right valve with minute commarginal striae, posterior ones smooth. Hinge line straight. Byssal notch moderately deep, byssal fasciole and ctenolium lacking.

Remarks

Dall (1898:754) considered the specimens which Verrill (1897) had identified as *Hyalopecten fragilis* to belong to a distinct species and named them *Pecten eucymatus*.

Catillopecten eucymatus and *Similipecten oskarssoni* are both fragile, strongly flattened, and circular in circumference. *Catillopecten eucymatus* differs, however, by having commarginal undulations (lacking in *S. oskarssoni*) and a smaller and more oblong anterior auricle in the right valve (broader and somewhat curved in *S. oskarssoni*).

Cragg (2006) reported a presence of prodissoconch 2 based on Schein's (1989) plate 5, figure 1, although Schein did not consider the narrow zone surrounding the prodissoconch in the figured specimen a true prodissoconch 2. We consider this narrow zone the normal feature of a lecithotrophic larva mature for metamorphosis.

For a discussion on the generic names *Bathypecten* and *Catillopecten* see Dijkstra and Gofas (2004) and Dijkstra and Marshall (2008).

Family Pectinidae Rafinesque, 1815

Genus *Hyalopecten* Verrill, 1897

Hyalopecten frigidus (Jensen, 1904) (Figures 1K,L, 2A, 5F,G, 9A,B)

Pecten frigidus Jensen (1904:305–07, fig. [original description]); Jensen (1912:33, pl. 1, figs 7a–f [description, distribution]).

Hyalopecten frigidus; Bouchet & Warén (1979:216, figs 31 and 32 [distribution]); Richling (2000:47, fig. 80 [references]).

Type material

Lectotype (here designated), the specimen figured by Jensen (1904:figs; 1912:pl. 1, figs 7a,b,e), ZMC BIV-442. Approximately 300 paralectotypes ('Ingolf' stations 102–105, 110–113, 117–120, 125).

Type locality

Northeast of Iceland, 1847 m depth.

Distribution

North of the Greenland–Scotland Ridge in the lower bathyal and abyssal parts, sometimes attached to shells and other objects (Jensen 1912:33; Bouchet & Warén 1979:216). Found alive in 23 samples NE of Iceland, at 1456–3006 m depth, NE off Iceland (Map 2).

Description

Shell (Figures 1K,L, 5F,G) up to ca. 30 mm high, fragile, opaque, drawn out anteriorly, weakly inflated, higher than long, left valve slightly more convex than right valve, anterior margin more circular than posterior one, anterior auricles slightly larger and longer than posterior ones in young specimens, almost equal in adult specimens, colour whitish. Prodissoconch (Figure 2A), length 220 µm, colour white.

Both valves regularly, commarginally undulated and sculptured with numerous fine, close set radial lirae (Figures 9A,B), somewhat coarser on the left valve. Auricles small, anterior one set off, posterior one continuous with the disc. Hinge line straight. Byssal notch deep, byssal fasciole broad, ctenolium weak.

Remarks

This species closely resembles *Hyalopecten pudicus* (Smith, 1885) from south of the Greenland–Scotland Ridge. *Hyalopecten frigidus* is flatter, has somewhat broader undulations and the radial ribs are weaker, almost absent on the right valve. *Hyalopecten pudicus* also has a reticulate sculpture on the auricles, which have radial striae in *H. frigidus*.

A single fragment of *Hyalopecten pudicus* was recovered by the INGOLF Expedition from a depth of 2050 m, west of Cape Farewell (Greenland, 61° 44'N 30° 29'W; Jensen 1912:38). It can be expected also closer to Iceland and we refer to Dijkstra and Gofas (2004) for description and figures.

Genus *Delectopecten* Stewart, 1930

Delectopecten vitreus (Gmelin, 1791)
(Figures 2J, 4A,B, 5A,D,E, 8G,H)

Ostrea vitrea Gmelin (1791:3328 [based on Chemnitz 1784:pl. 67, fig. 637a] [original description]).

Pecten vitreus var. *laevigata* Lovén (1846:31 [not Goldfuss 1833]). Syntypes, SMNH 4217, 8 v. Type locality Scandinavia.

Pecten vitreus var. *abyssorum* Lovén in Jeffreys (1869:169). Type material not seen (supposed to be in USNM). Type locality: Not given by Jeffreys. *Pecten abyssorum* Lovén in Sars (1878:22, pl. 2, figs 6a–c [figs and distribution]).

Pseudamussium gelatinosum Mabilite & Rochebrune (1889:H–126). Type material not searched for (supposed to be in MNHN). Type locality: 'Baie Orange' [Orange Bay, Beagle Channel, Tierra del Fuego].

Pecten chaperi Dautzenberg & H. Fischer (1897:190, pl. 5, figs 5–8). Syntypes, MOM 28 148–9. Type locality: Azores, 845–1600 m depth.

Cyclopecten (Delectopecten) vitreus; Grau (1959:47, pl. 18, fig. [synonymy]).

Delectopecten vitreus; Abbott (1974:446); Lucas (1979:9, 10, 18, figs); Wagner (1991:13, text fig. 5 [synonymy, references]); Dijkstra & Kilburn (2001:270, figs 3 and 4); Dijkstra & Goud (2002:48, figs 42–44 [description, distribution]); Dijkstra & Gofas (2004:59, fig. 18A–I [synonymy, references, distribution]).

Delectopecten vitreus var. *abyssorum* (Lovén); Schein (1989:75, pl. 2, figs 1–6).

Type material

Syntypes, ZMC BIV 54–55.

Type locality

'Oceano septentrionali' [North Atlantic Ocean].

Distribution

Atlantic Ocean, from north of Norway, 72°10'N (SMNH 56311) around Iceland, and the Labrador Sea, to the Antarctic; in Scandinavia more shallow, ca. 50–1000 m (SMNH), further south deeper, from 322 m (east of Gibraltar) to 4255 m (near the Azores, Schein 1989). The only littoral–sublittoral record from Greenland, 'off Sukkertoppen' (Posselt & Jensen 1898) is based on a misidentification of *Palliolium striatum* (SMNH 56310). Off the Icelandic northern coast *Delectopecten vitreus* is not found deeper than ca. 200 m, while in the south it occurred down to 1952 m. *Delectopecten vitreus* seems to prefer current-swept bottoms and is often attached to dead skeletons of gorgonians and scleractinia. *Delectopecten vitreus* is often inhabited by the large parasitic foraminiferid *Hyrrokin sarcophaga* Cedhagen, 1994, which penetrates the shell and sends pseudopodia into the host tissues. Found at 59 BIOICE stations in 165–1952 m (Map 8), mainly S and W of Iceland.

Description

Shell (Figures 5A,D,E) up to ca. 20 mm high, transparent to opaque, circular to somewhat oval in shape, valves nearly equiconvex, anterior auricles slightly larger than posterior ones, nearly equal in length, umbonal angle 110° , colour whitish. Prodissoconch 1 (Figure 2J), length $100\ \mu\text{m}$, prodissoconch 2, length $315\ \mu\text{m}$, colour white or brown.

Both valves (Figures 4A,B, 8G,H) may be smooth (var. *abyssorum*) or, more commonly, covered with antimarginal micro-sculpture (*Palliolium*-like) and commarginal rows of small vesicles. When commarginal scales are damaged, minute commarginal ridges are formed by their bases. Posterior auricles continuous with disc and similarly sculptured as disc. Anterior auricle of right valve demarcated from disc and sculptured with 3–5 radial riblets. Hinge line straight. Byssal notch well-developed, byssal fasciole rather broad. Active ctenolium well-developed.

Remarks

Delectopecten vitreus is variable in convexity and in sculpture, sometimes nearly smooth; sometimes with prominent, concentrically arranged scales. The specimens from Iceland are usually smooth and transparent, occasionally with a radial micro-sculpture.

Pecten vitreus var. *abyssorum* and *Chlamys chaperi* are based on sculptural variations for which we have failed to see any geographic pattern and we believe it to be phenotypic variations. *Pseudamussium gelatinosum* Mabile & Rochebrune, 1889 (from off southern Argentina) was synonymized by Grau (1959:48) and we cannot question this from morphological evidence. HD has also examined indistinguishable specimens from off Namibia. Such a wide distribution is, however, exceptional and suggests that more than one species may be involved, especially since the distribution seems not to be continuous.

Genus *Palliolium* Monterosato, 1884

***Palliolium striatum* (Müller, 1776)**
(Figures 11C,D, 13G, 14E,F, 15E,F, 16E,F)

Pecten striatus Müller (1776:248 [original description]); Müller (1788:26, pl. 60, figs 3–5 [subsequent description]). *Pecten striatus* Müller; Jensen (1912:24 [Icelandic distribution]); Madsen (1949:34 [Icelandic distribution]).

Palliolium striatum (Müller); Abbott (1974:446, fig. 5165); Wagner (1991:9, text fig. 3, pl. 2, figs 2, 4 [synonymy, references]).

Type material

Probably lost (not in ZMC, T. Schiøtte, personal communication).

Type locality

Although Müller (1776) did not indicate a locality for this species, it is most likely that the type material was collected from the Oslofjord (Norway), at that time belonging to Denmark (see Soot-Ryen 1963:111).

Distribution

North-western Atlantic from Newfoundland southwards to Massachusetts (USA), and north-eastern Atlantic from Hammerfest in Norway at 70.6°N , southwards into the Mediterranean Sea. A single record from south-western Greenland (Sukkertoppen, 27–36 m, 23 Sept 1870, SMNH 56310) earlier identified as *Delectopecten vitreus* (Posselt & Jensen 1898, see *D. vitreus*) must be considered uncertain although the label seems to be in order. All around Iceland, except the eastern and south-eastern coasts. Living in 25–400 m (HL), on coarse sediments, gravel, and shells, byssally attached to hard substrates. Found during BIOICE at a single station in 139–141 m (Map 4).

