How well are the northern whelks known? The genus *Anomalisipho* Dautzenberg & H. Fischer, 1912 (Gastropoda: Buccinidae) in the North Atlantic Ocean.

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MOTS CLEFS. Gastéropodes, Buccinidae, Colinae, *Anomalisipho*, Océan Atlantique, Océan Arctique, Pliocène, Pléistocène, Red Crag, Taxonomie, Systématique.

ABSTRACT. The Atlantic species assigned to the genus *Anomalisipho* Dautzenberg & H. Fischer, 1912 are discussed. The status of the genus and the conchological similarities with species assigned to *Helicofusus* Dall, 1916 and the differences with *Plicifusus* Dall, 1902 are discussed.
Anomalisipho virgata (Friele, 1879) is confirmed as distinct from *A. verkruezeni* (Kobelt, 1876), based on shape, sculpture, colour, periostracum, morphological characteristics of the operculum and the way erosion has impact on the outer layer of the shell. *Buccinum brucei* Melvill & Standen, 1900 is confirmed as a synonym of *A. virgata* instead of *Retifusus latericeus* (Möller, 1842).
Fusus altus Wood, 1842 (= *Trophon altum* Wood, 1848) is confirmed as exclusively fossil. The species is excluded from the genus based on conchological characteristics that differ from *A. verkruezeni*, but no alternative is proposed, its placement being still uncertain.
In addition, *Anomalisipho martensi* (Krause, 1885), a species that occurs in the adjacent Arctic Ocean, is discussed.

RESUMÉ. Les espèces atlantiques attribuées au genre *Anomalisipho* Dautzenberg & H. Fischer, 1912 sont ici discutées. Le statut du genre et les similitudes conchologiques avec les espèces attribuées à *Helicofusus* Dall, 1916 ainsi que les différences avec *Plicifusus* Dall, 1902 sont également abordées.
Anomalisipho virgata (Friele, 1879) est confirmée comme espèce distincte de *A. verkruezeni* (Kobelt, 1876) sur base de la forme, de la sculpture, de la couleur, du périostracum, des caractéristiques morphologiques de l'opercule et de la manière dont l'érosion exerce un impact sur la couche extérieure du test. *Buccinum brucei* Melvill & Standen, 1900 est confirmée comme synonyme de *A. virgata* au lieu de *Retifusus latericeus* (Möller, 1842).
Fusus altus Wood, 1842 (= *Trophon altum* Wood, 1848) est confirmée comme espèce exclusivement fossile. Elle est exclue du genre en raison de caractéristiques conchologiques différentes de celles de *A. verkruezeni*, cependant aucune alternative n'est proposée, sa position étant encore incertaine.
Anomalisipho martensi (Krause, 1885), espèce présente dans les eaux adjacentes de l'Océan Arctique est également commentée.

INTRODUCTION

The genus *Anomalisipho* has an enigmatic imago among scientists and collectors. The species are exclusively known from the northern cold-water fauna, from boreal up to the High Arctic, mainly in deep water. The number of known species is low and has always been under discussion, moreover the number of available specimens for study is limited. Notwithstanding its rarity, the genus is often recorded in faunal studies and appears regularly in malacological and conchological publications covering the North Atlantic. The result is a moderately rich synonymy, a phenomenon that is quite symptomatic for cold-water Buccinidae. Apart from the descriptions of the taxa and the subsequent records under various combinations, no revision of the genus has been published yet. The first constructive discussion about the Atlantic *Anomalisipho* species was produced by Bouchet and Warén (1985: 234) who listed the known names and type material as synonyms under *Colus verkruezeni* (Kobelt, 1876), at that time within the genus *Colus* for the sake of simplicity (Bouchet and Warén, 1985: 226–227), and who correctly hesitated to consider the fossil *Fusus altus* Wood, 1842 conspecific with the extant species. In the present paper we restore the specific status of *A. virgata*, retracting it from synonymy with *A. verkruezeni*. Óskarsson (1982: 250, 252) listed the two species from Icelandic waters under the names *Sipho verkrüzeni* and *Sipho altus* with respectively illustrations of the drawning from Dautzenberg & H. Fischer (1912) (which is *A. verkruezeni* indeed) and the one from Friele (1882) (which is *A. virgata*). In the past, however, many authors have clustered both species under a single name, whether under *A. altus* or *A. verkruezeni*. Under a single name, the resulting problem is the impossibility to tell which biogeographic record in literature belongs to which species, except from the rare cases where the specimens in question are figured or described.
The present publication will offer a new platform to review these topics and to facilitate further studies.

Abbreviations

BH: Collection Bart van Heugten, The Netherlands.
CDRS: Collection Christiane Delongueville and Roland Scaillet, Belgium
CMN: Canadian Museum of Nature, Ottawa (Ontario), Canada
DM: Collection David McKay, Scotland
FINM: Faroe Islands National Museum, Tjóðsavnið, Kaldbak, Faroe Islands
FN: Collection Frank Nolf, Belgium
KF: Collection Koen Fraussen, Belgium
MFRI: Marine and Freshwater Research Institute, Hafnarfjörður, Iceland
MLI: Maurice Lamontagne Institute, Pêches et Océans, Mont-Joli, Québec, Canada
MOM: Musée océanographique de Monaco, Monaco
MNHN: Muséum national d'Histoire naturelle, Paris, France
MNHU: Museum für Naturkunde, Humboldt-Universität, Berlin, Germany
NHM: Naturhistorisk Museum (Natural History Museum), University of Oslo, Norway
NHMD: Natural History Museum of Denmark, Copenhagen, Denmark
NHMUK: Natural History Museum, London, England
NMS: National Museums of Scotland, Edinburgh, Scotland
RBINS: Royal Belgian Institute of Natural Sciences, Brussels, Belgium
SH: Collection Steve Hubrecht, Belgium
SMF: Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt am Main, Germany
SMNH: Naturhistoriska Riksmuseet (Swedish Museum of Natural History), Stockholm, Sweden
USNM: Smithsonian Institution, National Museum of Natural History, NW Washington DC, United States
ZMB: Zoologisk Museum, Bergen, Norway
ZMMU: Zoological Museum of Moscow University, Russia

WoRMS: World Register of Marine Species

dd: empty shell(s)
lv: live collected specimen(s)
stn: station

SYSTEMATICS

Family **BUCCINIDAE** Rafinesque, 1815
Genus ***Anomalisipho*** Dautzenberg & H. Fischer, 1912: 99.

