

Revision of the Cancellariidae (Gastropoda: Caenogastropoda) in the deep water of the Norwegian Sea, with the description of a new species of *Admete*

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A new species of Admete Møller, 1842 (Cancellariidae), A. clivicola is described from the upper continental slope off south-western Norway, and the species Admete contabulata Friele, 1879 is reinstated as a valid species. Iphinopsis inflata (Friele, 1879) is redescribed and a lectotype for the species is established. The taxonomic status and bathymetric distribution of the species of Admete and Iphinopsis in the Norwegian Sea are discussed.

Keywords: Gastropoda, new species, upper continental slope, Norway, Cancellariidae, *Admete viridula*, *Admete clivicola*, *Admete contabulata*, *Iphinopsis inflata*, *Iphinopsis alba*

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INTRODUCTION

The family Cancellariidae in the bathyal and abyssal of the north-east Atlantic (including the Norwegian Sea) was last revised by Bouchet & Warén (1985). They included three species of *Admete* and three of *Iphinopsis* in this deep water fauna. Only two species, one in each of the genera, were reported for the bathyal of the Norwegian Sea. Recently new material has made it possible to extend and update the revision of Bouchet & Warén. The material is mainly but not exclusively from the slope off Norway, where several undescribed species and species not previously recorded from Norwegian waters were found (Høisæter, 2009b, 2010a, b).

With the inclusion of the new material it is clear that *Admete* in fact is represented by three species in the Norwegian Sea. One of these, *A. contabulata* Friele, 1879 was synonymized with *A. viridula* (Fabricius, 1780) by Bouchet & Warén, and is herein reinstated as a valid species. Further, *A. clivicola* with a restricted depth distribution on the upper slope is described as new. Finally *Iphinopsis inflata* (Friele, 1879) is redescribed and its possible confusion with *I. alba* Bouchet & Warén, 1985 is discussed. Based on literature data, the new material, material from the Norwegian North-Atlantic Expedition, 1876–1878 (NNAE), and from Spitsbergen, the geographical and bathymetric distribution of these species are discussed. This paper is the fourth in a series describing the gastropod fauna of the bathyal and abyssal of the Norwegian Sea.

MATERIALS AND METHODS

This paper is based mainly on material from the very extensive collection amassed by Torleiv Brattegard during 29 cruises with 'Håkon Mosby' in various parts of the Norwegian Sea. The material was mostly sampled with a modified Rothlisberg and Percy (RP)-sledge (Brattegard & Fosså, 1991), designed for collecting hyperbenthic fauna, but well suited also for the smaller and lighter epibenthos. This material was preserved in buffered formalin and later transferred to 80% ethanol (thus unsuited for molecular analysis). Gastropods from altogether 99 samples from 400 m to 3892 m were studied (see Høisæter, 2010a). Of these, 22 samples contained specimens or shells of Cancellariidae. The material from the NNAE has also been studied, especially the type material of *Admete contabulata* Friele, 1879 and *Iphinopsis inflata* (Friele, 1879). The material from the NNAE was caught with dredge or trawl with 'swabs'. Also a specimen of *A. clivicola* found in a sample from the MAREANO programme is included. Some comparative material of *A. viridula* from around the coast was procured during a series of summer cruises in which the author participated (Høisæter, 2009a). Finally six specimens and four shells of *A. viridula* from Spitsbergen recently collected by Christoffer Schander have contributed to a better description of the morphological variation of *A. viridula*. All photographs have been taken under a stereo microscope with an Olympus, 4.1 Mpix digital camera and processed in Adobe Photoshop™ by the author. All the material is deposited at the Zoological Museum of the University of Bergen (ZMBN). In the following the depth zones are named in a way diverging somewhat from the global norm, and adapted to this particular study. Thus the shelf is defined by its fauna and partly by the temperature, as extending down to 490 m while the upper slope extends further down to 750 m (Høisæter, 2010a).

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SYSTEMATICS

CANCELLARIIDAE Forbes & Hanley, 1851

The subfamily Admetinae Troschel, 1865, was erected for the deep water and polar genera of this otherwise tropical family. Admetinae is regarded as a full family by Russian malacologists, e.g. Kantor & Sysoev (2006). In the Norwegian Sea, the subfamily is represented by the genera *Admete* and *Iphinopsis*. While *Iphinopsis* was originally placed near *Trichotropis* Broderip & Sowerby, 1829, presently included in the family Capulidae, *Admete* has been placed in Cancellariidae at least since G.O. Sars (1878). *Iphinopsis* was (formally) transferred to the Cancellariidae by Bouchet & Warén (1985), although Friele in 1886 transferred the only species from Nordic waters to *Admete*, and thus implicitly transferred the genus to Cancellariidae. Members of this subfamily usually lack radula and operculum. See Harasewych & Petit (1986) for further anatomical details, and the anatomical basis for distinguishing the subfamily.

Admete Møller, 1842

TYPE SPECIES

Admete crispa Møller, 1842 (= *Tritonium viridulum* Fabricius, 1780) by monotypy (see discussion in Bouchet & Warén, 1985; Sneli & Stokland, 1986; Harasewych & Petit, 1987 concerning the type species).

Admete viridula (Fabricius, 1780)

Figures 1, 6 & 7.

Tritonium viridulum Fabricius, 1780: 402.

Admete crispa Møller, 1842: 88–89; Schiøtte & Warén, 1992: 9, figure 40.

Cancellaria viridula (Fab.)—Norman, 1879.

Admete viridula, Fabr. (incl. var. *undato-costata*, Verkr.; and var. *producta*)—G.O. Sars, 1878: 216.

Admete viridula, Fabricius—Friele, 1874, 1886; Norman, 1893, 1902; Friele & Grieg, 1901.

Admete viridula (Fabricius)—Odhner, 1915.

Admete viridula (Fabricius, 1780)—Fretter & Graham, 1985; Bouchet & Warén, 1985: 258, figure 683; Graham, 1988.

TYPE MATERIAL

Neotype (of *Tritonium viridulum*), 13.7 mm (ZMUC-GAS 417, designated by Bouchet & Warén 1985: 257, figure 683, one of Møller's specimens, see Remarks below).

TYPE LOCALITY

West Greenland. Not further specified, but said by Møller to be widely distributed, on clay, 55–109 m (Schiøtte & Warén, 1992).

MATERIAL SEEN

See Table 1.

In addition to the specimens listed in Table 1, I have looked at several hundred specimens and shells from the Norwegian coast and fjords, from the Bergen area (around 60°N) and northwards.

DESCRIPTION (BASED ON A SHELL FROM 543 M,

62°20'N, FIGURE 1 D)

Shell semitransparent, solid with a slight yellowish hue, wide, almost globular body whorl with relatively short, conical spire

Table 1. Material of *Admete viridula* studied. Near bottom temperatures measured at the time of sampling. Station numbers for the 'Håkon Mosby' cruises are of the form 'yy.mm.dd.no'. The 'Jan Mayen' stations are all from the end of August 2009, north of, or from the northern part of, Spitsbergen.

Station number	Depth m	Latitude N	Longitude E	Temperature °C	Numbers
Håkon Mosby 83.06.17.2	543	62°20'	1°25'	1.9	1d
Håkon Mosby 81.08.16.9	602	62°29'	1°45'	-0.9	2
Håkon Mosby 85.01.08.1	701	62°32'	1°27'	-0.9	1
Håkon Mosby 83.06.17.3	781	62°36'	1°14'	-0.9	1
Jan Mayen 2009-26	366	80°08'	16°59'		2d
Jan Mayen 2009-39	273	79°38'	19°46'		2
Jan Mayen 2009-67	168	81°00'	19°18'		2d
Jan Mayen 2009-69	174	81°02'	19°09'		3
Jan Mayen 2009-73	452	80°27'	12°47'		1

(6.5 × 4.15 mm) with slightly more than four whorls, the first somewhat angular, later ones rounded. Apical angle 58°. Body whorl ~70% of total length. Sculpture dominated by a few (five on penultimate whorl), strong spiral cords. Axial ribs ~10 on the first teleoconch whorl. On later whorls axial sculpture about 15–20 undulate costae. These die out gradually below the periphery. Aperture height 69% of body whorl and 48% of total length, its width 60% of its height, and ending in a short and wide siphonal canal. Inner lip forms a thin, glossy layer on the adapical part of the body whorl, partly obscuring the sculpture. Umbilical chink a long slit behind the columella. Protoconch with two keels in addition to three or four weaker spiral lines, of a little more than one whorl, its diameter 0.86 mm, and its H/D 0.82 (Figure 1D, upper panel). Soft parts (of specimen from 602 m; Figure 7) yellowish throughout.