Description

Shell (Figures 15E,F, 16E,F) up to ca. 25 mm high (usually smaller), thin, flattened, circular to more oval in shape, nearly equiconvex, slightly higher than long, anterior auricles larger and longer than posterior ones, umbonal angle ca. 95° , colour strongly variable with blotches or streaks. Prodissoconch 1, length $90\ \mu\text{m}$, prodissoconch 2, length $215\ \mu\text{m}$ (Figure 13G), colour brown.

Left valve (Figures 11C,D) covered with a coarsely granular antimarginal micro-sculpture and numerous, regularly spaced, scaly riblets (up to ca. 70). Anterior (large) and posterior (small) auricles indistinctly demarcated from disc, with similar micro-sculpture and 4–7 radial riblets.

Right valve with a more delicate antimarginal micro-sculpture and 3–5 anterior and posterior radial riblets. Auricles of similar sculpture, anterior ones with 7–10, posterior ones with 3–5 radial riblets. Hinge line nearly straight, somewhat raised laterally. Byssal notch deep, byssal fasciole broad. Active ctenolium well-developed with 5–7 teeth along suture.

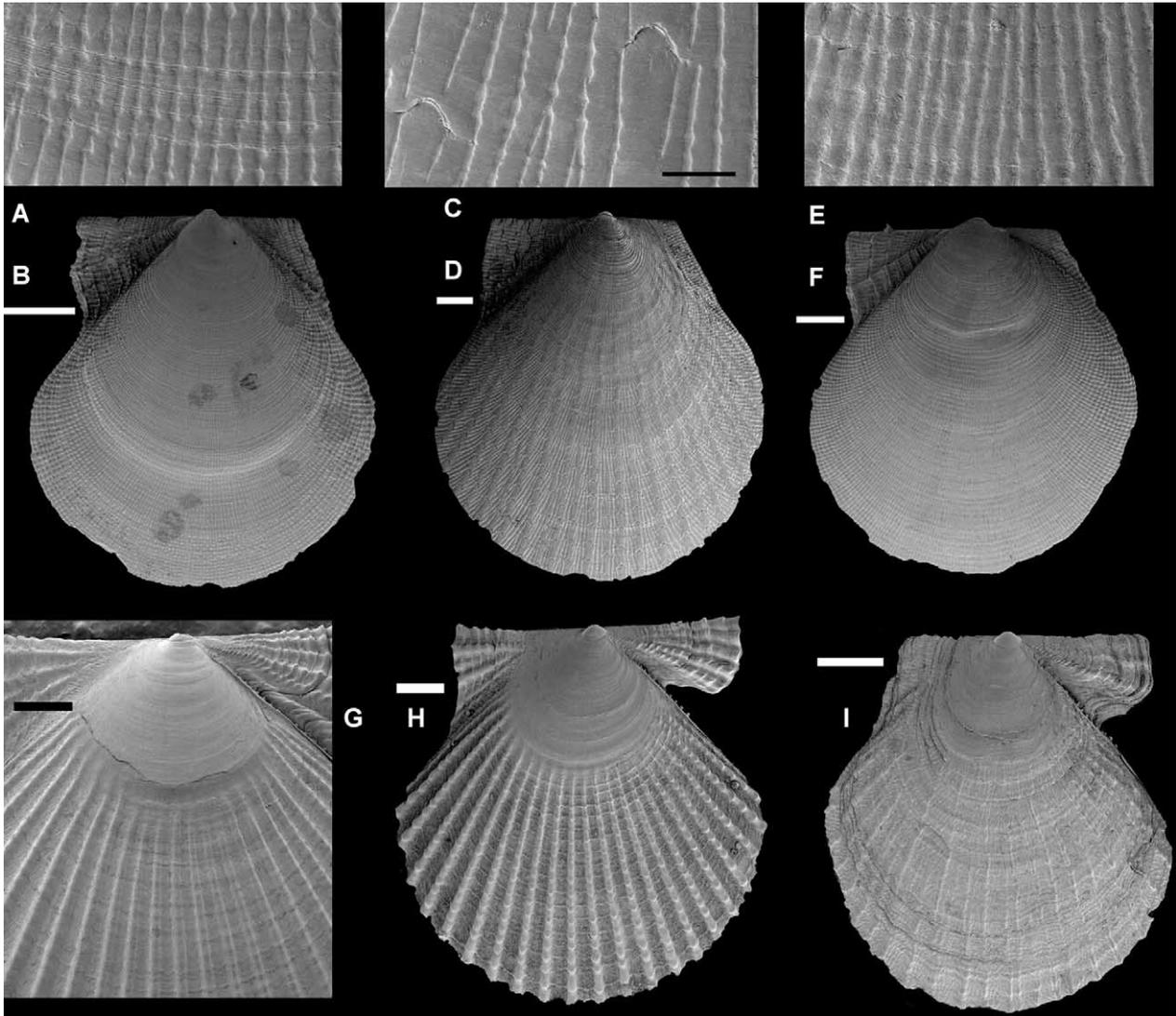


Figure 11. Young specimens of Pectinidae. Scale lines A, C, E, 50 μm , others 500 μm . (A,B) *Palliolium incomparabile*, Sweden, Bohuslän, Koster area, depth 35 m (SMNH 55523). (C,D) *Palliolium striatum*, western Norway, Korsfjord, depth 300–200 m (SMNH 19999). (E,F) *Palliolium tigrinum*, western Norway, Raunefjord, depth 65–70 m (SMNH 20064). (G) *Aequipecten opercularis*, western Norway, Raunefjord, depth 12–7 m (SMNH 20511). (H) *Aequipecten opercularis*, Italy, Sicily, Brucoli, depth 20 m (SMNH 56412). (I) *Chlamys islandica*, BIOICE#2537, off northwestern Iceland, depth 44 m (SMNH 55503).

Remarks

Juveniles (< 4 mm) (Figures 14E,F) may easily be confused with juveniles of *Palliolium incomparabile* (Risso 1826). However, *P. striatum* has small, radially arranged scales on the left valve, whereas *P. incomparabile* (Figures 14C,D) has a more uniform and delicate antimarginal sculpture on both valves. The small scales appear at a size around 1.5 mm, but at this size, only their bases are developed. The right valves of the two species can hardly be distinguished, even in adult specimens. Also *P. tigrinum* may be very similar, but its radial micro-sculpture is usually slightly stronger, also before the radial ribs appear.

Icelandic specimens agree well with topotype material (ZMO, SMNH) from the Oslofjord. To find only a single specimen in the BIOICE material is surprising since the species is not rare in private collections; perhaps it has a more shallow distribution than the BIOICE dredgings.

Palliolium incomparabile (Risso, 1826) (= *Palliolium furtivum* (Lovén, 1846)) is not known from Iceland or the Faroes, but occurs from ca. 69°N in Norway (Brattegard & Holthe 1997) and southwards along the European coast in 20–300 m depth (Dijkstra & Goud 2002, SMNH). It is figured (Figures 11A,B, 13I, 14C,D, 15C,D, 16C,D) for comparison.

Palliolium tigerinum (Müller, 1776)
(Figures 11E,F, 13H, 14A,B, 15A,B, 16A,B)

Pecten tigerinus Müller (1776:248 [original description]); Müller (1788:26, pl. 60, figs 6–8 [subsequent description]).

Pecten triradiatus Müller (1776:248 [original description]); Müller (1788:25, pl. 60, figs 1, 2 [subsequent description]); Soot-Ryen (1963:111, pl. 13, upper and lower figs). Type material: Probably lost (not in ZMC, T. Schiøtte, personal communication). Type locality: Oslofjord (see also *P. striatum*).

Pecten tigerinus; Jensen (1912:22 [Icelandic distribution]); Madsen (1949:34 [Icelandic distribution]); Oskarsson (1982:51, fig. 32 [Icelandic distribution]). *Palliolium tigerinus*; Wagner (1991:10, text fig. 4, pl. 2, fig. 5 [references, synonymy, description, distribution]).

Type material

Probably lost (not in ZMC, T. Schiøtte, personal communication).

Type locality

See *Palliolium striatum*.

Distribution

Eastern Atlantic, from northern, western, southern and south-eastern Iceland and all the Norwegian coast (absent in the White Sea) southwards into the Mediterranean and to the Cape Verde Islands. It normally occurs in 20–400 m depth on muddy, sandy or rocky bottoms (SMNH). Found during BIOICE at 16 stations in 64–356 m, but the general distribution is more shallow than these finds indicate (HL).

Description

Shell (Figures 15A,B, 16A,B) up to ca. 30 mm high, rather sturdy, higher than long, equivalve and equilateral, anterior auricles much larger and longer than posterior ones, left valve somewhat more convex than right one, umbonal angle ca. 85°. Colour usually based on purplish brown, often mottled with red, white, and yellow, but also pure yellow, white or red specimens occur. Prodissoconch 1, length 100 µm, prodissoconch 2, length 265 µm (Figure 13H), colour brown.

Both valves (Figures 11E,F) sculptured with anti-marginal micro-sculpture and radial macro-sculpture of up to ca. 80, sometimes weak or even lacking riblets. Auricles with radial ribs (anteriorly 4–5,

posteriorly 5–8). Byssal notch shallow, byssal fasciole narrow. Active ctenolium well-developed.