Type species. "*Sipho* (*Anomalisipho*) *Verkrüzeni*, Kobelt" (= *Anomalisipho verkruezeni*) by original designation (Dautzenberg & H. Fischer, 1912: 99).
"*Colus dautzenbergi* Dall, = *Sipho verkruzeni* D. & F., 1912, not of Kobelt, 1876" (= *Anomalisipho verkruezeni*) by subsequent designation (Dall, 1916: 8).

The spelling "*Anomalosipho*" by Harmer (1914: 149–152) and subsequent authors is an incorrect subsequent spelling.

In his brief prodrome, Dall (1916: 8) suggested "*Colus dautzenbergi* Dall (= *Sipho verkruzeni* Dautzenberg & H. Fischer, 1912, not of Kobelt, 1876)" as type species (as subsequent designation). He considered the shell figured by Dautzenberg & H. Fischer (1912) (thus the type species) as being different from the real *A. verkruezeni*. A full report was more or less delayed and the data upon which this prodrome was based became published two years later (Dall, 1918: 212–213, 218). Dall placed *Anomalisipho* as a subgenus in *Colus* (1916: 7–8 and 1918: 216–218). He proposed (1918) *A. dautzenbergi* (the shell figured by Dautzenberg & H. Fischer as *A. verkruezeni*) for type species of the subgenus. We will discuss this subject below, under *A. verkruezeni*.

Tiba & Kosuge (1981: 7–9) placed *A. verkruezeni* in the genus *Fusivolutopsius* Habe & Sato, 1973 [type species *F. hirasei* (Pilsbry, 1907)], based on conchological similarities with *Plicifusus aurantius* (Dall, 1907). They selected (Ibid, 1981: fig. 1) a lectotype for *A. verkruezeni*. The other shells figured on that plate (Ibid, 1981: fig. 2–6) under the name "*Fusivolutopsius verkruzeni*", from Japan, Mombetsu, however, have a more *Plicifusus*-like shape and sculpture and, including the text figure with the radula "of *P. verkruzeni*" (Ibid, 1981: 8), do not belong to *A. verkruezeni*. They may belong either to *Plicifusus rhyssoides* Dall, 1918 according to Hasegawa (2009: 301) or to *P. aurantius* according to our observations. Both *P. rhyssoides* and *P. aurantius* are synonymized with *P. rhyssus* (Dall, 1907) by Kosyan & Kantor (2012: 77–78).

Remarks. - *Anomalisipho* is characterized by its thin to moderately thick, solid, medium sized shell, the slender shape with high spire, the moderately small protoconch on a rather blunt apex, the peculiar short but broad siphonal canal, the spiral sculpture consisting from fine to obscure spiral cords, the axial sculpture consisting of weak ribs usually present on the upper spire whorls only and the paucispiral, elliptical operculum with a marginal umbo which is lifted in virtually all adult and subadult specimens. The radula is typical for Colinae and was figured by Friele (1882: pl. 6, fig. 3–4, for *A. virgata*).
Species belonging to the genus *Anomalisipho* may display a high variation in shape. The surface of the shell is often eroded and, consequently, looks distinct from fresh or subadult specimens. Moreover, subtle differences in erosion patterns between *A. verkruezeni* and *A. virgata* may help the determination.
Plicifusus Dall, 1902 (type species: *Fusus kroyeri* Möller, 1842, by original designation) and in particular the species commonly assigned to "*Helicofusus*" by authors (for a discussion of the

status of *Helicofusus* see Kosyan & Kantor, 2012: 88), differs from *Anomalisipho* by the usually more curved and much stronger axial ribs, the constricted base with a slightly longer siphonal canal and the more convex whorls.
Some species belonging to *Kanamarua* Kuroda, 1951 look much similar to *Anomalisipho*. The type species of this genus, *Colus* (*Aulacofusus*) *adonis* Dall, 1919 (original designation by Kuroda, 1951: 69), was therefore included within the subgenus "*Anomalosipho*" by Dall (1918: 218). *Kanamarua*, however, belongs to the family Colubrariidae Dall, 1904 and has a much smaller operculum and a minute, distinct radula. The shells can be distinguished from *Anomalisipho* by the usually larger protoconch that forms a blunt shaped apex, the glossy shell, the usually narrower aperture, the presence of a short siphonal canal and by the much thinner periostracum.

Included species
Anomalisipho verkruezeni (Kobelt, 1876)
Sipho Verkrüzeni Kobelt, 1876
= *Anomalosipho dautzenbergi* Dall, 1916 (part)
= *Anomalosipho frielei* Kantor, 1981
Anomalisipho virgata (Friele, 1879)
Neptunea (*Sipho*) *virgata* Friele, 1879
= *Sipho Verkrützeni* var. *plicifera* Brøgger, 1900
= *Buccinum brucei* Melvill & Standen, 1900
= *Anomalosipho dautzenbergi* Dall, 1916 (part)
= *Helicofusus paraelatior* Kantor, 1981
Anomalisipho martensi (Krause, 1885)
Sipho martensi Krause, A., 1885: 287, pl. 18, fig. 18
= *Fusus* (*Euthria*) *conulus* Aurivillius, 1885: 354, 377, pl. 13, fig. 6
= *Anomalisipho conulus* monstr. *reversa* Löyning, 1932
Anomalisipho species from the northern Pacific are not handled in the present study.

Excluded species (see further)
Murex pullus Woodward, 1833 - fossil
= *Fusus altus* Wood, 1842 - fossil (= *Trophon altum* Wood, 1848)
= *Trophon altus* var. *bucciniformis* Wood, 1872 - fossil
= *Trophon altus* var. *costellatus* Wood, 1872 - fossil

Anomalisipho verkruezeni (Kobelt, 1876)
Figs 1A–C, 2A–E, 4A–D, 9A–D.