VARIABILITY

Admete viridula is a variable species (e.g. Friele, 1886; Odhner, 1915; Bouchet & Warén, 1985), and based on the material available, much of this variability seems to be due to geographical variation. At least three geographical 'forms' may be told apart, an Arctic form (Figure 1C), a slope form (Figure 1D & E), and a form found on the coast and fjords of Scandinavia (Figure 1A & B). These forms may be distinguished on the relative length of the body whorl, with the Arctic form having a body whorl from 75 to 82% of the total length, while in the slope form it is between 69 and 73% and between 65 and 73% in the coastal form. The sculpture is also slightly different, more coarse (and often rather eroded) in the Arctic form, while the axial sculpture is less pronounced (more 'wavy') in the slope and Arctic forms than in the shelf/coast form (on the upper whorls of these latter the sculpture consists of a grid of spiral and axial elements of equal strength). Finally the protoconch is smallest in the shelf/coast form with a mean diameter of 0.69 mm, as against 0.71 mm in the Arctic form, and 0.90 mm in the slope form. The protoconch size in the

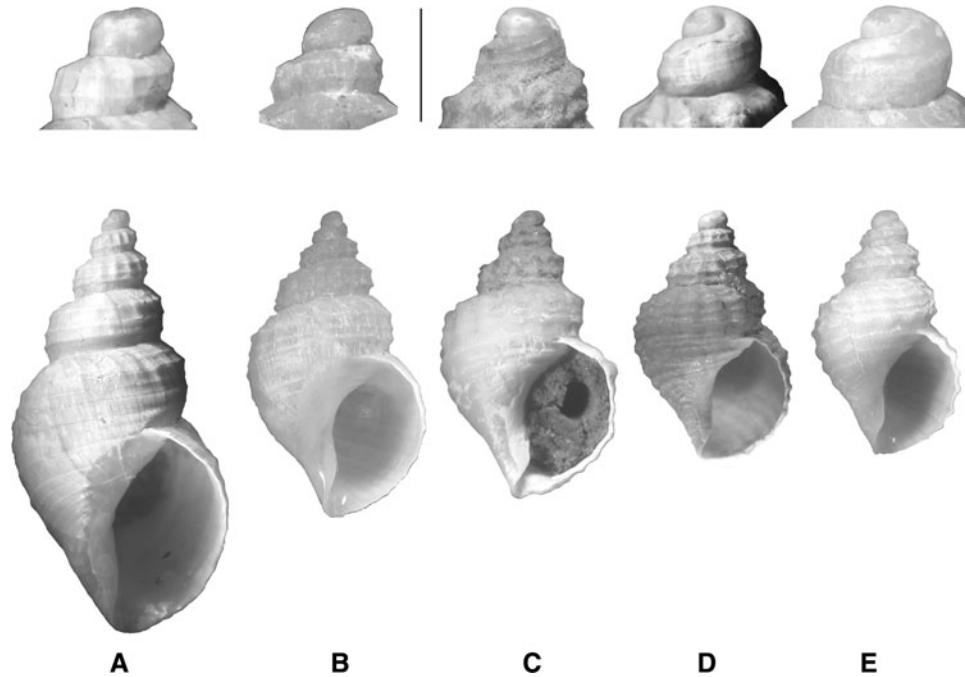


Fig. 1. *Admete viridula*, five specimens showing contrast between slope, Arctic, and outer coast forms. Specimens to scale, the largest 11.1 mm. (A & B) from the outer coast of Norway at 65°N, 80–30 m; (C) from north of Spitsbergen, 366 m; (D & E) from the upper slope off Norway, 543 and 781 m respectively. Scale bar = 1 mm.

slope form does not overlap the coastal form, and tends to increase with depth, thus the protoconch diameter of the specimen from 543 m is 0.86 mm, while the one from 781 m is 1.08 mm (compare Figure 1D & E, upper panel).

These observations are based on very sparse material, thus the material of the Arctic form consists of just ten juveniles, and the slope form of only five, and any conclusions concerning the taxonomic status of these three forms will therefore be premature.

DISTRIBUTION

Admete viridula has been reported from the Arctic, the shelf, coast and fjords of Scandinavia and from deep water in the Norwegian Sea (Friele & Grieg, 1901; Odhner, 1915; Bouchet & Warén, 1985; Sneli *et al.*, 2005; Hansson, 2005; Kantor & Sysoev, 2006). But as these sources do not all distinguish between the three species recognized here, the bathymetric distribution is uncertain. In my material there are only four specimens plus an empty shell from the slope, the deepest from 781 m (where an egg capsule was also found) all from around 62°35'N off Norway (see Table 1). Friele & Grieg (1901) who distinguished between *A. viridula* and *A. contabulata* reported a lower limit of 402 m on the shelf/slope. The lower limit on the slope off Norway at present is 781 m. In my material from the coast and fjords of Norway, I have specimens from at least down to 680 m (Fensfjorden, north of Bergen). The majority of the records from the coast and fjords are from fairly shallow water, from 30 m in northern Norway to around 200 m in mid-Norway and further south.

Worldwide, Friele & Grieg (1901) report it to be found down to 2300 m (this needs confirmation). Sneli *et al.* (2005) report a specimen from 1319 m south-west of the Faroes, in positive temperature water, while Bouchet & Warén (1985) report a shell from 1416 m west of Iceland. Sneli *et al.* (2005) also list a number of records from Norwegian Sea deep water (600 to

1100 m) north and east of the Faroes. The southernmost record in the literature is from around 60°30'N in the southern extension of the Faroe–Shetland Channel, south of the Faroes. Some of these latter records might be specimens of *A. contabulata* or *A. clivicola*. At its southern limit in Scandinavia, it is reported from the northern parts of Bohuslän in Swedish Skagerrak, usually associated with *Lophelia* reefs (Hansson, 2005). Shells reported from British waters are apparently sub-fossil (Fretter & Graham, 1985). In Norwegian fjords it is one of the more common gastropods found on fjord bottoms with silt or clay substrate. Further north it is usually associated

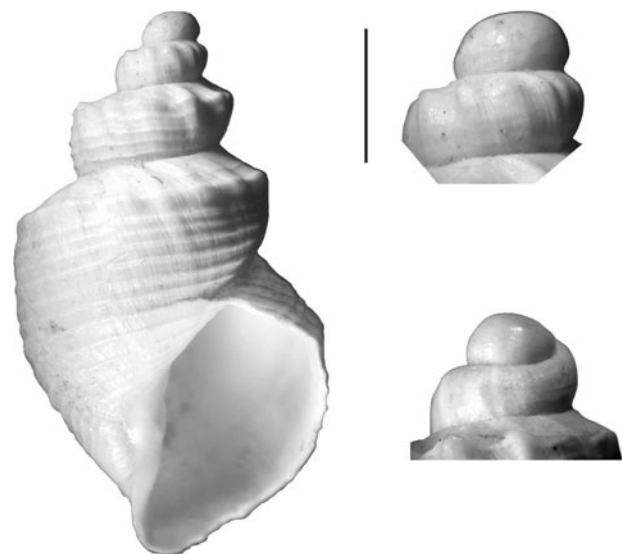


Fig. 2. *Admete contabulata*, lectotype (ZMBN 20724). 8.2 mm. Scale bar = 1 mm.