Remarks

Icelandic specimens are similar to Norwegian ones (SMNH, ZMC), where radially sculptured specimens dominate, including the more unusual variant *triradiatus* (with three prominent radial ridges), contrasting specimens from the Irish Sea (HD, ZMA), which are smooth. Mature shells are sometimes swollen, with a distinct increase in convexity close to the margin. All these variations have been observed from Iceland.

Palliolium tigerinum may be difficult to separate, especially when young (Figures 14 A,B), from *P. striatum* (Figures 14C,D) and *P. incomparabile* (Figures 14E,F). Helpful features are that the anterior auricle has a much stronger cancellate sculpture (in addition to the regular micro-striae covering the shell) and the posterior ear is disproportionately short. The height of the shell more distinctly exceeds its length, than in *striatum* and *incomparabile*.

Genus *Pseudamussium* Mörch, 1853

Pseudamussium peslutrae (Linnaeus, 1771)
(Figures 12H, 13B, 17C,D, 18E,F)

Ostrea peslutrae Linnaeus (1771:547); Dijkstra (1999:427, figs 7E,F [lectotype]).

Pecten septemradiatus Müller, 1776; Jensen (1912:20, pl. 1, figs 6a–c [var. *scaber*] [distribution]); Madsen (1949:33 [distribution]).

Pseudamussium septemradiatum; Wagner (1991:14, pl. 3 fig. 1, text-fig. 6 [synonymy, references]).

Pseudamussium peslutrae; Dijkstra & Goud (2002:53, fig. 50 [description, distribution]).

Type material

Lectotype, LSL, designated by Dijkstra (1999:427).

Type locality

Off Largs, Ayrshire, Scotland (Dijkstra 1999).

Distribution

The eastern Atlantic from western, southern and south-eastern Iceland and the whole Norwegian coast (absent in the White Sea) to Morocco, and into the western Mediterranean Sea, living sublittorally to bathyally, on fine sediments. Depth range usually 50–500 m, occasionally recorded much

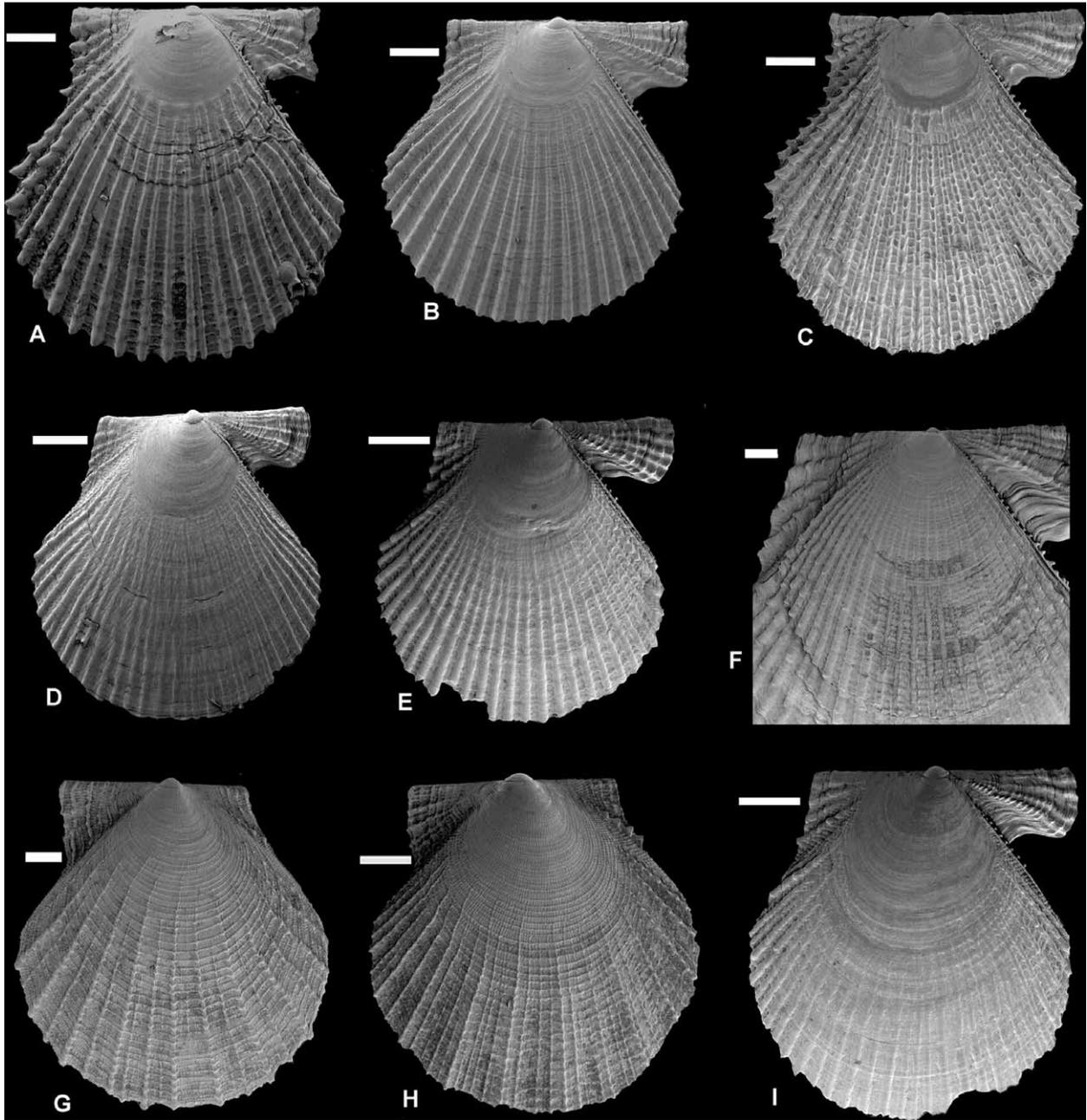


Figure 12. Young specimens of Pectinidae. Scale lines 0.5 mm. (A) *Talochlamys pusio*, Strait of Gibraltar, Ceuta, depth 20–40 m, (SMNH 59345). (B) *Talochlamys pusio*, Acores, Sao Miguel, depth 15–22 m (SMNH 59346). (C) *Talochlamys pusio*, western Norway, Korsfjord, 276–256 m (SMNH 55505). (D) *Talochlamys multistriata*, Strait of Gibraltar, Ceuta, depth 9–10 m (SMNH 56215). (E) *Talochlamys multistriata*, Strait of Gibraltar, Ceuta, depth 16–25 m (SMNH 57226). (F) *Mimachlamys varia*, Sweden, Bohuslän, Gullmarsfjord (SMNH 54319). (G) *Pseudamussium sulcatum*, western Norway, Korsfjord, depth 260–250 m (SMNH 20130). (H) *Pseudamussium peslutrae*, BIOICE#2393, off southwestern Iceland, depth 291 m (SMNH 55502). (I) *Mimachlamys varia*, Strait of Gibraltar, Ceuta, depth 16–25 m (SMNH 20577).

deeper (mostly empty shells). BIOICE material alive from 35 stations in 146–993 m (Map 3).

Description

Shell (Figures 18E,F) up to ca. 65 mm high, rather thin, right valve slightly more convex than left one, almost circular, auricles nearly equal in size, umbonal

angle ca. 95°. Colour reddish-brownish, mottled with darker or lighter shades; right (lower) valve paler, interior glossy white. Prodissoconch 1, length 100 µm, prodissoconch 2, length 320 µm (Figure 13B), colour brown.

Both valves (Figure 18E,F) with 5–10 equidistant radial plicae, on right valve broader than on left one; secondary radial scaly riblets (sometimes lacking),