Sipho Verkrüzeni Kobelt, 1876: 70–72, pl. 2, fig. 1–1b (Fig. 1A–C).
The original spelling *verkrüzeni* has to be mandatory corrected to *verkruezeni* according to I.C.Z.N. 32.5.2.
Colus dautzenbergi (part) Dall, 1916: 8, under subgenus "*Anomalosipho*".
Anomalosipho frielei Kantor, 1981: 1148–1149, fig. 2–3.

Chresonymy
Sipho (*Anomalisipho*) *Verkrüzeni* — Dautzenberg & H. Fischer, 1912: 99–100.
Sipho (*Anomalisipho*) *Verkruzeni* — Dautzenberg & H. Fischer, 1912: pl. 4, fig. 8 (Fig. 9B).
Colus dautzenbergii (part) — Dall, 1918: 212–213, 218, under subgenus "*Anomalosipho*".
Anomalosipho verkruzeni — Pain, 1980: 19.
Anomalosipho verkrüzeni — Kantor, 1981: 1147.
Fusivolutopsius verkruzeni —Tiba & Kosuge, 1981: 1, 7–9.
Sipho verkrüzeni — Óskarsson, 1982: 250–251, fig. 101.
Colus verkruezeni — Bouchet & Warén, 1985: 234, fig. 661–664.
Anomalosipho frielei — Ivanov & Sysoev, 2000: pl. 17, fig. E–F.

Anomalosipho verkruezeni — Kantor & Sysoev, 2006: 178, pl. 88, fig. A–B.
Colus (*Anomalosipho*) *altus* (part) — Zakharov, 2013: 35, 37, 119–120.
Colus verkruzeni — Gulliksen et al., 1999: 66, 96.
Colus verkruezeni (part) — Sneli et al., 2005: 70.
Anomalisipho verkruezeni — Alf et al., 2020: 165–166: pl. 136.

Figure 1, si possible.

Dall (1916: 8), in his brief "prodrome", proposed the name "*Colus dautzenbergi* Dall, (= *Sipho verkruzeni* D. & F. 1912, not of Kobelt, 1876)", while the data upon which this name was based was published two years later (Dall, 1918: 212–213). The short note in 1916, that *A. dautzenbergi* is the same as the interpretation of *A. verkruezeni* by Dautzenberg & H. Fischer, is, according to I.C.Z.N. rules, sufficient for validating the species. Note that Dall spelled *A. dautzenbergi* with a single *–i* (*-i*) in 1916 (8) but with a double (*-ii*) in 1918 (213, 218). Differences in shape and colour between the species described by Kobelt and the shells recorded by Dautzenberg & H. Fischer (1912: 99–100, pl. 4, fig. 8) were sufficient reasons for Dall (1918: 212) to establish this second taxon. A few lines later, Dall (1918: 213) also mentions differences in accentuation of the spiral sculpture. Dall received several specimens from Verkrüzen and mentioned (1918: 212) "*It is possible that Verkrüzen, who was not an expert, may have sent out more than one species under that name.*" but we are uncertain if he also received specimens of *A. virgata* among them. Note that Dall took the opportunity to impose his personal opinion about the supposed "abilities" of Verkrüzen within this remark. We assume that Dall had, apart from *A. verkruezeni*, also specimens of *A. virgata* in front of him. His remark (Dall, 1918: 213) on the strength of the spiral cords is clear, "*…which has perfectly obvious strong spiral sculpture and is closely related to* "Euthria" conulus *Aurivillius, from the Arctic Ocean near Bering Strait, …*". Nevertheless, it is remarkable that Dall did not mention *A. virgata*, a specimen described by Friele more than 35 years earlier. Yet that species must have been known by him. It is hard to believe that Dall would have exaggerated the differences in spiral sculpture, or that he made a mistake, and that all the specimens studied by him are extreme morphs of *A. verkruezeni*. A specimen labelled as "*Sipho verkruzeni*" that we studied in the Dautzenberg collection (RBINS) is badly eroded but, judging from the characteristics at hand, indeed appears to belong to *A. verkruezeni*. But here also we found no reference to *A. virgata* in the work of Dautzenberg & H. Fischer (1912). Neglecting *A. virgata* seems to be symptomatic for the species already at that time and part of *Anomalisipho* specimens in collections, also the ones sent to Dall, may have belong partly to *A. virgata*. Whatever the case, the specimen figured by Dautzenberg & H. Fischer (1912: pl. 4, fig. 8) has all characteristics of a real *A. verkruezeni*. Notwithstanding this, the name *A. dautzenbergi* may be based on both *A. verkruezeni* (the specimen figured by Dautzenberg & H. Fischer) and *A. virgata* (the, above mentioned, strongly sculptured specimens studied by Dall).
Sufficient variation is present within *A. verkruezeni* to cause confusion and to get the impression that we are dealing with two species rather than a single. We have no evidence whether all morphs assigned to *A. verkruezeni* belong to more than a single species. We discuss the variability below, under the remarks on that species.

Anomalispho verkruezeni is often placed in synonymy with the fossil *Fusus altus* Wood, 1842, eventually together with *A. virgata*. Records in literature are, as a result, impossible to assign to a single species and may belong to *A. verkruezeni* or *A. virgata* or both (see for example Zakharov, 2013: 35, 119–120 who briefly discussed this problem and the use of *A. altus* and *A. verkruezeni* in literature).

The spelling "*verkrützeni*" was used by Brøgger (1900: 32, 50–51) in combination with a form of *A. virgata*. The placement of this spelling under *Anomalosipho altus*, together with *Sipho virgata*, confirms that Gulliksen et al. (1999: 96) had correctly *A. virgata* in mind. We therefore do not list this reference here but under *A. virgata* instead.

Figure 2, si possible.