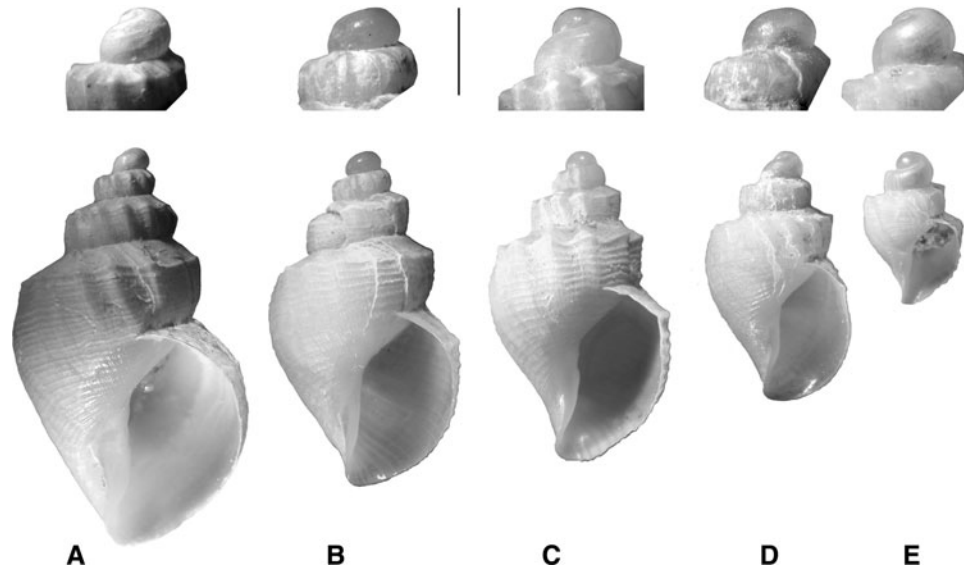


Fig. 3. *Admete contabulata* of various sizes. Specimens to scale, the largest 9.1 mm. (A) 1009 m; (B) 804 m; (C) 897 m; (D) 656 m; (E) 708 m. All specimens from between 62°12' and 62°48' N off Norway. Scale bar = 1 mm.

with mixed bottoms, lots of coarse substrate in depths from 10 to 100 m.

REMARKS

Bouchet & Warén (1985) and Schiøtte & Warén (1992) operate with two different sets of types, the latter with five syntypes (of *A. crispa*), one deposited in SMNH, and four in BMNH, and the former with a neotype of *T. viridulum* deposited in ZMUC ('To stabilize the nomenclature, we have therefore selected one of Möller's specimens as neotype of *T. viridulum*.' Bouchet & Warén 1985: 257). This specimen was taken from alcohol material determined '*Admete viridula* Fabricius' by Möller. Since the name *crispa* was not associated with this material, Schiøtte & Warén (1992) decided to exclude this material from their type series for *A. crispa* although it probably was part of the material Möller originally named *A. crispa* (Tom Schiøtte, personal communication). Based on the photographs of the neotype (Bouchet & Warén, 1985, figure 683) and one of the syntypes (Schiøtte & Warén, 1992, figure 40) I find it unlikely that *A. crispa* and *T. viridulum* will ever be found to be distinct species.

I have not made any attempts to sort out the many synonyms and varieties reported (see e.g. Bouchet & Warén, 1985) for this variable species, and the question of whether a single polymorph species or a species complex is found here is still unsettled (see further Discussion below). For differences from *A. contabulata* and *A. clivicola*, see those two species.

Admete contabulata Friele, 1879
Figures 2, 3, 6 & 7.

Admete contabulata Friele, 1879: 276—Friele, 1886: 24, pl. 8, figures 31–32; Friele & Grieg, 1901: 85; CLEMAM; Høisæter, 2009a, 2010a.

Admete contabulata Friele—Odhner, 1915.

Admete viridula (in part)—Bouchet & Warén, 1985: 258, figure 684.

TYPE MATERIAL

Lectotype (designated by Bouchet & Warén, 1985: 259), 8.2 mm, largest of several specimens. ZMBN 20724.

Table 2. Material of *Admete contabulata* studied. The specimen in row 7 is a small larval shell, therefore the question mark. Near bottom temperatures measured at the time of sampling. Station numbers for the 'Håkon Mosby' cruises are of the form 'yy.mm.dd.no'. Station numbers from the Norwegian North-Atlantic Expedition, 1876–1878 are preceded by Vøringen.

Station number	Depth m	Latitude N	Longitude E	Temperature °C	Numbers	Museum label
Håkon Mosby 81.08.16.9	602	62°29'	1°45'	−0.9	1	
Håkon Mosby 84.05.23.1	656	62°35'	1°48'	−0.8	1	
Håkon Mosby 83.06.02.1	708	62°12'	0°00'	−0.3	1	
Håkon Mosby 82.01.21.4	804	62°34'	0°59'	−0.9	4	
Håkon Mosby 85.01.08.2	897	62°42'	1°11'	−0.9	2	
Håkon Mosby 81.08.16.3	1009	62°48'	1°03'	−1.0	1	
Håkon Mosby 83.06.03.1	1338	61°21'	3°11'W	−0.8	1?	
Vøringen Station 124	640	66°41'	6°59'	−0.9	3	ZMBN 20723
Vøringen Station 192*	1187	69°46'	16°15'	−0.7	1	ZMBN 20724
Vøringen Station 192	1187	69°46'	16°15'	−0.7	4	ZMBN 20725

*, lectotype.

TYPE LOCALITY

Continental slope outside northern Norway, 'Vøringen', Station 192, 69°46'N 16°15'E, 1187 m.

MATERIAL SEEN

See Table 2.

DESCRIPTION

The lectotype (Figure 2) is white, has 4.5 rapidly expanding, strongly angulated whorls, with a dominating, rather inflated body whorl. The shell (8.2×4.75 mm) has a body whorl that is 72% of the height. Apical angle $\sim 55^\circ$. Spiral sculpture dominating, with seven spiral cords on the penultimate whorl and seven below upper lip. Axial sculpture mainly as wavy costae on the angulated shoulder of early whorls, gradually disappearing on later whorls. The slope of the shoulder increases gradually with growth. Dense prosocline growth lines covering surface. Aperture high, 65% of body whorl and 47% of total height, and wide (68% of its height) ending in a short siphonal canal. Inner lip not clearly marked off from columella. On the columellar wall there is a thin, glossy glaze covering $1/2$ the width of body whorl. The umbilical chink ends abruptly $2/5$ up from siphonal canal. Protoconch wide and low, of ~ 1.5 whorls, 1.10 mm wide, H/D ~ 0.70 . Protoconch surface with four or five weak spiral lines. Soft parts apparently uniformly white throughout.

VARIABILITY

In many ways the lectotype is 'atypical' for the species. The body whorl is usually 76–77% of the total height (Figure 3) and the aperture height correspondingly 52–56%. Both the number of spiral cords and development of axial costae vary (Figure 3). The relative 'flatness' of the shoulder is also rather variable, although always better expressed on the first few whorls. The body whorl is generally rather convex, with its greatest diameter at the level of the upper lip rather than at the shoulder. Size of protoconch varies, but usually rather wide and low. The diameter of 10 measured specimens was between 0.81 and 1.11 mm, with a mean of 0.95, and H/D was between 0.55 and 0.70, with a mean of 0.66. Maximum height of 17 measured specimens is 9.1 mm.