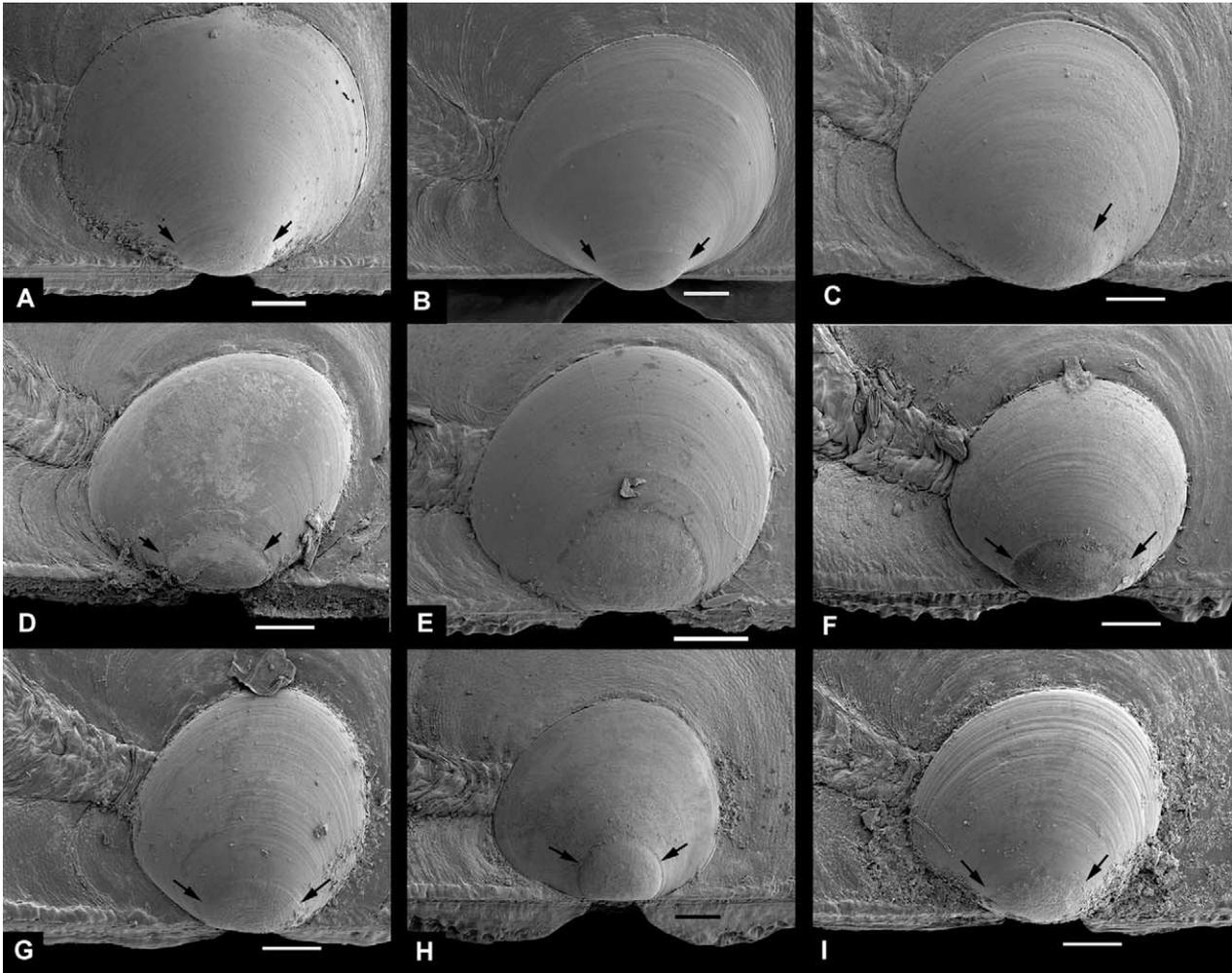


Figure 13. Larval right valves. Scale lines 50 μ m. Arrows indicate demarcation of prodissoconch 1. The scale line is valid for length only; the height may differ slightly because of tilt. (A) *Pseudamussium sulcatum*, western Norway, Korsfjord, depth 260–250 m (SMNH 20130). (B) *Pseudamussium peslutrae*, BIOICE#2393, off southwestern Iceland (SMNH 55502). (C) *Chlamys islandica*, 55503, BIOICE#2537, off northwestern Iceland (SMNH 55503). (D) *Aequipecten opercularis*, Italy, Sicily, Brucoli, depth 20 m (SMNH 56412). (E) *Mimachlamys varia*, Sweden, Bohuslän, Koster area, depth 1–2 m (SMNH 20569). Prodissoconch 1 too corroded to indicate. (F) *Talochlamys pusio*, western Norway, Korsfjord, depth 276–256 m (SMNH 55505). (G) *Palliolium striatum*, western Norway, Korsfjord, depth 300–200 m (SMNH 19999). (H) *Palliolium tigrinum*, western Norway, Raunefjord, depth 65–70 m (SMNH 20064). (I) *Palliolium incomparabile*, Sweden, Bohuslän, Koster area, depth 35 m (SMNH 55523).

and microscopic radial striae cover all surface; micro-sculpture of incremental lamellae in early growth stage. Auricles short, anterior ones slightly longer than posterior ones, with radial ridges and dorsal scales; antimarginal microsculpture weak or lacking. Hinge line straight. Byssal notch and active ctenolium weakly developed.

Remarks

Pseudamussium peslutrae is rather variable in form, macro- and micro-sculpture. Specimens from the boreal region are larger (up to ca. 65 mm high) and more sharply sculptured than those from further south, which have an evenly undulated shell, rather

than groups of ribs forming a ‘mega-sculpture’. Young specimens (Figures 12H, 17A,B) closely resemble *P. sulcatum* (Figures 12G, 17C,D), which is more coarsely sculptured, but safe identification needs access to a good growth series.

Pseudamussium sulcatum (Müller, 1776) (Figures 12G, 13A, 17A,B, 18A–D)

Pecten sulcatus Müller (1776:248 [original description]).

Ostrea arata Gmelin (1791:3327). Based on Müller’s (1776) description and takes the same type locality and type material.

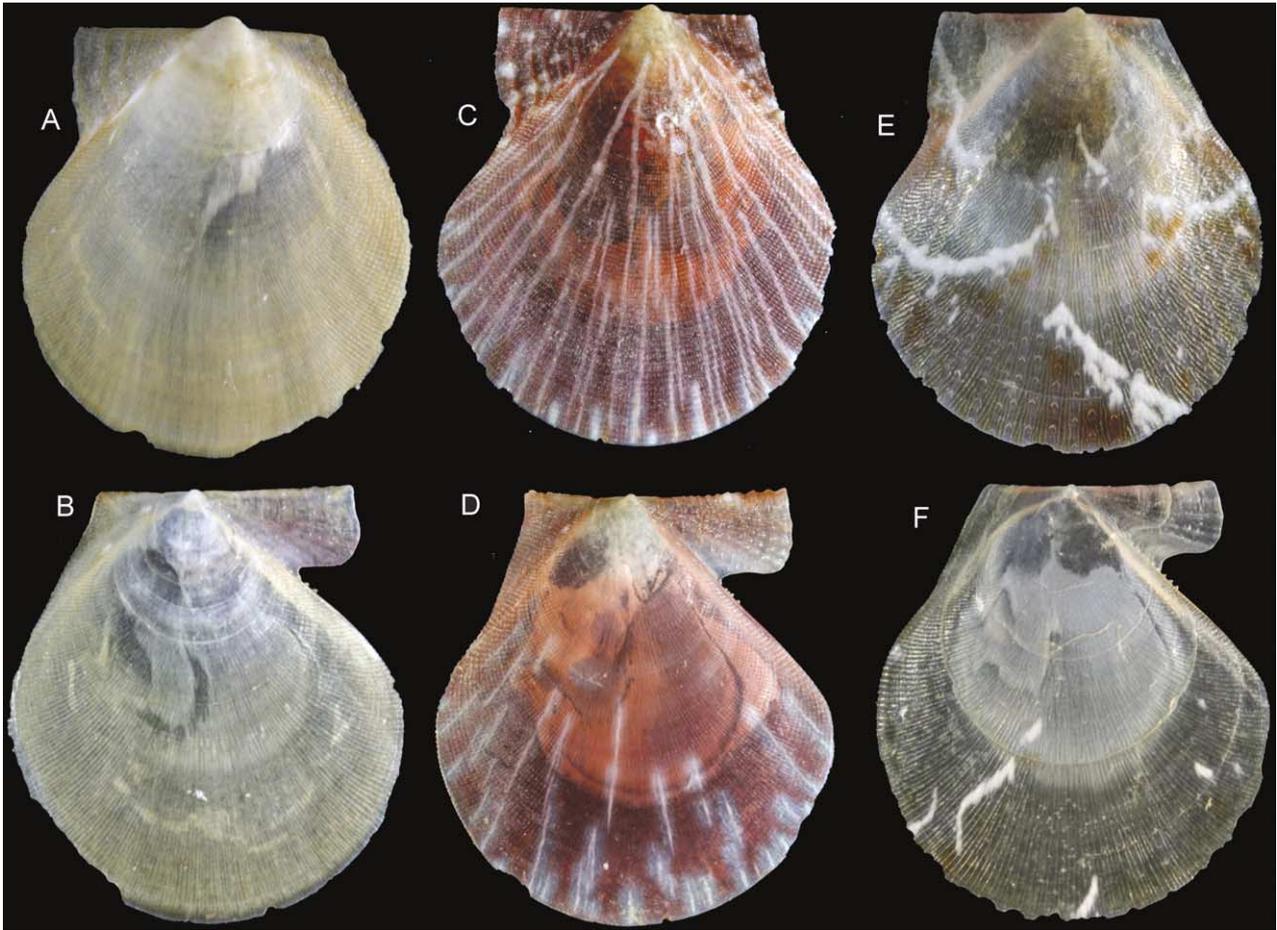


Figure 14. *Palliolum* spp., young specimens. (A,B) *P. tigrinum*, Ø 4.0 mm, western Norway, Raunefjord, depth 65–70 m (SMNH 20064). (C,D) *P. incomparabile*, Ø 5.0 mm, Sweden, Bohuslän, Gullmarsfjord (SMNH 55958). (E,F) *P. striatum*, Ø 5.2 mm, western Norway, Korsfjord, depth 300–200 m (SMNH 19999).

Pecten bruei Payraudeau (1826:78, figs 10–14). Type material: Syntypes, MNHN [no register number]. Type locality: ‘Les golfes de Sagone, d’Ajaccio, de Valinco, de Porto-Vecchio’ (Corsica).

Pecten idaeus Reeve (1853:species 153 [unpaginated], pl.33, fig. 153). Type material: Holotype, BMNH 19990407. Type locality: Unknown.

Pecten aratus; Jensen (1912:19, pl. 1, figs 5a–e [Icelandic distribution]); Madsen (1949:32 [distribution]).

Karnekampia sulcata; Wagner (1988:41, 43 fig. 2); Wagner (1991:19, pl. 3, fig. 4, text-fig. 9 [synonymy, references]); Waller (2006:17).

Pseudamussium sulcatum; Waller (1991:18, 35); Dijkstra & Goud (2002:57, fig. 54 [description, distribution]); Dijkstra & Gofas (2004:62, fig. 19A–D [synonymy, distribution])

Type material

Pecten sulcatus: probably lost, not traced in ZMC (T. Schiøtte, personal communication).

Type locality

See *Palliolum striatum*.