Type material. Lectotype of *Sipho Verkrüzeni* in SMF 253576/1, selected and figured by Tiba & Kosuge (1981: fig. 1), Bouchet & Warén (1985: fig. 661) and Kantor & Sysoev (2006: pl. 88, fig. A). Holotype of *Anomalosipho dautzenbergi* in MOM, which is the specimen figured by Dautzenberg & H. Fischer, 1912: pl. 4, fig. 8 as *Sipho* (*Anomalisipho*) *Verkruzeni* (Fig. 9B). Holotype of *Anomalosipho frielei* in ZMMU Lc-5156, figured by Kantor (1981: fig. 2–3), Ivanov & Sysoev (2000: pl. 17, fig. E–F) and Kantor & Sysoev (2006: pl. 88, fig. B).

Kobelt (1876: pl. 2, fig. 1–1b) had two specimens at hand for his description of "*Sipho Verkrüzeni*" and gave both figures the number "1", with figure 1b being an operculum. He clearly gave the size of this shells "*Long. spec. majoris 50, lat. max. 22, alt. apert. 20 mm." and " – – min. 46, lat. 20, alt. apert. 17 mm*." (1876: 71). Tiba & Kosuge (1981: 9–8) selected as lectotype for "*Fusivolutopsius verkruzeni*", chosing the largest of the two, which is the left shell on Kobelt's figure 1, but measuring it 53 mm. Bouchet & Warén (1985: 234) and Kantor & Sysoev (2006: 178) measured 49.7 mm which is the correct size and agreeing with the size given by Kobelt (Fig. 1A).

Type localities. *Sipho verkruezeni*: Barents Sea, North Norway, Porsangerfjorden (Kobelt, 1876: 71); *Colus dautzenbergi*: Barents Sea, off North Cape, "Stn. 960, entre la Norvège et l'Ile des Ours", 72°37'N, 20°00'15''E, 394 m (Dall, 1916: 8 = Dautzenberg & H. Fischer, 1912: 534, pl. 4, fig. 8); *Anomalisipho frielei*: Barents Sea, off Murmansk coast, 69°31'5N, 36°00'E, 200–202 m (Kantor, 1981: 1148, fig. 2–3).

Material examined. Off Newfoundland: *Hirondelle* stn 161, 46°04'40''N, 49°02'30''W [49°02'30''W of Paris = 46°42'16''W of Greenwich], 1267 m, 1 dd, RBINS I.G.-10591 (Fig. 4A); Flemish Cap, on sand, gravel and sponges, 285 m, 2 lv, KF-4323 (Fig. 4C), SH.
Off Iceland: MFRI (Figs 2A–E, 9C) stn A3-2016-109, 67°06.02'N, 23°32.00'W – 67°08.94'N, 23°38.88'W, 228–250 m, 1 lv, CDRS (Fig. 2A); stn A10-2015-601, 66°28.60'N, 26°24.26'W – 66°31.41'N, 26°26.79'W, 595–560 m, 1 lv, CDRS (Figs 2B, 9C); stn A3-2016-93, 66°54.25'N, 22°57.42'W – 66°56.75'N, 22°49.51'W, 203–212 m, 1 lv, CDRS (Fig. 2D); stn A4-2018-76, 67°06.09'N, 23°13.63'W – 67°04.09'N, 23°22.42'W, 246–246 m, 1 lv, CDRS (Fig. 2C); stn A3-2016-90, 66°51.00'N, 23°19.66'W – 66°51.94'N, 23°09.93'W, 216–194 m, 1 lv, CDRS (Fig. 2E); off Iceland, trawled by Belgian fishermen, 5/1971, 2 lv, FN.
Off Svalbard: E-SE off Hopen Island, 75°40'N – 76°20'N, 27°50'E – 32°10'E, 350–400 m, 1 lv, KF-1536.
Barents Sea: Swedish Arctic Expedition 1898 stn 42, between Bear Island and Norway, 73°03'N, 18°30'E, 410 m, 1 dd, SMNH 88856; Kola Peninsula, off Murmansk, trawled by fishermen, 150 m, 1 dd, BH; off Kola Peninsula, 40°E., 210 m, 1 dd, KF-1889 and trawled by fishermen, old collection, 1 dd, KF-5210 (Fig. 4D).
Off Faroe Islands: BIOFAR stn 080, 60°38.89'N, 08°27.93'W, 678 m, 1 lv, FINM (Fig. 4B).

Range. North Atlantic Ocean from eastern Canada (Newfoundland), north and west Iceland, Svalbard, North Norway and Barents Sea and to the Faroe Islands in the south (Fig. 9A, D).
The first record of *A. verkruezeni* from Icelandic waters was published by Óskarsson (1982: 250–251). The shell was taken alive by fishermen but without detailed data. The species in Icelandic waters seems to live mainly along the north and the west coast as suggested by the results of the MFRI sampling campaigns.
The southernmost locality for *A. verkruezeni* off the Faroe Islands (Fig. 4B) recorded by Sneli et al. (2005: 70, BIOFAR stn 080 at 60°38.89'N) is hereby confirmed.
The shell recorded by Macpherson (1971: 79–80, pl. 5, fig. 6) as *Anomalosipho* cf. *verkruezeni* (Fig. 7I) from Beaufort Sea (MacKenzie Bay) is *A. martensi* as we could confirm on the basis of recent images provided by CMN (Ottawa), Canada.

We found no confirmation for the presence of *A. verkruezeni* in the Pacific Ocean. All records we studied from outside the Atlantic Ocean, belong to other species.
Feder et al. (1994: 160) listed *Colus dautzenbergi* from eastern Chukchi Sea. We have not studied this material and therefore cannot confirm the identification or wether the specimen(s) belong to *A. martensi*.

Bathymetric range. From 150 m (Barents Sea) to 1267 m (Newfoundland). [off Newfoundland, 285 to 1267 m (KF-4323, lv and RBINS I.G.-10591, dd) for empty shells, alive at 285 m (KF-4323, 2 lv); off West Iceland, 219 to 595 m (MFRI, lv, 5 stns); off Faroe Islands, 678 m (BIOFAR, stn 80, lv); in Barents Sea, 150 to 410 m (Kola Peninsula, BH, dd) and between Bear Island and Norway (SMNH 88856, dd) for empty shells, alive at 200-202 m (Kantor, 1981: 1148)].