DISTRIBUTION

The 11 specimens in the 'Håkon Mosby' material were found at seven stations (Table 2), spanning the depth zone from 602 to 1009 m, with most specimens between 800 and 900 m. In addition a postlarva from the Faroe–Shetland Channel (at 1338 m) might belong to this species. The material from NNAE is not very numerous, and the type locality (Station 192 at 1187 m) is known to be the repository for many shells actually living further up on the slope (Friele & Grieg, 1901). In addition to the five specimens reported from this locality, Friele (1886) reports only four specimens, three from Station 124 (67°N at 640 m) and one from the shelf south of Spitsbergen (Station 338, 76°N at 267 m). This latter is most likely a misidentification (see below). The distribution is thus at present limited to the slope off Norway from 600 to 1200 m, between 62°N and 70°N. I would not consider it unlikely that some of the 18 records of *A. viridula* from Norwegian Sea deep water around the Faroes, in Snelli *et al.* (2005) in fact are specimens of *A. contabulata*.

REMARKS

For differences from *A. clivicola*, see that species. From *A. viridula* it is distinguished by having a proportionally larger body whorl, more numerous spiral cords, a larger protoconch and more clearly defined shoulder. The axial sculpture on the first few teleoconch whorls is also less distinct, consisting of wavy prosocline costae. The protoconch is usually wider, and without the three or more marked keels seen on the lower part of the *A. viridula* protoconch (see e.g. figures 688 & 689 in Bouchet & Warén, 1985).

Admete contabulata was described by Friele in 1879, but has apparently not been found again (see however Odhner, 1915 who reported two specimens from 41 m in Isfjorden on Spitsbergen. No illustrations or descriptions were provided, and the author seemed to be in doubt as to the validity of the species. In my opinion this record needs verification). Bouchet & Warén (1985) studied the type material and synonymized it with *A. viridula* without any discussion, except that *A. viridula* is extremely variable. With the material available today, I find it evident that Friele was correct in erecting a separate species for this form. That the species specific characters are not due to geographical or bathymetric variation is seen in the species rich sample from 602 m where the three species were found together (see Figure 7). The lectotype was illustrated (figure 684, as holotype in Bouchet & Warén (1985)). In the ZMBN collection this specimen is also marked as 'type'.

I am inclined to think that the specimen from the shelf south of Spitsbergen (Vøringen Station 338) by Friele identified to *A. contabulata* is really a specimen of *A. clivicola* (Table 3). Of the remaining eight specimens in Friele's material, the lectotype illustrated above is by far the best preserved and therefore the most logical choice of type.

Of the many species and variety names included by Bouchet & Warén (1985) under the *A. viridula* umbrella, CLEMAM has retained *A. contabulata* and also *A. sadko* Gorbunov, 1946 as valid European species, although Kantor & Sysoev (2006) include both *A. contabulata* and *A. sadko* as synonyms of *A. viridula*. I am not aware of any other sources in which this synonymy is discussed. In McClain *et al.* (2005), the name is apparently accepted for a member of the north-west Atlantic deep water fauna. Kantor & Sysoev (2006) list a number of species of *Admete* from Arctic Russian waters, but none that might be confused with the slope species discussed here.

Admete clivicola sp. nov.

Figures 4, 5, 6 & 7.

Admete sp. nov.—Høisæter, 2009a, 2010a.

TYPE MATERIAL

Holotype (ZMBN 86414) and 17 paratypes from 'Håkon Mosby' Station 81.08.16.9.

TYPE LOCALITY

Upper slope off western Norway, 62°29.2'N 1°44.5'E, at 602 m, sampled August 1981. The temperature at the type locality measured at the time of sampling was -0.9°C . However, six months later the temperature was $+1.1^\circ\text{C}$, measured at the same depth and locality.

ETYMOLOGY

From Latin *clivus* meaning sloping hillside and *-cola* inhabitant. Referring to the preferred habitat of the species, on the continental slope.

Table 3. Material of *Admete clivicola* studied. Station numbers for the 'Håkon Mosby' cruises are of the form 'yy.mm.dd.no'. Station numbers from the Norwegian North-Atlantic Expedition, 1876–1878 are preceded by Vøringen. The queries in rows 1 and 7 are because these specimens had atypical morphologies. The specimen in row 2 is a very small larval shell. Near bottom temperatures measured at the time of sampling.

Station number	Depth m	Latitude N	Longitude	Temperature °C	Numbers	Museum label
Håkon Mosby 83.06.07.2	400	64°26'	11°10'W	−0.2	2?	
Håkon Mosby 81.08.16.12	502	62°28'	2°02'E	0.3	1?	
Håkon Mosby 84.05.23.3	576	62°30'	1°51'E	−0.4	2	
Håkon Mosby 81.08.16.9*	602	62°29'	1°45'E	−0.9	1	ZMBN 86414
Håkon Mosby 81.08.16.9*	602	62°29'	1°45'E	−0.9	17	
Håkon Mosby 82.01.21.2	604	62°30'	1°43'E	1.1	8	
Vøringen Station 338	267	76°16'	17°49'E	−1.1	1?	ZMBN 20726
Mareano R322A	2001	70°12'	16°12'E		1	

*, holotype and paratypes.

MATERIAL SEEN

See Table 3.

DESCRIPTION

Shell (holotype; Figure 4) greyish-white, semitransparent, oblong (6.1 × 3.4 mm), pagoda-shaped with three angulated shouldered whorls in addition to the protoconch. Apical angle ~50°, shoulders (of whorl two and three) 125° from vertical, suture deep. Body whorl 68% of total length. Sculpture dominated by narrow spiral cords, five on the penultimate whorl. Axial sculpture most prominent on the upper few teleoconch whorls.

Around ten beak-like protuberances on the shoulders. Axial sculpture gradually disappearing on lower whorls, but remaining as knobs on the spiral cord defining the shoulder on body whorl. Aperture height 66% of body whorl, its width 54% of its height, ending in a short and wide, poorly defined siphonal canal below. Inner lip well defined, clearly demarcated from body whorl. Umbilical chink indistinct, slit-like. Protoconch smooth, glossy, knoblike with 1.5 whorls. In this (and some other) specimen(s) marred by a boring organism responsible for superficial canals in the shell. Diameter 0.95 mm, height 0.79 mm, and height thus 83% of diameter. Soft parts: blackish spire and pinkish body whorl visible through the partly transparent shell.

VARIABILITY

Admete clivicola is less variable than the other species in this group (Figure 5), although the limited distribution precludes any discussion of bathymetric or geographical variability. Sometimes less tightly coiled (Figure 5A) and thus proportionally narrower (D/H 0.53 as against 0.58–0.60 for the majority of the measured specimens). The single specimen from 2000 m at ~70°N is much larger than any of the some 30 specimens from the upper slope. Only two of the 33 specimens of *A. clivicola* in my material, at 6.5 and 6.75 mm, surpassed 6.25 mm in length, while the specimen from 70°N is reported to be 10 mm at half an extra whorl. As I have only seen a photograph of this specimen I am unable to verify the length. The protoconch is generally proportionally higher than in the other two species. In 15 measured specimens, the H/D varied from 0.70 to 0.92, with a mean of 0.79. In juveniles with well preserved protoconchs a number (at least three) of very fine incised spiral lines can be seen.

DISTRIBUTION

Based on the present material the species has a very restricted depth distribution. With a single exception (the specimen from 2000 m) all specimens were found between 576 and 602 m on the slope off Norway, around 62°30'N. A specimen taken at Station 338 in the NNAE, at 267 m on the shelf just south of Spitsbergen may belong to this species, as might also two specimens from 400 m on the Iceland–Faroe Ridge. Both of these localities had negative temperature water masses at the time of sampling (measured to −1.1°C and −0.4°C respectively). Both are situated close to the border line between the fluctuating Atlantic water masses, and Polar or Norwegian Sea deep water.