Distribution

The eastern Atlantic, all around Iceland (except the north-eastern coast, HL), the Norwegian coast from Andfjorden (69°10’N; SMNH), southwards to the Madeira Archipelago, and into the Mediterranean Sea. It lives in sublittoral to upper bathyal depths on current-swept bottoms, byssally attached to rocks or amongst gravel and/or rubble. It is one of the most common bivalves on North-east Atlantic *Lophelia* reefs, where it lives attached to coral debris. BIOICE material alive at 31 stations in 98–922 m (Map 4).

Description

Shell (Figures 18A–D) up to ca. 30 mm high, weakly convex, left valve somewhat more convex than right one, slightly higher than long, anterior auricles much larger and longer than posterior ones, umbonal angle ca.

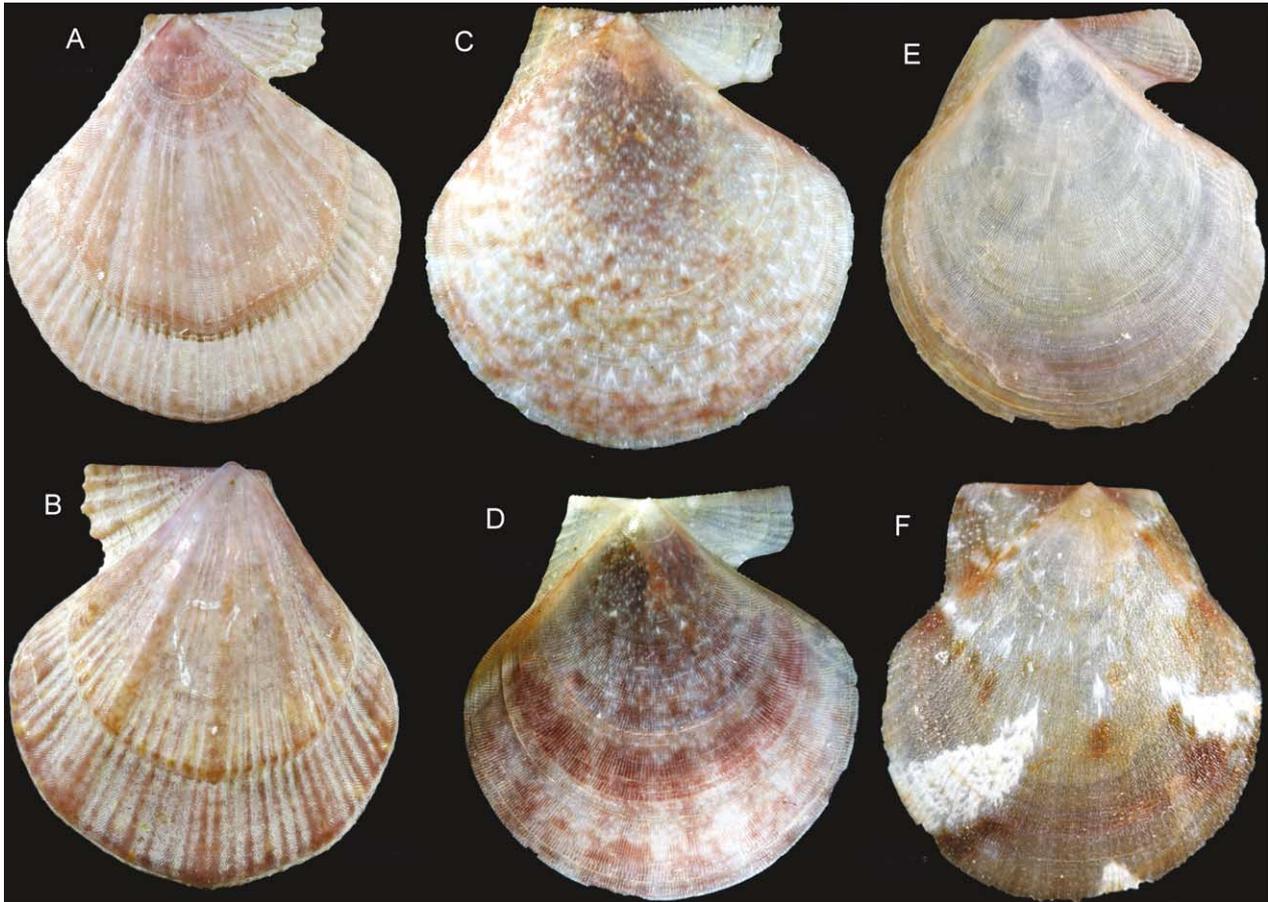


Figure 15. *Palliolium* spp., adult specimens. (A,B) *P. tigrinum*, Ø 18.9 mm, off southeastern Iceland, 63° 54' N, 15° 11.5' W, 134 m (IMNH 8670, SMNH 55496). (C,D) *P. incomparabile*, Ø 14.6 and 13.4 mm, Sweden, Bohuslän, Koster area (SMNH 55497). (E,F) *P. striatum*, Ø 12.3 mm, BIOICE#2388, off southwestern Iceland, depth 171 m (SMNH 55508).

90°, colour variable, usually uniform deep red, orange, yellow or rarely white, occasionally with commarginal stripes. Prodissoconch 1, length 110 µm, prodissoconch 2, length 310 µm (Figure 13A), colour white.

Left valve (Figures 18A,C) sculptured with 15–40, irregularly spaced, primary ribs, often hollow sometimes more solid, with tubercles, spines or lamellae. Intercalated secondary radial riblets commence on central part of disc. Primary and secondary ribs sometimes of almost equal size and spacing.

Right valve (Figures 18B,D) with clustered or equally spaced ribs. Antimarginal micro-sculpture present laterally and on auricles, absent from anterior auricle of right valve. Auricles with 3–6 radial riblets and commarginal riblets in early growth stage on anterior auricle of left valve. Hinge line straight. Byssal notch moderately deep, byssal fasciole broad. Active ctenolium well-developed with 4–6 teeth.

Remarks

Jensen (1912) and Madsen (1949) recorded *Pseudamussium sulcatum* from Iceland under the absolute synonymous name *Pecten aratus*.

Pecten bruei was based on Mediterranean specimens with more developed groups of ribs. This form intergrades with Atlantic *sulcata*, and we can see no possibility to separate them morphologically (see Dijkstra & Gofas 2004). For separation from *P. peslutrae*, see that species.

Genus *Chlamys* Röding, 1798

Chlamys islandica (Müller, 1776)
(Figures 11I, 13C, 19A,B, 20D,E)

Pecten islandicus Müller (1776:248 [original description]).

Chlamys islandica; Abbott (1974:444, pl. 19, fig. 5147); Wagner (1991:25, text fig. 13, pl. 4, figs 1–3 [synonymy, references, description]).

Type material

Probably lost, not in ZMC (T. Schiøtte, personal communication).



Figure 16. *Palliolium* spp., adult specimens. (A,B) *P. tigrinum*, Ø 12.3 mm, BIOICE#2710, off western Iceland, depth 220 m (SMNH 55507). (C,D) *P. incomparabile*, Ø 14.6 and 13.4 mm, Sweden, Bohuslän, Koster area (SMNH 55497). (E,F) *P. striatum*, Ø 18.2 mm, Sweden, Bohuslän, Koster area (SMNH 55494).

Type locality

Iceland.

Distribution

Circumpolar except Beaufort Sea, Chukchi Sea and the entrance of Bering Strait (not in the North Pacific). In the north-eastern Atlantic it reaches southwards to ca. 69°N in Norway, the Faeroes, all of Iceland and Greenland. In the western Atlantic it reaches Massachusetts. In Norway there are scattered more southern relict pockets, south to the Bergen area, a reminiscence of its more southern distribution during the glaciation. *Chlamys islandica* lives in littoral to uppermost bathyal depths, byssally attached to gravel, stones and rocks. All around Iceland, except the south-eastern coast. BIOICE material alive from 20 stations in 19–327 m (Map 9), but the large populations occur in 50–300 m depth off eastern and western Iceland (HL).

Description

Shell (Figures 20D,E) up to at least 140 mm high, but generally smaller than 90 mm, sturdy, elongate to nearly circular; weakly inflated, of almost the same convexity, anterior auricles much larger and longer than posterior ones, umbonal angle ca. 82–90°. Colour highly variable, orange-red (common), pink, yellow, purple, brown or white (rare), sometimes with patterns of concentric coloured bands, often with 3 or 5 light radiating streaks. Prodissoconch 1, length 100 µm, prodissoconch 2, length 250 µm (Figure 13C), colour white.

Both valves sculptured with numerous irregularly spaced, small scaly radial riblets of variable prominence; usually 5 ribs are distinctly stronger. At 2 mm shell height ca. 20 ribs commence and extend to the ventral margin, increasing with intercostal riblets to ca. 140 in adult specimens. Right valve with 10–15 riblets less than left valve. A shagreen micro-sculpture is usually present at a size of 5–40 mm.