Habitat. *Anomalisipho verkruezeni* is collected on mud and clay (Swedish Arctic Expedition 1898 stn 42 in SMNH 88851), sometimes with gravel (Dautzenberg & H. Fischer, 1912: 534–535), off the Faroe Islands on fine sand (Nørrevang et al., 1994: 173).
Bottom temperatures recorded by MFRI range from 0.1 and 0.2°C (at stn A10-2015-601 and A3-2016-109) to 4.1 and 4.2°C (at stn A3-2016-93 and A3-2016-90 respectively).

Remarks. *Anomalisipho verkruezeni* is characterized by its moderately thin but solid shell with high spire, the laterally only weakly convex whorls and the smooth surface with minute spiral lines that are hardly visible and without axial sculpture, the thin and rather greyish periostracum, the purplish or brownish coloured shell of fresh specimens especially on the columella and in the aperture, the usually purple-brown band along the periphery of the last whorl in fresh specimens (Fig. A–B, D) and the usually small operculum.
The variability in *A. verkruezeni* is rather high, as is usual among most Buccinidae. Spiral sculpture can range from obscure, occasionally almost invisible, to moderately pronounced spiral lines forming deep incisions. This spiral sculpture, however, stays always fine in both cases. Larger specimens (which comprise the majority of the specimens we studied) tend to have a thin shell, while smaller shells (some offshore Newfoundland) usually have a thicker shell with a slightly narrower shape and, consequently, a smaller aperture. It is entirely possible that both morphs represent distinct species, nevertheless we have no proof and we see no reason to stray away from the common knowledge that Buccinidae show a high degree of morphological plasticity.
Anomalisipho virgata differs from *A. verkruezeni* by its usually more fragile shell, the slightly more convex whorls, the usually shorter spire, the presence of fine but distinct spiral cords, the presence of thin axial ribs at least along the upper spire whorls, the white columella also in fresh specimens, the usually slightly greener periostracum, the usually larger operculum and the usually smaller adult size. *A. virgata* usually comes with badly eroded upper spire whorls as described already by Thorson (1941: 84–85), while *A. verkruezeni* appears to have a more intact shell in most of the cases. When eroded, then the remaining shell is much thinner and more fragile in *A. virgata*, with a more abrupt edge around the affected place, while *A. verkruezeni* appears to have lost a thinner outer layer.

Anomalisipho virgata (Friele, 1879)
Figs 3, 4E–G, 5A–I, 9A, D–F.4E, 9F

Neptunea (*Sipho*) *virgata* Friele, 1879: 281 (Fig. 3).
Buccinum brucei Melvill & Standen, 1900: 9, (fig.) (Figs 4E,9F).
Sipho Verkrützeni var. *plicifera* Brøgger, 1900: 32, 50–51, pl. 1, fig. 1.
Helicofusus paraelatior Kantor, 1981: 1147–1148, fig. 1.

Figure 3, si possible.

Chresonymy

Neptunea (*Sipho*) *virgata* — Friele, 1882: 13–14, pl. 1, figs. 21–25, pl. 6, figs. 3–4.
Neptunea (*Sipho*) *virgata* — Friele & Grieg, 1901: 104.
Anomalosipho altus var. *virgata* — Harmer, 1914: 151, pl. 15, fig. 7.
Sipho (*Anomalosipho*) *altus* — Odhner, 1915: 206–207, non Wood, 1842.
Colus dautzenbergi (part) — Dall, 1916: 8, under subgenus "*Anomalosipho*"; Dall, 1918: 212–213, 218, under subgenus "*Anomalosipho*".
Sipho (*Anomalosipho*) *altus* — Thorson, 1941: 84–85, non Wood, 1842; Thorson, 1944: 83–84, non Wood, 1842.
Anomalisipho brucei — Smaldon et al., 1976: 44.
Anomalosipho altus — Pain, 1980: 18–19, non Wood, 1842.
Sipho altus — Óskarsson, 1982: 252, fig. 103.
Helicofusus paraelatior — Ivanov & Sysoev: 2000: pl. 17, fig. C–D.
Anomalosipho altus — Gulliksen et al., 1999: 65, 96.
Colus verkruezeni (part) — Sneli et al., 2005: 70 (Fig. 5I).
Colus (*Anomalosipho*) *altus* (part) — Zakharov, 2013: 35, 119–120, fig. 87.

A couple of years after his description of *Anomalisipho virgata*, Friele (1882: 13–14) suggested that his species may be a form of *Trophon altum* Wood, 1848 (see below, under *Murex pullus*, for more details and the citations), a species that we exclude from the genus. It seems that numerous authors took note of Friele's remark and used Wood's name for *A. virgata* and/or for *A. verkruezeni*, especially in Russian literature. Records in literature are, as a result, not based on a single species but may belong to *A. verkruezeni* or *A. virgata* or both (see for example Zakharov, 2013: 35, 119–120 and Gulliksen et al., 1999: 65, 96).

Dall (1918: 218) misspelled the form "*plicifera"* described by Brøgger, as well as its author, as "*plicata*" by "Brögger", and suggested that it may be a subadult *Plicifusus arcticus* (Philippi, 1850) [= *Plicifusus kroyeri* (Möller, 1842)]. Both type figures look quite similar indeed. Moreover, the fossil fauna reported on by Brøgger has more affinities with a fauna from moderately shallow water (where one can expect to find *P. kroyeri*) rather than a deep-water fauna (where *A. virgata* lives). The type figure of *plicifera* (Brøgger, 1900: pl. 1, fig. 1), however, shows axial ribs that are clearly straight, whorls that are only weakly convex and about 7 whorls on a small (about 5 cm) shell. *P. kroyeri* differs by its more convex whorls and larger adult size. We didn't study the material reported on by Brøgger but as he already mentioned the presence of weak axial folds and compared his shell to "*Sipho Krøyeri*" (Brøgger, 1900: 51), we rely on his expertise.