REMARKS

This is the species called *Admete* sp. nov. in Høisæter (2010a). *Admete clivicola* seems to rarely reach the size of a fully grown *A. contabulata*. At the same number of whorls, *A. clivicola* is approximately 20% shorter than *A. contabulata*. The body whorl is also far less dominating in *A. clivicola*, with length 67% of the total as against (generally) 76% in *A. contabulata*. The number of spiral cords are lower, the aperture is wider, the siphonal canal is less developed (except in juveniles), and the thickened inner lip ends more abruptly and lacks a

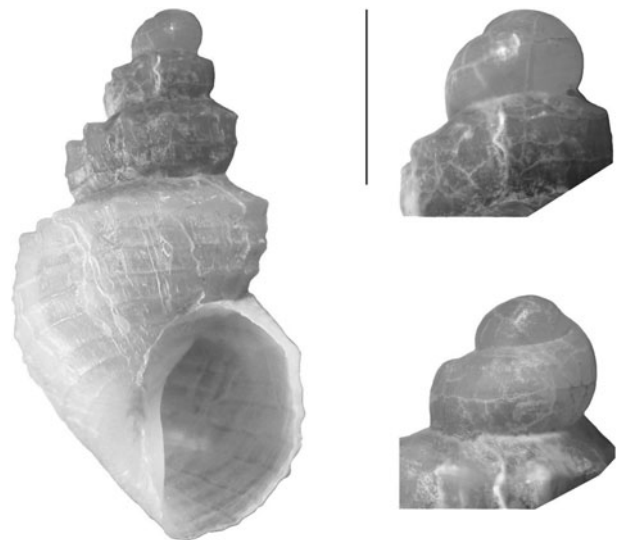


Fig. 4. *Admete clivicola*, holotype (ZMBN 86414). 6.0 mm. Scale bar = 1 mm.

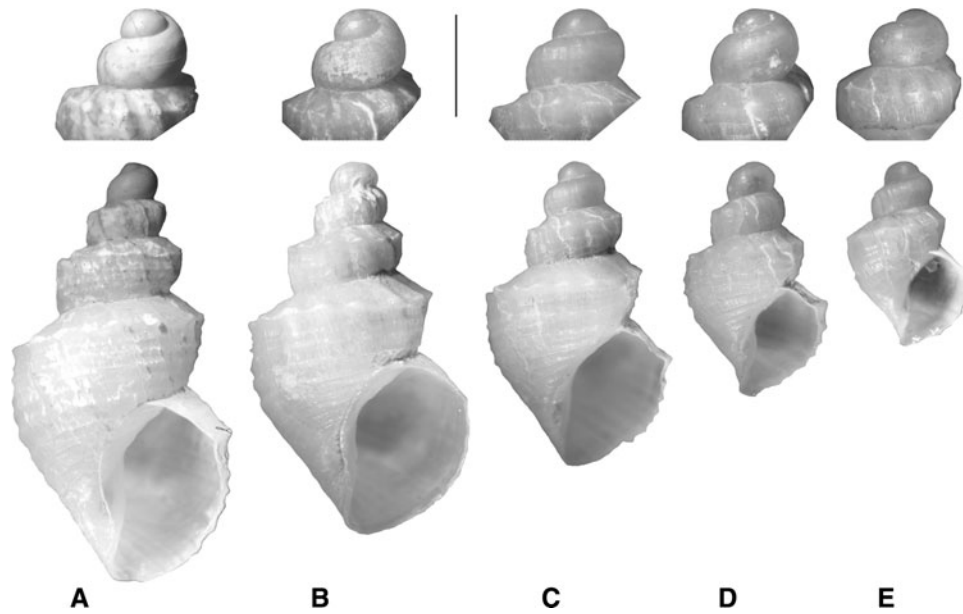


Fig. 5. *Admete clivicola*, growth series. Specimens to scale, the largest 6.75 mm. (A) 604 m; (B–E) 602 m. All specimens from 62°29' or 62°30'N 1°45' or 1°4'3E. Scale bar = 1 mm.

wide polished, glossy area adjacent to the aperture. The thickened inner lip is almost diagnostic for *A. clivicola*. Photographs of juveniles (Figure 6) clearly demonstrate the size difference of early stages of the three species. At same number of whorls, a juvenile *A. clivicola* is much smaller than *A. contabulata* (Figure 6A, B). The protoconch is widest in *A. contabulata*, intermediate in *A. clivicola* and

narrowest (although more variable) in *A. viridula*. On the other hand it is proportionally higher in *A. clivicola* than in *A. contabulata*, with protoconch H/D 0.55 to 0.70 in *A. contabulata*, and 0.70 to 0.92 in *A. clivicola*. Three (or more) faint spiral lirae start a little distance from the transition zone to the teleoconch (marked by a series of vertical folds) in *A. contabulata* and *A. clivicola*, while *A. viridula* has two keels (in

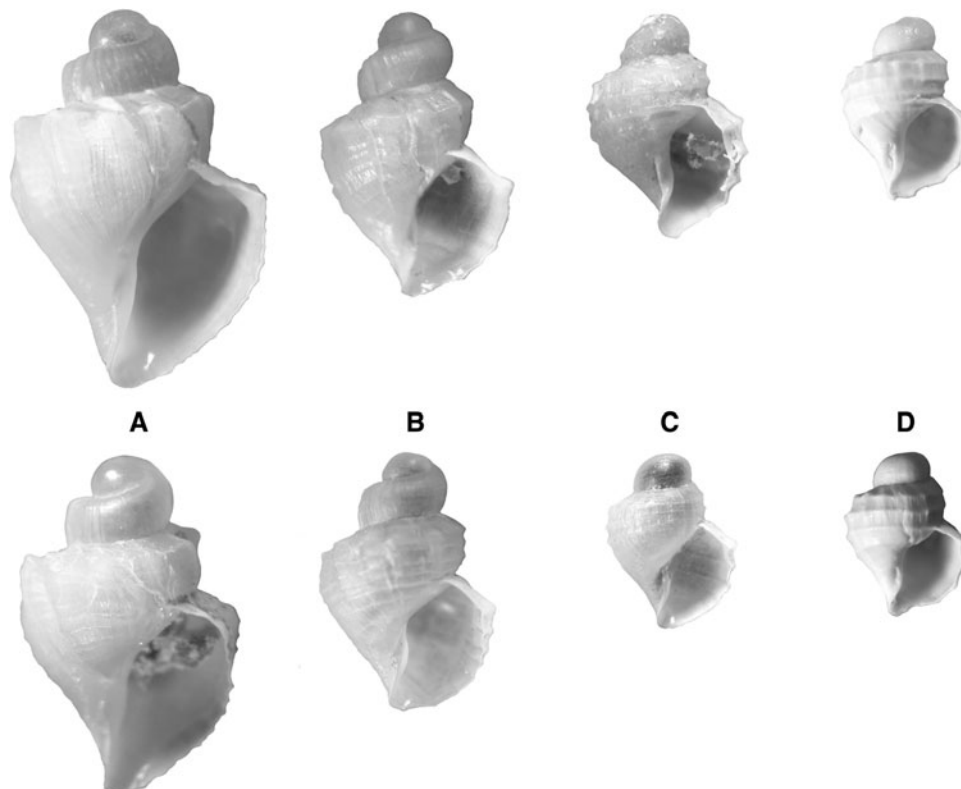


Fig. 6. Juveniles of the three species, two specimens of each form. (A) *Admete contabulata*; (B) *A. clivicola*; (C) Spitsbergen form of *A. viridula*; (D) Norwegian outer coast form of *A. viridula*. Specimens to scale, the largest is 3.9 mm.