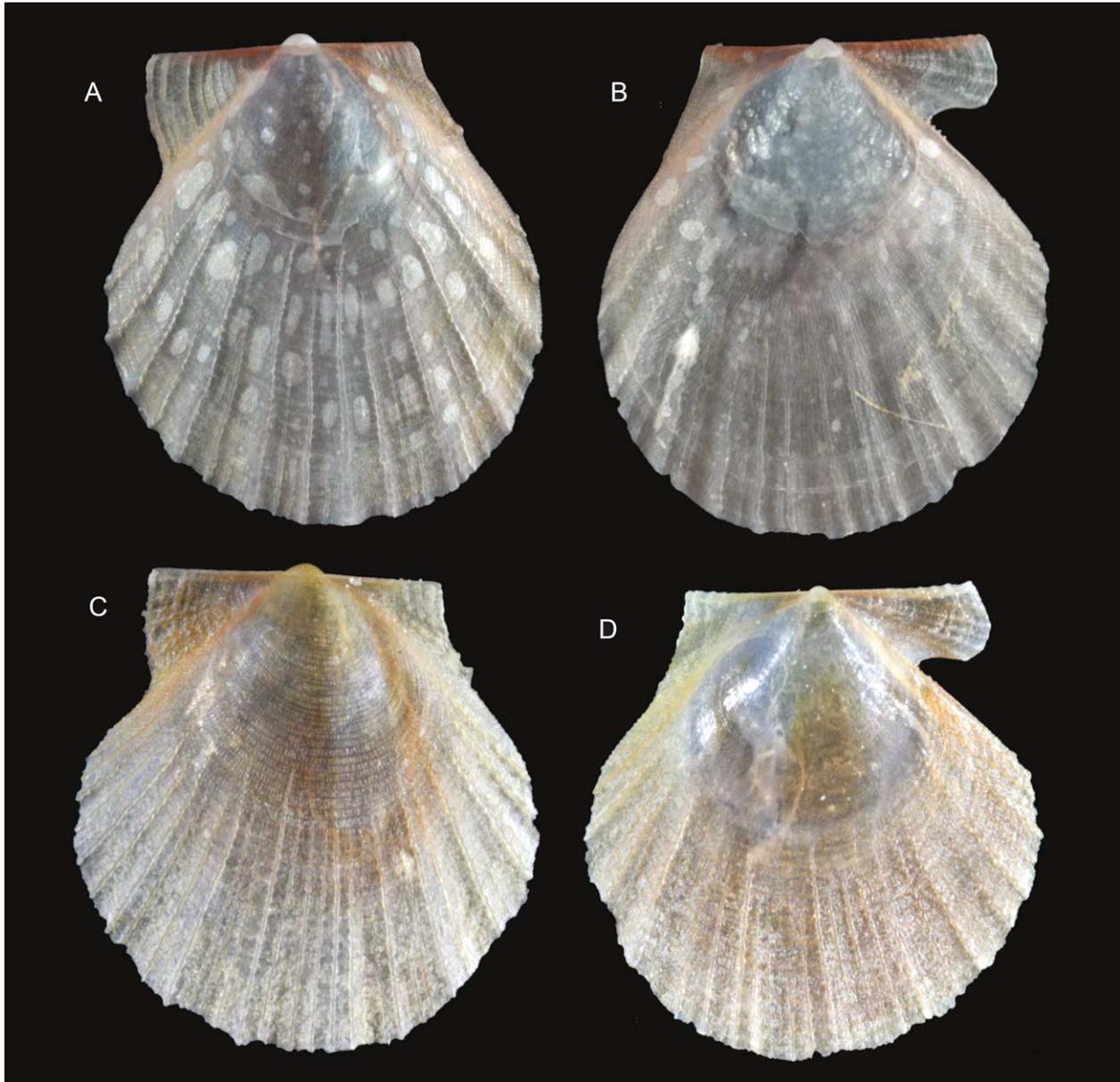


Figure 17. *Pseudamussium* spp., young specimens. (A,B) *P. sulcatum*, Ø 4.0 mm, western Norway, Korsfjord, depth 260–250 m (SMNH 20130). (C,D) *P. peslutrae*, Ø 3.8 mm, BIOICE#2393, off southwestern Iceland, depth 291 m (SMNH 55502).

Anterior auricles with ca. 12 scaly radial riblets in left valve; the ribs are weaker and fewer (4–6) on the right valve. Posterior auricles with ca. 12 weak radial riblets on left valve, ca. 10 on right valve. Hinge line straight. Byssal notch moderately deep; byssal fasciole rather broad. Active ctenolium well-developed with 4–6 teeth.

Remarks

Chlamys islandica is a highly variable species. The shape varies from much higher than long to nearly circular, sometimes weakly undulated radially; the sculpture from delicate to coarse with single or

clustered ribs; the shagreen microsculpture may occur all over the shell or is only developed in early growth stages. Maximum size in Iceland ca. 125 mm, but unconfirmed reports indicate a diameter exceeding 145 mm in Labrador (Nain).

Small specimens (Figures 11I, 19A,B) may resemble *Mimachlamys varia* (not present in Iceland), but that species (Figures 12F, 13E, 19C,D, 20F–I) has more numerous ribs when young. Large specimens of *M. varia* have fewer ribs and lack the shagreen sculpture present in *C. islandica*.

Mimachlamys varia is known in Norway from Lofoten (ca. 68°N) and southwards (Brattegard & Holthe 1997, SMNH).



Figure 18. *Pseudamussium* spp. (A,B) *P. sulcatum*, Ø 25 mm, BIOICE#2305, off southwestern Iceland, depth 406 m (SMNH 55524). (C,D) *P. sulcatum*, Ø 16 mm, western Norway, Hjeltefjord, depth 100–180 m (SMNH 20143). (E,F) *P. peslutrae*, Ø 18.8 mm, Sweden, Bohuslän, Koster area (SMNH 55495).

Chlamys islandica is the subject of commercial fishery in Iceland and Norway, and has a delicious taste. In 1987 the Norwegian fishery peaked at 45,000–50,000 tons, but due to over-fishing it dropped abruptly. It is now strictly regulated and all fields are closed at present. The fishery in Iceland has dropped from 17,000 tons in 1984, to ca. 6000 tons in 2002. Rearing of larvae and artificial habitats are being explored in Norway.

Genus *Talochlamys* Iredale, 1929

Talochlamys pusio (Linnaeus, 1758)
(Figures 12A–C, 13F, 19E,F, 20A–C)

Ostrea pusio Linnaeus (1758:698, no. 169 [original description]); Dijkstra (1999:417, figs 4c–f [synonymy]).

Hinnites (Hinnites) distortus; Wagner (1991:32, text-fig. 17 [synonymy, references]).

Crassadoma pusio; Waller (1993:215, figs 5b,e,h,k,l [type data]).

Talochlamys pusio; Dijkstra & Goud (2002:69, figs 73 and 74 [distribution]).

Type material

Lectotype in LSL, designated by Waller (1993:215). See also Dijkstra (1999:418–19).

Type locality

‘*O. australiore*’. Waller (1993:215) designated a slightly more precise locality: ‘North-eastern Atlantic’.

Distribution

Northern to tropical eastern Atlantic from southwestern Iceland and northern Norway (69.5°N, Høisæter 1986) southwards to the Ivory Coast (Waller 1993:216), also occurring in the western Mediterranean Sea and the Azores (Dijkstra & Goud 2002:69). It is very rare in the Skagerrak, common throughout the British Isles, the Channel Islands and Azores, rare in the western Mediterranean

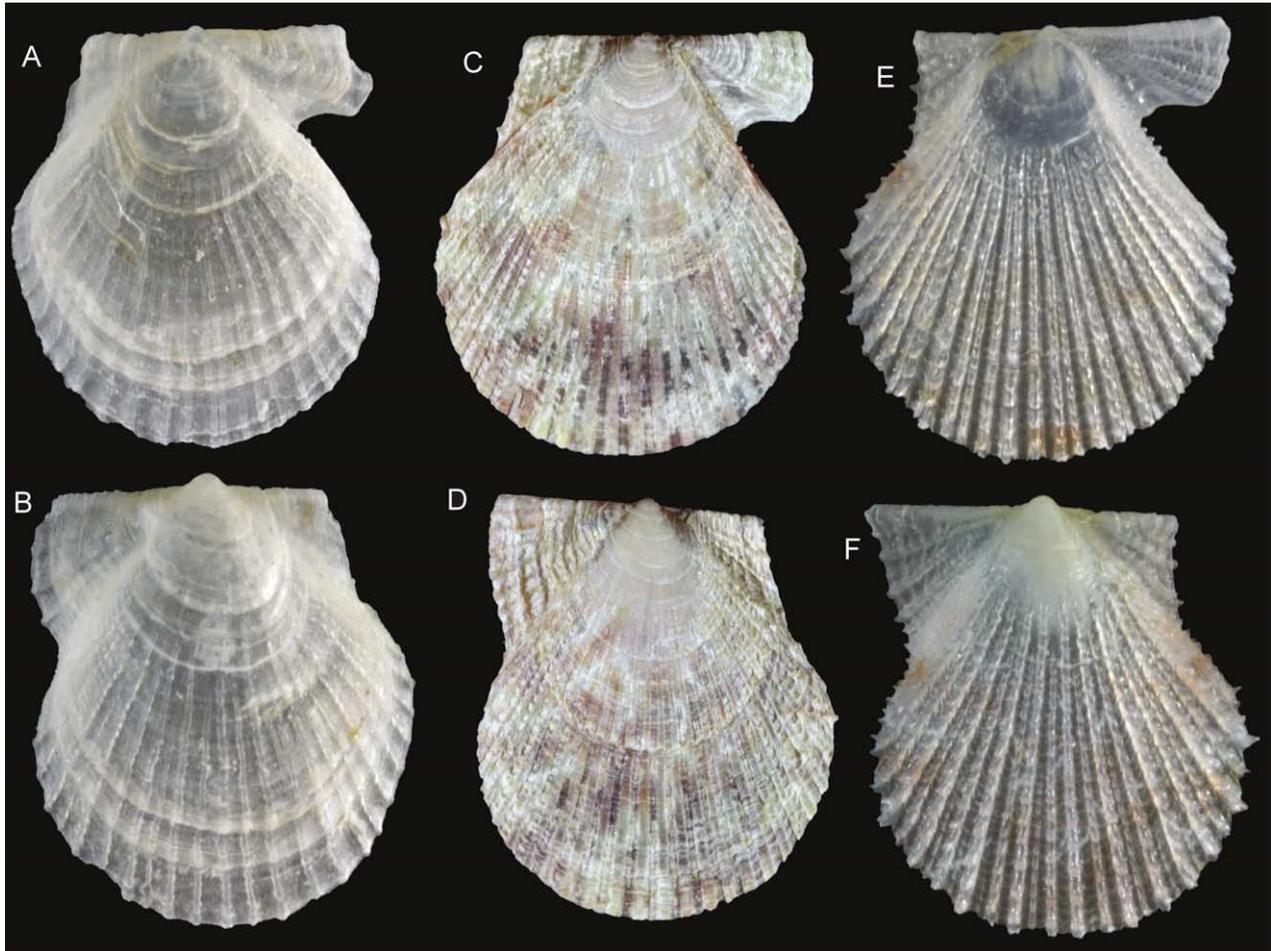


Figure 19. Young pectinids. (A,B) *Chlamys islandica*, Ø 3.6 mm, BIOICE#2537, off northwestern Iceland, depth 44 m (SMNH 55503). (C,D) *Mimachlamys varia*, Ø 4.5 mm, Sweden, Bohuslän, Koster area (SMNH 20571). (E,F) *Talochlamys pusio*, Ø 3.4 mm, western Norway, Korsfjord, northwest of Marsteinen, depth 276–256 m (SMNH 55505).