We agree with Friele & Grieg (1901: 104) who were the first to place their *Buccinum brucei* in synonymy with *Neptunea* (*Sipho*) *virgata*.
Golikov & Scarlato (1977: 328) placed *Buccinum brucei* in synonymy with *Microfusus latericeus*. Maybe they based their opinion on the record by Petrov (1966: 173–174, pl. 8, fig. 4) of *Sipho latericeus* from the Quaternary fauna of Chukotsk Sea. That shell in question, however, is not that species but looks more similar to *Anomalisipho martensi*. Note that this species cited by Petrov (1966) and by Golikov & Scarlato (1977) is now placed in *Retifusus* by Kosyan & Kantor (2014: 158–160) and named *Retifusus latericeus* (Möller, 1842).
We studied the holotype of *Buccinum brucei* (Fig. 4E), thanks to images provided to the public on Mollusca Types in Great Britain (Ablett et al., 2019). The species is named after William Bruce, zoologist at the Jackson-Harmsworth Expedition, notable for retrieving molluscs and other specimens from the stomach of walrus (Bruce, 1898: 137 and Melvill & Standen, 1900: 9) shot for food (Jackson, 1898: 115, 117). This is also the expediton where on 17 June 1896 the legendary meeting between Jackson and Nansen took place. But this is another story to be read in Jackson (1898 and 1935).

Fossils are recorded from Pleistocene deposits at Sandefjord, Norway, as *Sipho Verkrützeni* var. *plicifera* by Brøgger (1900: 32, 51) and from the Pliocene of Hallbjarnarstaðir, Iceland, as *Anomalisipho verkrüzeni plicifera* by Schlesch (1924: 330, pl. 7, fig. 12). We have not studied the material listed by Harmer (1914: 149–151, pl. 15, fig. 7–10) as "*Anomalosipho Verkruzeni* Var. *Plicifera*" and "*A. altus* Var. *virgata*".

Type material. Holotype of *Anomalisipho virgata* in ZMB 20622, its protoconch figured by Bouchet & Warén (1985: fig. 664). Holotype of *Helicofusus paraelatior* in ZMMU Lc-5155, figured by Kantor (1981: 1148, fig. 1) and Ivanov & Sysoev (2000: 145, pl. 17, fig. C–D). Holotype of *Buccinum brucei* in NMS.Z.1921.145.179. (Figs 4E,9F). Type of *Sipho Verkrützeni* var. *plicifera* in NHM, not studied.

Type localities. *Neptunea (Sipho) virgata*: Vöringen stn 124, SW of Lofoten, N Norway, 640 m (Friele, 1879: 281); *Buccinum brucei*: Franz Josef Land, Günther Sound, North end of Windy Gulley, 10 fathoms (about 18 m) (Melvill & Standen, 1900: 9); *Sipho Verkrützeni* var. *plicifera*: Pleistocene deposits at Sandefjord, Norway (Brogger, 1900: 32, 51); *Helicofusus paraelatior*: Barents Sea, off Murmansk, "A. Otkupshchikov" cruise 181, stn 43, 69°29'N, 34°06'E, 200–207 m (Kantor, 1981: 1147).

Material examined. Off Iceland: MFRI (Fig. 5A–H) stn A5-2017-71, 67°14.99'N, 22°06.23'W – 67°14.98'N, 22°16.46'W, 372–346 m, 2 lv, CDRS (Fig. 5A,G); stn A3-2014-67, 67°15.04'N, 22°15.47'W – 67°14.98'N, 22°05.19'W, 344–374 m, 1 lv, CDRS (Fig. 5B); stn A10-2013-616, 67°37.30'N, 20°43.81'W – 67°35.37'N, 20°37.63'W, 540–477 m, 1 lv, CDRS (Fig. 5C); stn A13-2017-637, 64°34.46'N, 11°27.88'W – 64°35.33'N, 11°21.30'W, 439–430 m, 1 lv, CDRS (Fig. 5H); stn A2-2015-90, 67°15.06'N, 22°05.54'W – 67°15.03'N, 22°15.80'W, 371–341 m, 1 lv, CDRS (Fig. 5F); stn A10-2015-669, 64°34.17'N, 10°28.03'W – 64°31.61'N, 10°31.61'W, 467–440 m, 1 lv, CDRS (Fig. 5E); stn A10-2015-671, 63°58.08'N, 09°37.21'W – 64°00.75'N, 09°39.79'W, 712–724 m, 1 lv, CDRS (Fig. 5D); stn A12-2018-710, 64°01.32'N, 9°50.60'W – 64°03.20'N, 9°55.83'W, 703–686 m, 1 lv CDRS.
Svalbard: *YMER* stn 0098, E of Nordaustlandet, 79°19'N, 33°32'E, 240 m, 1 dd, SMNH 55532; *YMER* stn MB15, NE of King Charles Land, 79°19'N, 33°30'E, 235–240 m, 1 dd, SMNH 88851; Swedish Arctic Expedition 1861 stn 07, West Spitsbergen, 78°50'N, 15°00'E, 54.6 m, 1 dd, SMNH 88855.
Franz Josef Land: Günther Sound, North end of Windy Gulley, 10 fathoms (about 18 m), 1 dd, NMS.Z.1921.145.179.
South of Svalbard: E-SE off Hopen Island, 75°40'N – 76°20'N, 27°50'E – 32°10'E, 350–400 m, 4 lv, KF-1537 (Fig. 4F,G), BH, DM.
Off Faroe Islands: BIOFAR stn 095, 60°41.51'N, 05°18.63'W, 803 m, 1 lv, FINM; stn 425, 62°56.03'N, 09°28.12'W, 509 m, 1 lv, FINM (Fig. 5I).
Off Shetland Islands, United Kingdom: 44' N-NW off Muckle Flugga, 61°27'N, 01°42'W, 650 m, 1 lv, DM.

Figure 4, si possible.