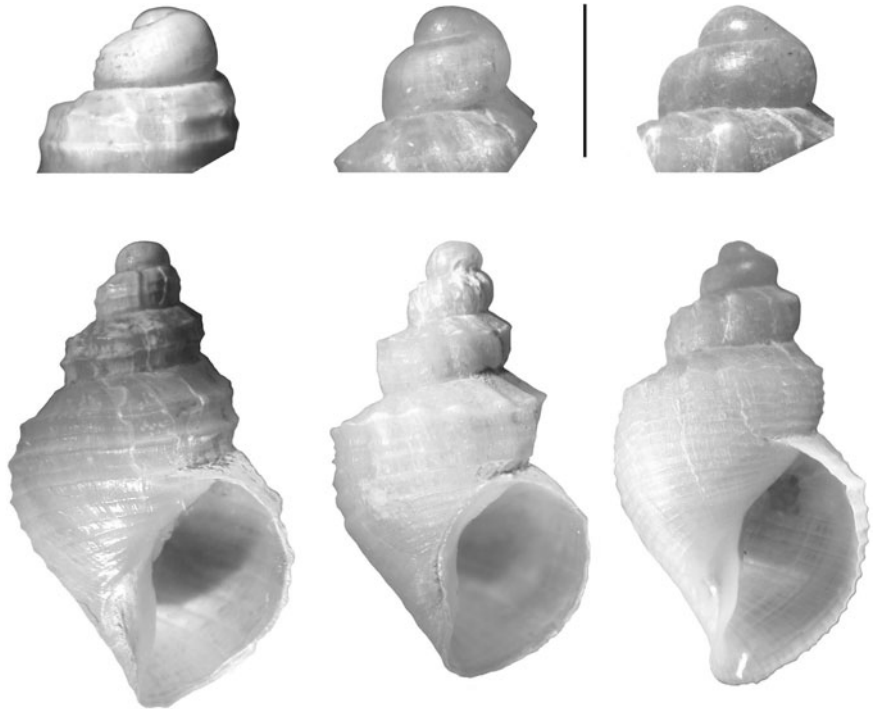


Fig. 7. The three species of *Admete* found together on the upper slope station at 602 m. From left to right *A. viridula*, *A. clivicola* and *A. contabulata*. Specimens to scale, the largest is 6.35 mm. Scale bar = 1 mm.

addition to several secondary spirals) on the lower part of the protoconch. In addition the protoconch in this last species is sometimes decorated with a number of irregular and uneven line segments which are partly crossing each other or anastomosing and mixed with small irregularities (Figure 1).

Figure 7 shows three specimens from the 602 m station, one of each species. The three almost equally large, sympatric specimens clearly demonstrate the specific differences listed above.

Iphinopsis Dall, 1924

TYPE SPECIES

Iphinoe kelseyi Dall, 1908 by original designation. Deep water off southern California and Baja California.

This genus was introduced to the Norwegian Sea fauna by Bouchet & Warén (1985).

Iphinopsis inflata (Friele, 1879)

Figures 8 & 9.

Trichotropis inflata sp. nov. Friele, 1879: 275.

Admete inflata Friele—Friele 1886: 25.

Iphinopsis inflata (Friele, 1879)—Bouchet & Warén, 1985:262; Warén, 1991; Snøli *et al.*, 2005.

TYPE MATERIAL

Lectotype (ZMBN 86413. Ex ZMBN 20721) and two paralectotypes from the same sample (here designated).

TYPE LOCALITY

Continental slope outside Bear Island, 'Vøringen', Station 312, 74°54'N 21°51'E, 1203 m.

MATERIAL SEEN

See Table 4.

DESCRIPTION

Shell (lectotype, Figure 8) white, thin-shelled, semi-transparent, oval (7.9 × 4.7 mm) with 4.5 to 5 rapidly increasing, very tumid whorls. Apical angle 70°. Suture distinct and deep. Body whorl

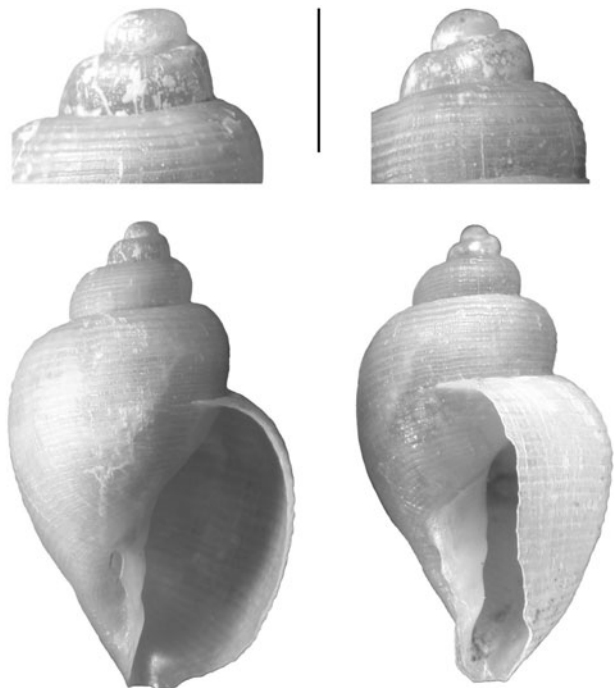


Fig. 8. *Iphinopsis inflata*, lectotype (ZMBN 86413). 7.9 mm. Scale bar = 1 mm.

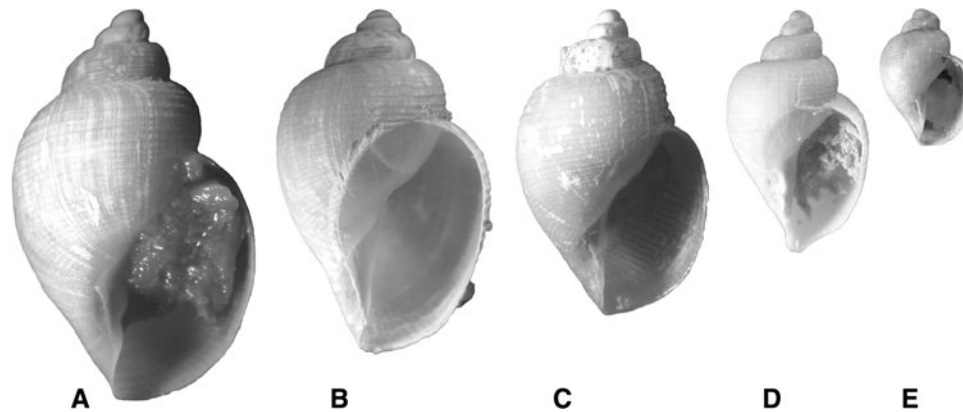


Fig. 9. Five specimens of *Iphinopsis inflata*. Specimens to scale, the largest 9.0 mm. (A) 897 m; (B) 1030 m; (C) 604 m; (D) 897 m; (E) 408 m. Specimen (E) from the Barents Sea, all the others from the slope off Norway.

81% of total length, and meeting penultimate whorl at roughly 110° .

Sculpture numerous (11 on penultimate whorl) spiral ridges of variable thickness but usually thin and somewhat wavy, with wide interspaces, in addition to dense vertical (orthocline) growth lines. Aperture height 61% of total, width 53% of its height, ending in poorly defined, undulating siphonal canal. Inner lip extended as a smooth and glossy glaze covering part of the columellar wall (as in *A. contabulata*). Umbilicus wide and deep, partly concealed by columellar lip. The columella has two weak but distinct columellar folds. Protoconch button-shaped, smooth of 1.5 whorls, 0.85 mm in diameter, and H/D ratio 0.54. Soft parts voluminous, not completely retractable in the shell (see Figure 9A).

VARIABILITY

The distinctness of the columellar folds varies a lot and while some columellae almost completely lack folds others have two distinct ones (compare Figure 9B, D & E with Figures 8 & 9A). The whorls may be more or less shouldered (compare Figure 9A & D). The shape of the aperture, especially its lower end (siphonal canal) varies from wide and squarish to

almost channelled. Growth lines are sometimes rather prominent (e.g. Figure 9A). The protoconch is often heavily eroded in specimens from depths beyond 1000 m (e.g. Figure 9B) making it hard to assess the variability of the protoconch. The 'glaze' covering the columellar wall varies in thickness and in an extreme case an almost complete peristome is found, as in the specimen from 1315 m, and a slightly less thickened callus in one from 1030 m (Figure 9B). It is possible that some of this variability is correlated with distribution.