Sea and Canary Islands. This species lives in littoral and sublittoral depths; from a size of 10–20 mm it is cemented with the right valve to hard substrates. In Scandinavia frequent in empty shells of *Arctica islandica*. During BIOICE a single specimen was found alive in 31–33 m (Map 7), but the species has also been taken in shallow water at Reykjanes (SMNH) and washed ashore in other localities at the south-western coast (HL).

Description

Shell (Figures 20A–C) up to ca. 40 mm high, usually less than 30 mm, sturdily built. Before permanent attachment at a size of 10–20 mm, the shape is higher than long, inflated, right valve slightly more convex than left one. After attachment the right valve takes its shape after the substrate and may be higher than long or longer than high with a concave, flat or convex left (upper) valve. Anterior auricles

larger and longer than posterior ones, umbonal angle ca. 82–90°. Colour variable, whitish, creamy, yellow, orange, red or brown, colour pattern dotted, blotched, or with zigzag lines. Prodissoconch 1, length 85 µm, prodissoconch 2, length 230 µm (Figure 13F), colour white.

In the non-cemented stage (Figures 12A–C, 19E,F) both valves have numerous, irregularly spaced, squamous radial riblets of varying strength, commencing with ca. 10 at 5 mm shell height, gradually increasing in number to ca. 70 near the ventral margin in adult specimens. Anterior auricles larger than posterior ones, with 6–9 radial riblets on left valve, 5 on right valve and posterior auricles with 6–8 on left, 6 on right. Micro-sculpture granular on umbo, later radially striated between the ribs. Shagreen or reticulated micro-sculpture lacking. Byssal notch relatively deep, byssal fasciole moderately broad. Active ctenolium well-developed with 6–9 teeth.

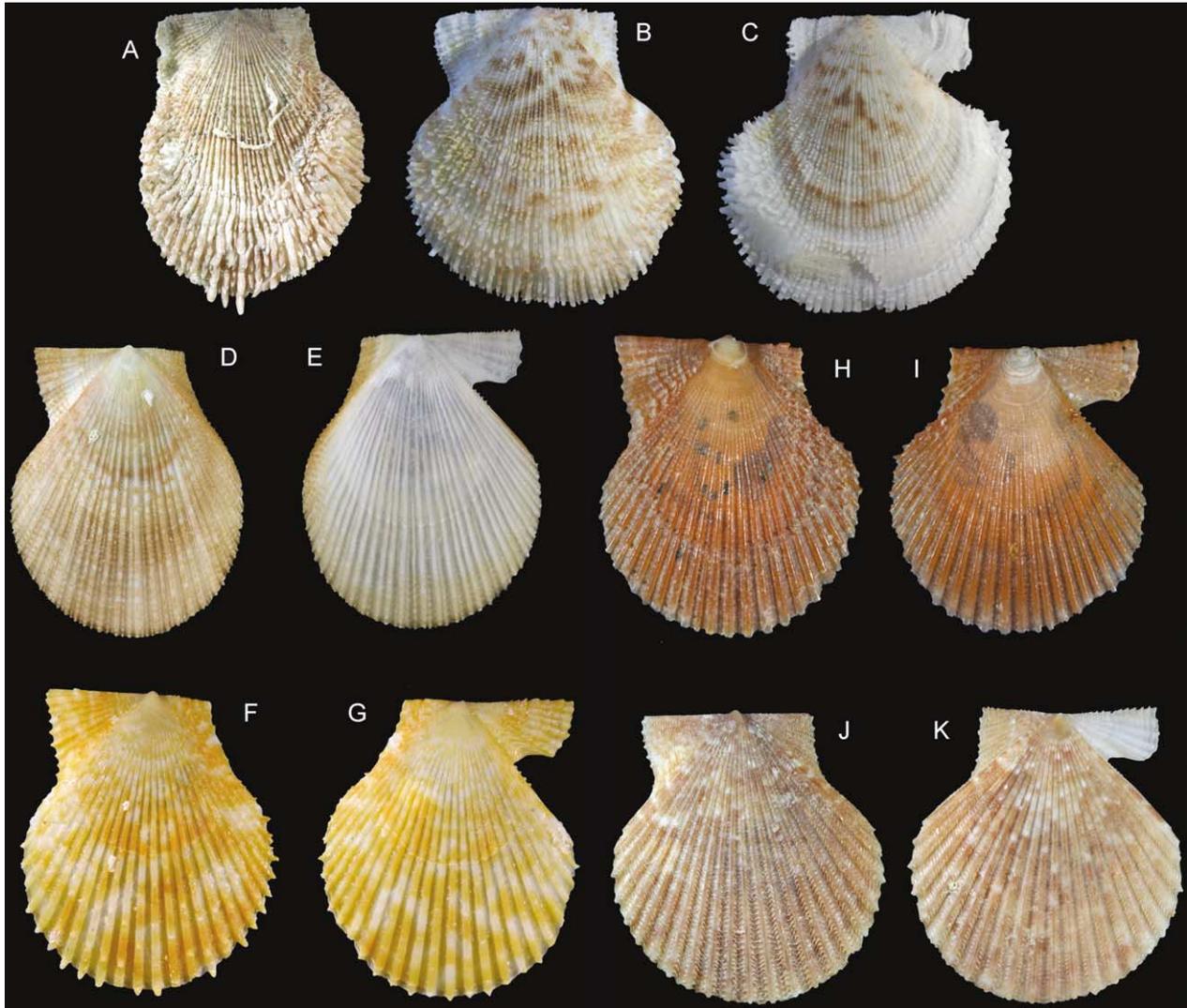


Figure 20. Pectinidae spp. (A) *Talochlamys pusio*, Ø 23.3 mm, western Norway, 39–41 m (SMNH 55498). (B,C) *Talochlamys pusio*, Ø 29.1 mm, western Norway, Bergen (SMNH 55500). (D,E) *Chlamys islandica*, Ø 14.7 mm, BIOICE#2941, off northwestern Iceland, depth 156 m (SMNH 55492). (F,G) *Mimachlamys varia*, Ø 7.0 mm, Sweden, Bohuslän, Gullmarsfjord (SMNH 55943). (H,I) *Mimachlamys varia*, Ø 16.0 mm, Norway, Raunefjord, intertidal (SMNH 20567). (J,K) *Aequipecten opercularis*, Ø 15.2 mm, Sweden, Bohuslän, Koster area (SMNH 55493).

Remarks

Free-living juveniles of *Talochlamys pusio* (Figures 12A–C) and *T. multistriata* (Poli, 1791) (Figures 12D,E), the latter never cemented, are hard to distinguish and often misidentified. Adult specimens can be differentiated by a secondary calcareous layer inside the umbo, present in *T. pusio* and lacking in *T. multistriata*. Moreover, *T. pusio* has a stronger microsculpture on the umbo of the left valve, than *T. multistriata*. These characters can be observed in the pre-cemented *Chlamys*-resembling stage. No intermediates have been found (Waller 1993). Small specimens may be imagined to closely resemble *Mimachlamys varia*, but that species has a much finer sculpture at the same size (Figures 12F,I, 19C,D) and its ribs are of uniform size, not

alternating broader and more narrow ones, as in *T. pusio*. *Mimachlamys varia* is not known from Iceland or the Faeroes, but occurs in Norway, north to 64° N (Trondheimsfjord; Høisæter 1986, SMNH), so it is figured here for comparison (Figures 20H,I).

Genus *Aequipecten* Fischer, 1886

Aequipecten opercularis (Linnaeus, 1758)
(Figures 11G,H, 13D, 20J,K)

Ostrea opercularis Linnaeus (1758:698, no. 171);
Dijkstra (1999:421, figs 7A–D [lectotype]).

Aequipecten opercularis; Wagner (1991):40, pl. 6 figs 1–5, text fig. 22 [synonymy, references];
Dijkstra & Goud (2002:70, fig. 76 [description, distribution]).

Type material

Lectotype in LSL, designated by Dijkstra (1999:423).

Type locality

'O. meridionali', restricted to Brittany (France) by Dijkstra (1999:422).

Distribution

Throughout the eastern Atlantic along the European coasts from south-eastern Iceland and Norway south of Lofoten (Høisæter 1986; Senja at 69.5° N, valves in SMNH) to the Canary Islands and the Mediterranean Sea. As an adult it lives free, in colonies on sandy or silty sediments in the littoral to sublittoral zone. Juveniles are usually byssally attached. A single BIOICE specimen was taken alive in 134–141 m (Map 9), and the species was previously not known in Iceland.