We studied part of the material listed by Odhner (1915: 206) under *Sipho* (*Anomalosipho*) *altus*, thanks to images provided by SMNH. The specimens are the juveniles from Swedish Arctic Expedition 1908 stations 44, 78 and 130, stored in SMNH (88857 to 88859), the adults from station 94 and 99 could not be traced. The juveniles are too small, and often eroded, to confirm the identification. We found no juveniles with an intact sculpture that overlaps with the remaining sculpture of the adult and subadult specimens we have at hand. The only specimen we know with an intact apex is the holotype of *A. virgata*, figured by Friele (1882: pl. 1, fig. 21, 24) and Bouchet & Warén (1985: fig. 664) but also that protoconch is slightly eroded.

Range. *Anomalisipho virgata* is known from the Northeast Atlantic Ocean, from East Greenland, along Iceland and Norway (Sørfjorden) to as south as the Faroe Islands and the Shetland Islands, in the Barents Sea and along Svalbard to Franz Josef Land in the east. (Fig. 9A,D).
Anomalisipho virgata was recorded from East Greenland (off Little Pendulum Island, at Franz Joseph Fjord and Scoresby Sund) by Thorson (1944: 83–84) and from northern Iceland (off Horn in NW Iceland by Óskarsson (1982: 252) and off Þistilfirði in NE Iceland by Thorson (1941: 84). In the present paper we record the species also from southwestern Iceland (Iceland-Faroe Ridge). Thorson (1951) does not report the presence of *A. virgata* along the western coasts of Greenland.
The southern most localities for *Anomalisipho virgata* are recorded herein [off Shetland Islands at 61°27'N (DM) and off Faroe Islands at 60°41.51'N (BIOFAR stn 95)].
We observed that *Anomalisipho verkruezeni* lives along the more northern coast of Iceland while *A. virgata* appears to have a range that extends more southwards as suggested by the results of the MFRI sampling campaigns.
Both *Anomalisipho verkruezeni* and *A. virgata* are collected close together in cold, northern waters like, for example, off northern Iceland (Denmark Strait) and off Hopen Island (southern Barents Sea); but in southeastern waters we found mainly *A. virgata*. It therefore appeared to us that the records of *A. verkruezeni* from the Faroese fisheries territory by Sneli et al. (2005: 70), or at least part of them, could belong to *A. virgata* instead. BIOFAR material was retrieved in FINM (Kaldbak, Faroe Islands) and made available to us for study. Two of the three records we could study belong indeed to *A. virgata*, the single record belonging to *A. verkruezeni* being the most southern Faroese record known [stn BIOFAR 80, (Fig. 4B)].

Bathymetric range. From 18 m (Franz Josef Land) to 829 m (Iceland). [100 to 450 m in East Greenland (lv) (Thorson, 1944: 82–83); 371 to 829 m in Iceland (lv) (MFRI, 8 stations); 509 to 803 m off Faroe Islands (lv) (BIOFAR stns 425 and 095); 54.6 m to 400 m at Svalbard (SMNH 88855, dd and KF-1537, lv); 235–240 m at NE of King Charles Land (SMNH 55532, dd and 88851, dd); 200 to 207 m off Murmansk, (lv) (Kantor, 1981: 1147); 596 to 640 m in the Norwegian Sea, lv (Friele, 1882: 14) and 640 m off the Shetland Islands, lv (DM)]. The shallowest records, 54.6 m at Svalbard (SMNH 88855, dd) and 18 m (dd) in the high Arctic of Franz Josef Land (Melvill & Standen, 1900: 9) agree with the trend that Arctic species are found in deeper water towards the south.

Habitat. *Anomalisipho virgata* is trawled on mud and clay (Friele & Grieg, 1901: 130–131, Odhner, 1915: 206, Thorson 1944: 83–84, SMNH 88855 and SMNH 88851), often with gravel and stones (Odhner, 1915: 206, Thorson 1944: 83–84), off the Faroe Islands on fine sand (Nørrevang et al. 1994: 168, 173).
The near-bottom temperatures recorded during BIOFAR range from minus 0.6°C to 1.6 (at BIOFAR stn 095 and stn 425 respectively) (Nørrevang et al.: 168, 173).

Figure 5, si possible.

Remarks. *Anomalisipho virgata* is characterized by its rather fragile shells with moderately convex whorls, the presence of fine but distinct spiral cords, the presence of moderately weak axial ribs at least along the upper spire whorls, the large operculum that often does not fit into the aperture, the greenish periostracum and the moderately small adult size. The animal is white with blue-greyish tentacles and siphonal canal (Friele, 1882: 14).
The variability in *A. virgata* is moderately low, apart from the strength of the axial sculpture which may vary from weak and only present on the upper spire whorls, to strong and present down to the body whorl.
Anomalisipho verkruezeni differs from *A. virgata* by its usually more solid shell with laterally more flattened whorls, the higher spire, the smooth surface without spiral or axial sculpture, the

purplish or brownish coloured columella in fresh specimens (Fig. A–B,D), the thin and rather greyish periostracum, the usually purple-brown band along the periphery of the last whorl in fresh specimens, the smaller operculum and the usually larger adult size.
Anomalisipho verkruezeni appears to be lesser affected by erosion and, in the case of erosion, to lose a thinner outer layer, while the usually badly eroded upper spire whorls in *A. virgata* are much thinner, more fragile and with a more abrupt edge around the affected place.

Anomalisipho martensi (Krause, 1885)
Figs 6, 7A–I, 9G–I

Sipho martensi Krause, A., 1885: 287, pl. 18, fig. 18 (Fig. 6).
Fusus (*Euthria*) *conulus* Aurivillius, 1885: 354, 377, pl. 13, fig. 6 (Fig. 9H).
Anomalisipho conulus monstr. *reversa* Løyning, 1932: 14, pl. 2, fig. 18.

Figure 6, si possible.