DISTRIBUTION

Fairly common in depths from 800 to 1350 m on the slope all around the Norwegian Sea. Particularly common in the sample from 'Vøringen' Station 192 at 1187 m. The shallowest of my specimens is in the sample from 604 m (temperature fluctuating between $+1.1$ and -0.9°C), the deepest are three specimens from 1338 m in the Faroe–Shetland Channel. Three specimens from the Barents Sea, one from 410 m ($73^\circ\text{N } 18^\circ 30'\text{E}$; Bouchet & Warén, 1985), and two from 408 m ('Vøringen' Station 323, $73^\circ\text{N } 21^\circ 50'\text{E}$, $+1.5^\circ\text{C}$) are the only known records of this species from the shelf. According to Bouchet & Warén (1985), the species is only

Table 4. Material of *Iphinopsis inflata* studied. Station numbers for the 'Håkon Mosby' cruises are of the form 'yy.mm.dd.no'. Station numbers from the Norwegian North-Atlantic Expedition, 1876–1878 are preceded by Vøringen. Near bottom temperatures measured at the time of sampling.

Station number	Depth m	Latitude N	Longitude E	Temperature °C	Numbers	Museum label
Håkon Mosby 82.01.21.2	604	$62^\circ 30'$	$1^\circ 43'$	1.1	1	
Håkon Mosby 81.06.06.7	794	$65^\circ 43'$	$5^\circ 14'$	-0.9	1	
Håkon Mosby 85.01.08.2	897	$62^\circ 55'$	$1^\circ 11'$	-0.9	5	
Håkon Mosby 81.08.16.3	1009	$62^\circ 48'$	$1^\circ 03'$	-1.0	1	
Håkon Mosby 82.11.26.1	1030	$63^\circ 11'$	$2^\circ 46'$	-1.0	1	
Håkon Mosby 84.11.20.2	1087	$63^\circ 08'$	$1^\circ 54'$	-0.9	1	
Håkon Mosby 85.01.08.3	1112	$62^\circ 55'$	$0^\circ 56'$	-0.9	3	
Håkon Mosby 81.03.22.1	1260	$63^\circ 17'$	$4^\circ 25'$	-0.9	1	
Håkon Mosby 82.08.15.1	1286	$63^\circ 03'$	$0^\circ 49'$	-1.0	1	
Håkon Mosby 85.01.12.3	1293	$63^\circ 03'$	$0^\circ 49'$	-0.9	1	
Håkon Mosby 86.07.30.2	1315	$67^\circ 42'$	$3^\circ 04'$	-0.9	1	
Håkon Mosby 83.06.03.1	1338	$61^\circ 21'$	$3^\circ 11'\text{W}$	-0.8	3	
Vøringen Station 192	1187	$69^\circ 46'$	$16^\circ 15'$	-0.7	2	ZMBN 20719
Vøringen Station 192	1187	$69^\circ 46'$	$16^\circ 15'$	-0.7	31	ZMBN 20720
Vøringen Station 312*	1203	$74^\circ 54'$	$14^\circ 53'$	-1.2	1	ZMBN 86413
Vøringen Station 312*	1203	$74^\circ 54'$	$14^\circ 53'$	-1.2	3	ZMBN 20721
Vøringen Station 323	408	$72^\circ 53'$	$21^\circ 51'$	+1.5	2	ZMBN 20722

*, lectotype and paralectotypes.

known from between Norway and Spitzbergen and around Iceland, in depths from 408 to 1412 m. However, Sneli *et al.* (2005) present a number of records outside this area, most notably two records from the upper slope (606 and 702 m, $\sim +8^{\circ}\text{C}$) on the Lousy Bank south-west of the Faroes at $12^{\circ}40' \text{ W}$. Another one from 732 m, with slightly negative temperature, on the upper slope of the south-western extension of the Faroe–Shetland channel is also outside the accepted range for the species. However, the possibility of confusion with *I. alba* Bouchet & Warén, 1985 cannot be excluded (see below).

REMARKS

Bouchet & Warén (1985) list as type material two syntypes, ZMBN 20719, from 'Vøringen' Station 192, 1187 m on the steep slope west of Tromsø ($69^{\circ}46' \text{ N } 16^{\circ}15' \text{ E}$). This is based on a label ('type') in the tube containing two (out of 33) shells identified to this species from Station 192. These shells are partly broken and some shell characters are lacking. None of them fit the dimensions or the drawing of *Admete inflata* in Friele (1886) particularly well (no illustration was given in Friele (1879)). According to Article 72.4.7 of ICZN (1999) the 'type' label cannot be accepted as a valid type designation. As Bouchet & Warén (1985) did not follow up their statement with specification of lectotype, any illustration or further description, their listing is not a valid type designation. The description, the shell dimensions and the drawing in Friele (1886) fit very well the best preserved shell (of three) in the tube marked ZMBN 20721. This batch is from 'Vøringen' Station 312, 1203 m on the slope west of Bear Island ($74^{\circ}54' \text{ N } 14^{\circ}53' \text{ E}$), one of 14 stations from around Spitzbergen which supplied the material used by Friele (1879). The lectotype here designated is based on this best preserved shell, which I am reasonably certain is the one Friele illustrated (Friele, 1886: table VIII; figure 33) and mainly based his description on.

Bouchet & Warén (1985: 262) (see also Warén, 1991) described a species from deep water (1900 to 2900 m) south of the Wyville-Thomson Ridge as *Iphinopsis alba*, with the main distinguishing shell characters being the presence of two distinct columellar folds and slightly less tumid whorls, while *I. inflata* should have at most one, very retracted fold. In both Figures 8 & 9A, two folds are clearly visible in the aperture. Based on the photographs in Bouchet & Warén and in Warén (1991) of *I. alba* and those in Figure 9, it is not possible to distinguish unambiguously between *I. alba* and the variable *I. inflata*. Bouchet & Warén (1985: 261) indicate that *I. alba* might be hermaphroditic while *I. inflata* is dioecious.

Based on available material it appears that *I. inflata* is the most common species in the family on the slopes of the Norwegian Sea.

DISCUSSION

In their revision of the north-east Atlantic deep water species of the family, Bouchet & Warén (1985) included three species of *Admete* and three of *Iphinopsis*. Two of the species of *Admete* (*A. nodosa* Verrill, 1885 and *A. azorica* Bouchet & Warén, 1985) are only known from deep water in the southern part of the North Atlantic and they state that they are probably not very closely related to the type species, *Admete viridula*. These

two species have since been transferred to the genus *Brocchinia* Jousseaume, 1887. The remaining species, *A. viridula*, they regard as a most variable species with a pan-Arctic distribution from 10 m to 1416 m (the latter a shell from west of Iceland). In Scandinavia this nominal species is found all along the coast and in the fjords as well as on the slope. It is thus found in water temperatures ranging from -0.9°C (on the continental slope) to at least $+8^{\circ}\text{C}$ (in Scandinavian fjords). Such a wide temperature range is a fairly uncommon phenomenon (e.g. Høisæter, 2010a), and as is obvious from the above, I find it likely that three species of *Admete* are mixed together in the nominal species. In negative temperatures (and in the transition zone between negative and positive temperatures) on the slope off Norway, at least two additional species are present, *A. contabulata* and the very characteristic *A. clivicola* described above.

The type locality of *A. viridula* is the Arctic shelf (West Greenland, somewhere between 55 m and 109 m), and it is not obvious that the type specimens are conspecific with the fjord/shelf species in Scandinavia. The illustrations (figures 683 & 685) in Bouchet & Warén (1985) indicate that at least two species might be present in the Arctic, as the large shell from Spitsbergen shown in figure 685 is very similar to the shell called *A. laevior* Leche, 1878 in figure 108D in Kantor & Sysoev (2006). This form was described from the Bering Sea, and is accepted as a valid species by Kantor & Sysoev. The other form (figure 683 in Bouchet & Warén, 1985 and figure 40 in Schiøtte & Warén, 1992) is largely similar to the one I have described above as the Arctic form of *A. viridula*, while the shell from Säcken on the Swedish west coast (figure 686 in Bouchet & Warén) in all essentials is similar to my shelf/coast form. Future investigations might then reveal that the Arctic form, *Admete viridula sensu stricto*, is specifically distinct from the shelf/coast form in a species complex where also the slope form might warrant a separate name.