Description

Shell (Figures 20J,K) usually up to ca. 60 mm high, occasionally 100 mm; weakly inflated, left valve slightly more convex than right valve, somewhat longer than high, equilateral. Periphery slightly drawn out posteriorly. Anterior auricles somewhat larger and longer than posterior ones. Umbonal angle ca. 105°. Colour extremely variable; uniformly coloured or with blotches. Prodissoconch 1, length 110 µm, prodissoconch 2, length 250 µm (Figure 13D), colour white.

Both valves with 18–25, regularly arranged, radial, scaly ribs, secondary radial, scaly riblets and com-marginal lamellae on and between primary ribs, more prominent on left valve. Hinge line straight, byssal notch moderately deep and small, byssal fasciole rather narrow. Active ctenolium with 3–6 teeth.

Remarks

Petersen (1968:12) commented that *Aequipecten opercularis* was not known from Iceland, but is common around the Faeroes, where it forms the basis for a strictly regulated fishery. Young specimens (Figures 11G,H) resemble those of *Talochlamys pusio* and *Mimachlamys varia*, but are proportionally lower and flatter and the size of the ribs is more uniform.

Discussion

About 450 species of Pectinoidea, 150 Propeamussiidae and 300 Pectinidae are known worldwide.

About 80 species, 25 propeamussiids and 55 pectinids occur north of the Equator in the Atlantic. Pectinidae is probably one of the best known bivalve families, but still new species are being described regularly.

A total of 17 species, represented by ca. 8000 specimens, were collected at 356 stations around Iceland, an average of ca. 25 specimens per station or ca. 10 specimens based on the total number of stations. Their bathymetrical range is intertidal to more than four km depth. Two species seem more rare than they actually are, namely *Palliolium striatum* and *Talochlamys pusio*, because their normal depth range is more shallow than the working range of the BIOICE programme, mainly deeper than 100 m. *Aequipecten opercularis*, from the littoral to upper bathyal zone seems to be an occasional guest.

The poverty of the pectinoid fauna north of Iceland in bathyal depths is striking. *Hyalopecten frigidus* is the only species known below 1000 m depth. The Ingolf expedition took about 300 shells and specimens, from ca. 1050 to 2400 m, in a temperature of ca. –0.6 to –1°C (Jensen 1912). More than 300 specimens were then found living at 8 out of 16 stations in this depth range; at 4 only valves were found. During 1991 to 2004 it was found at 24 stations NE of Iceland, at 1456–3006 m water depth, and at a temperature range from –0.7 to –0.9°C. In these samples it is one of the most common bivalves.

North of Iceland and more shallow, *Cyclopecten hoskynsi* dominates in 300–1000 m. At ca. 600 m, *Similipecten greenlandicus* and *S. similis* are added. *Cyclopecten hoskynsi* and *S. similis* occur considerably deeper south of Iceland, down to 1400 m. It seems thus that low water temperatures constitute a limiting factor north of Iceland.

South of Iceland, a slightly impoverished North Atlantic bathyal fauna is encountered. *Hyalopecten pudicus* and *Parvamussium fenestratum* were not found, although they probably occur there.

We were a little surprised when examining the collections at SMNH for Scandinavian juveniles of certain species, but could hardly find a single small specimen of *Mimachlamys varia*, *Aequipecten opercularis* and *Pecten maximus*. The collections there include material collected by Lovén in 1840–1860 and he also searched for juvenile specimens. The same has been the intention of AW, and other, more rare species like *Talochlamys pusio* were well represented by small specimens in the collections (as are most other Scandinavian bivalves). In the Mediterranean and West European material, such juveniles were very common for all pectinids. If the observation on the rarity of juvenile *Mimachlamys varia*, *Aequipecten* and *Pecten*, is correct, a possible

explanation may be that they are non-reproducing pseudo-populations and that they are maintained by an inflow of larvae from the south. Certainly this is the origin of the single Icelandic specimen of *Aequipecten opercularis* which has a stable population in the Faroes.

As a consequence of its reflection in the larval shell, much has been speculated about the connections between types of larval development, dispersal and distribution among marine molluscs. Examination of larval shells is easier in pectinids than in most other bivalves since the animals live *on* the bottom, not *in* it, and therefore abrasion against sediment and corrosion by drops in pH are avoided, and the larval shells stay in good shape. Table II summarizes the type of larval development and gives the size of the parts of the larval shell.

There may be a phylogenetic constraint on the type of larval development, since all propeamussiids investigated here have lost planktotrophy; that was also the case in their slightly more southern relatives discussed by Dijkstra & Gofas (2004) and may be a trait of the family. *Hyalopecten frigidus* forms an exception among the Pectinidae and follows Thorson's (1951) rule, that deep-sea animals predomi-

nantly have lecithotrophic development (not correct for gastropods: Rex & Warén 1982). All other pectinids have a shallower upper distributional limit and have planktotrophic development.

Furthermore, the relation between the size of prodissoconch 2 and 1 reflects the length of the planktotrophic life. In the species discussed here the ratio varies between 3.4 and 2.0. Cragg (2006), table 2.1) presented such relations for 34 pectinoids, of which 6 were in the range 1.13–1.02, the others higher than 1.8. We believe the group of six unexpectedly low values to be based on erroneous original data.

The fact that only some of the North European pectinids with planktotrophic larvae occur in Iceland is not reflected in the size of the larval shell; it is of similar size as in those that do not reach Iceland. Three species of *Palliolium* occur in Scandinavia, all with similar size of prodissoconch 1 and 2; actually *P. striatum*, which occurs on both sides of the Atlantic, has the smallest larval shell. It should also be considered that a short or no dispersal phase may be favourable for maintaining small, isolated populations (Johannesson 1988). Such populations are, however, probably more vulnerable for temporary

Table II. Distribution and larval shell data on Northeast Atlantic Pectinoidea. AA, Amphiatlantic; EA, East Atlantic incl. Iceland. Colour of larval shell indicated by w, white, b, brownish. In *Delectopecten vitreus* we have seen both brown and white larval shells. Figure for *Pecten maximus* based on Cragg (2006).

Species	Prodisso-conch 1	Prodisso-conch 2	Prod 2 /Prod 1	Distributional type	Distribution in Iceland
<i>Propeamussium lucidum</i>	220 (w)	Absent	–	EA, bathyal–abyssal	W of Iceland
<i>Parvamussium propinquum</i>	215 (w)	Absent	–	EA, bathyal–abyssal	W of Iceland
<i>Cyclopecten hoskynsi</i>	180–190 (w)	Absent	–	EA, sublittoral–bathyal	All coasts
<i>C. ambiannulatus</i>	215 (w)	Absent	–	EA, bathyal	W and SW of Iceland
<i>Similipecten similis</i>	145 (w)	Absent	–	EA, boreal, sublittoral.	All coasts except NE of Iceland
<i>S. greenlandicus</i>	150–170 (w)	Absent	–	Arctic, sublittoral to upper bathyal	Northern and Eastern Iceland
<i>S. oskarsoni</i>	175 (w)	Absent	–	EA, bathyal	W and S of Iceland
<i>Catillopecten eucymatus</i>	175 (w)	Absent	–	AA, bathyal–abyssal	W of Iceland
<i>Hyalopecten frigidus</i>	220 (w)	Absent	–	Arctic abyssal	NE of Iceland
<i>Delectopecten vitreus</i>	95–100	315–350 (w/b)	3.4	AA, bathyal–abyssal	All coasts except NE of Iceland
<i>Palliolium striatum</i>	90	215 (b)	2.4	AA, Boreal, sublittoral	Western Iceland
<i>P. tigerinum</i>	100	265 (b)	2.7	EA, Boreal, sublittoral	Southern Iceland
<i>P. incomparabile</i> (Figure 13I)	80	230 (b)	2.9	EA, Boreal, sublittoral	Absent from Iceland
<i>Pseudamussium sulcatum</i>	110	310 (w)	2.8	EA, Boreal, sublittoral–bathyal	All coasts except NE of Iceland
<i>P. peslutrae</i>	100	320 (b)	3.2	EA, Boreal, sublittoral	Southwestern to southeastern Iceland
<i>Chlamys islandica</i>	100	250 (w)	2.5	AA, Arctic, sublittoral	All around Iceland
<i>Mimachlamys varia</i> (Figure 13E)	120	210 (b)	1.8	EA, Boreal, sublittoral	Not in Iceland
<i>Aequipecten opercularis</i>	110	250 (w)	2.3	EA, Boreal, sublittoral	(SE of Iceland)
<i>Talochlamys pusio</i>	85	230 (w)	2.7	EA, Boreal, sublittoral	Southwestern Iceland
<i>Pecten maximus</i>	80	240	3.0	EA, Boreal, sublittoral	Not in Iceland; Faeroes, southern Norway and south

environmental changes in their habitat since they do not regularly communicate with more distant and perhaps unchanged places.

The zoogeographic connections of the Icelandic pectinoid fauna are clearly European, seven of the seventeen species occur in Europe but not in the western Atlantic; no species has only West Atlantic affinity. This fits with the current ideas about the zoogeography of the North Atlantic (see Gudmundsson 1998), for molluscs recognized already by Mörch (1868) and confirmed by Thorson (1941) and Madsen (1949), although Dahlgren et al. (2000) found more connection between Icelandic and American populations of the bivalve *Arctica islandica* than with European ones. Probably the long coastline with subarctic conditions, from Greenland to Massachusetts, forms a barrier for the more shallow species that cannot rely on a deeper continuous distribution along the Greenland–Scotland Ridge.

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