The possibility that *A. clivicola* has been described before as a variety of *A. viridula* should not be neglected. Bouchet & Warén (1985) list no less than 13 synonyms of *A. viridula*, but only two of these nominal species are illustrated, viz. the specimen of Møller's *Admete viridula* which they adopt as neotype of *Tritonium viridulum* Fabricius, 1780. The other one is the lectotype of *Admete contabulata* Friele, 1879. Apparently the large majority of the material available to Bouchet & Warén was specimens and shells from Arctic shallow water, and from shelf and fjord waters in southern Scandinavia. There are really no problems with *A. contabulata*, as the species described by Friele in 1879 is certainly the same as the one I have described above under this name. The choice of type material may be said to be less than optimal, as this specimen is somewhat 'atypical' (compare Figure 2 with Figure 3). The two varieties listed by G.O. Sars (1878) (var. *producta* and var. *undatocostata*), are definitely varieties of *A. viridula*, and can safely be eliminated as possible synonyms of *A. clivicola*. Although I have not seen specimens of the other varieties, they are all described on material from Arctic waters. Two species, in addition to *A. viridula*, are accepted by CLEMAM viz. *A. contabulata* and *A. sadko*. In WoRMS (2010) *A. sadko* is accepted, while *A. contabulata* is still regarded as a synonym of *A. viridula*. *Admete sadko* is presumably a high Arctic species, but no information is available to discuss its morphology relative to *A. clivicola* or to *A. contabulata*. I conclude that it is unlikely that my upper slope species has been named before.

Table 5. Depth distribution on the slope of *Iphinopsis* and the three species of *Admete*, based solely on the material from the 'Håkon Mosby' cruises. For queries see Tables for respective species. Station numbers are of the form 'yy.mm.dd.no'. Near bottom temperatures measured at the time of sampling.

Station number	Latitude N	Longitude E	Temperature °C	Depth m	<i>Admete clivicola</i>	<i>Admete contabulata</i>	<i>Admete viridula</i>	<i>Iphinopsis inflata</i>
83.06.07.2	64°26'	11°10'W	-0.2	400	2?			
81.08.16.12	62°28'	2°02'	0.3	502	1?			
83.06.17.2	62°20'	1°25'	1.9	543			2	
84.05.23.3	62°30'	1°51'	-0.4	576	2			
81.08.16.9	62°29'	1°45'	-0.9	602	18	1	2	
82.01.21.2	62°30'	1°43'	1.1	604	8			1
84.05.23.1	62°35'	1°48'	-0.8	656		1		
85.01.08.1	62°32'	1°27'	-0.9	701			1	
83.06.02.1	62°12'	0°00'	-0.3	708		1		
83.06.17.3	62°36'	1°14'	-0.9	781			1	
81.06.06.7	65°43'	5°14'	-0.9	794				1
82.01.21.4	62°34'	0°59'	-0.9	804		4		
85.01.08.2	62°42'	1°11'	-0.9	897		2		5
81.08.16.3	62°48'	1°03'	-1.0	1009		1		1
82.11.26.1	63°11'	2°46'	-1.0	1030				1
84.11.20.2	63°08'	1°54'	-0.9	1087				1
85.01.08.3	62°55'	0°56'	-0.9	1112				3
81.03.22.1	63°17'	4°25'	-0.9	1260				1
82.08.15.1	63°03'	0°49'	-1.0	1286				1
85.01.12.3	63°03'	0°49'	-0.9	1293				1
86.07.30.2	67°42'	3°04'	-0.9	1315				1
83.06.03.1	61°21'	3°11'W	-0.8	1338		1?		3

As is evident from Table 5, the four species exhibit a distinct zonation on the slope, with *A. clivicola* occupying a narrow zone from 576 to 604 m (with a single exception from 2000 m at 70°N), and *Iphinopsis* being confined to the lower slope, roughly from ~900 to 1350 m, with a few scattered specimens higher up on the slope. *Admete contabulata* is found mainly in depths from 600 to 1000 m, but with a single specimen at 1338 m in the Faroe–Shetland channel. Finally *A. viridula* is mainly a shelf and fjord species, although it is found scattered at least as far down as 781 m, in negative temperature water.

Except for *A. sadko* Gorbunov, 1946 the synonymy of Bouchet & Warén (1985) has been accepted by almost all later authors. Thus Malacolog (Rosenberg, 2009) lists 15 synonyms (including *A. sadko*) of *A. viridula* in the western Atlantic. This has had some unfortunate consequences, as Harasewych & Petit (1986) mixed together two species from the north-western Atlantic, one most likely an *Iphinopsis* and the other a juvenile very similar to *A. clivicola*, in their description of the shell and soft parts of *A. viridula*. Hasegawa (2000) and Kantor & Sysoev (2006) both accept *A. viridula* as the only species present in the Arctic, but they name several additional species from the Bering Sea and the north-west Pacific. There is no correspondence between the two sources or WoRMS (2010) concerning these names though, and the synonymy of *Admete* and *Iphinopsis* (and some related genera) in northern waters is apparently still in a chaotic stage.

The genus *Iphinopsis* might be a clear case of two sibling species inhabiting respectively Norwegian Sea sub-zero waters (*I. inflata*), and warmer North Atlantic deep water (*I. alba*). My material seems to contradict this conclusion, as I have specimens largely fitting the description of *I. inflata* both in positive temperature shelf water (the two specimens from the Barents Sea, Figure 9E, in addition to the one from 410 m reported by Bouchet & Warén, 1985) and in sub-zero

water from the slope between 900 and 1300 m. The records from BIOFAR (Snæli *et al.*, 2005) also seem to contradict this theory. One specimen of *I. alba*, verified by Warén was recorded from sub-zero water (-0.9°C) at 1098 m in the Faroe–Shetland Channel, while nine specimens of *I. inflata*, verified by Øystein Stokland, were recorded from various stations around the Faroes, at depths from 600 to 1100 m in both sub-zero and positive temperature water. Without access to the types of *I. alba*, it is impossible to be categorical, but my impression is that *I. alba* is an enigmatic species. Either *I. alba* is a junior synonym of the wide ranging *I. inflata*, or both *I. alba* and *I. inflata* are represented in my material from the slope outside Norway and the Barents Sea.

Both *Admete viridula* and *Iphinopsis inflata* have been found in both negative and positive temperatures, the former mainly in positive, the latter mainly in negative temperatures on the slope. They thus belong to a subset of species able to live both on the shelf and on the slope, although the preferences of both species are clear. *Admete contabulata* on the other hand is definitely a slope species, and has not been recorded from positive temperatures, while *A. clivicola* is perhaps the most restrictive of the four, occurring almost exclusively in the 'ecotone' depth zone where warm Atlantic water meets cold Norwegian Sea water in internal waves, fluctuating between positive and negative values on a diurnal basis (Høisæter, 2010a). A similar case is the two species of *Eumetula* discussed in Høisæter (2010b).

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Without the resourcefulness and persistent collecting efforts of Torleiv Brattegard throughout the 1980s, the material for this paper would have been non-existent. Several workshops have been arranged to work up the material from the series of 'Håkon Mosby' cruises. Jon Anders Kongrud and Tom

Alvestad of the Zoological Museum in Bergen have contributed with complete sorting of a majority of the samples. Jon Kongsrud is also thanked for having loaned me the museum material of *Admete* and *Iphinopsis*. Warm thanks also to Christoffer Schander who gave me a small sample of gastropods recently collected in Spitsbergen. He also kindly read an earlier version of this paper, as did Anders Warén who also sent a photograph of the MAREANO specimen. Warm thanks as well to Tom Schiøtte who contributed to fundamental clarification on the type material of *A. viridula*. Finally thanks to Per Bie Wikander who brought to my attention the specimen of *A. clivicola* from the MAREANO material, and the MAREANO-team for permitting me to use the specimen. Two anonymous referees suggested a number of useful changes.

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