Chresonymy
Chrysodomus Martensi — Dall, 1885a: 525.
Chrysodomus martensi — Dall, 1885b: 180, 184.
Chrysodomus martensi — Murdoch, 1885: 186.
Tritonofusus (*Plicifusus*) *martensi* — Dall, 1902: 526–527, pl. 34, fig. 6.
Colus (*Anomalosipho*) *martensi* — Dall, 1921: 93 (*Colus*), 95 (subgenus "*Anomalosipho*").
Colus (*Anomalosipho*) *conulus* — Dall, 1921: 93 (*Colus*), 95 (subgenus "*Anomalosipho*").
Sipho martensi — Petrov, 1966: 174, pl. 8, fig. 5–7.
Anomalosipho martensi — Macpherson, 1971: 78–79, pl. 5, fig. 5 (Fig. 7E).
Anomalosipho cf. *verkruzeni* — Macpherson, 1971: 79–80, pl. 5, fig. 6, non Kobelt, 1876 (Fig.7I).
Anomalosipho conulus — Kantor & Sysoev, 2006: 178, pl. 88, fig. C.
Anomalosipho conulus — Sirenko et al, 2013: 160.
Anomalisipho martensi ("*Sipho Martensi*") — Merkuljev, 2015: 135–136, fig. 1B.

Two questions regarding the validity of *Sipho martensi* Krause, 1885 and *Fusus conulus* Aurivillius, 1885 have to be answered: whether the name is preoccupied, thus a junior primary homonym, or not, by *Fusus conulus* Risso, 1826 and which name (*Sipho martensi* or *Fusus* (*Euthria*) *conulus*) has been published first (in 1885) and becomes a junior or a senior synonym for the other name.
Risso (1826: 207) referred for his *Fusus conulus* to "Oliv., p. 134, t. V. F. 1.". Olivi (1792: 134) describes a *Cypraea* on that page and therefore most subsequent authors believe that Risso refers to page 154 with *Murex conulus*, which is indeed also the species figured on his plate 5, figure 1. This *Murex conulus* by Olivi is without doubt a junior synonym of *Mitrella scripta* (Linnaeus, 1758), Columbellidae, as is to be seen on that figure (Olivi, 1792: pl. 5, fig. 1). The description given by Risso (1826: 207), however, mentions a shorter spire and knobbed upper spire whorls with a strong canaliculation. This fits well, even without imagination, for *Euthria cornea* (Linnaeus, 1758). This species is, however, listed as "*Murex*" "*corneus* Linn.", by Olivi on page 152, with a description that may fit the species but without figure. It is doubtful that Risso wanted to refer to that description by Olivi as the page number is quite different and no figure is given. In addition, the assumption that Risso did not describe a *Mitrella* under *Fusus conulus* is, except from the description on page 207, strongly suggested by the fact that he described the genus *Mitrella*, including *M. flaminea* which is a junior synonym for *Mitrella scripta*, 40 pages later in that same work. In addition, as a kind of confirmation for that opinion, we could not find another description by Risso that may refer to *E. cornea*. Potiez & Michaud (1838: 442) placed "*Fus. conulus* Risso" under synonymy with "*Fusus lignarius* Lamarck" which is *E. cornea* but gave no further reason for doing so. As far as we could find out, they are the first authors to do so. Also, Monterosato (1884: 115) followed this and placed

"*F. conulus* Risso" in synonymy with *E. cornea* (Linnaeus, 1758). Monterosato did not list any *Mitrella* or other Columbellidae in that work (1884) but in an earlier paper (1878: 103–104) he confirmed "*M. conulus* Olivi" a synonym of *M. scripta*. The study of all the numerous references to *E. cornea* is beyond the scope of the present paper. Sherborn (1925: 1501) questionned Risso's reference by placing a question mark in the line where he refered to Risso's name and its reference: "*conulus Fusus, A. Risso, H. N. Europe, IV. 1826, 207. -? Murex, Ol. 1792*.". Nowadays two interpretations exist. The first that "*Fusus conulus* Risso" is the same species as "*Murex conulus* Olivi" but placed in the genus *Fusus*, see Snyder (2003: 71) and, as a result, not an available name. Also Sysoev & Kantor (2002: 115) have followed this. Our interpretation, shared with other taxonomists (Kevin Monsecour, pers. comm.), is that "*Fusus conulus* Risso" is the description (thus a junior synonym) of *E. cornea*, consequently an available name with the result that "*Fusus conulus* Aurivillius" is preoccupied and thus a junior primary homonym.
Whatever the case, the second question is which of both names has priority. Krause's description of *Sipho martensi* and Aurivillius's description of *Fusus conulus* are published around the same time: 1885. We could not find the exact dates of publication or distribution of the publications by Krause and Aurivillius. Both publications are listed in the Zoologischer Jahresbericht für 1885 by Mayer (1886: 53, 59, 68, 74) and in the Zoological record for 1885 by Hoyle (1886: 1, 13, 54–55, 81–82) but without further details about the exact date of publication and, weirdly, without mentioning *Fusus* (*Euthria*) *conulus* while all other species described by Aurivillius are listed by Mayer and most (but including the other *Fusus*) by Hoyle. The work by Aurivillius was re-issued in the 4th volume of Nordenskiöld's work on the Vega Expedition, and printed by F. & G. Beijers Förlag (Stockholm), in 1887 with that date on the front page, as it is the 5th volume. But we could not find the first printed issue (1885) of this publication. Dall (1885a: 525) listed "*Chrysodomus Martensi* Krause" in an issue of the Proceedings (vol. 3, nr. 33) that is dated "Jan. 19, 1885" (however the date "19" is crossed and corrected to "26" on the copy in the USNM library that is also available at Biodiversity Heritage Library). This means that Dall knew about the publication, wheather it was already printed or still being in preparation. Løyning (1932: 14) has no doubt that both names belong to the same species, but could not prove which name is oldest, giving *A. conulus* priority "*because the Swedish specimens were collected several years earlier than the others and published in the same year*". Other authors, for example Oldroyd (1978: 222–223) and Abbott (1974: 210), followed Dall and kept both "*Colus martensi*" and "*Colus conulus*" as distinct species, within the subgenus "*Anomalosipho*", together with "*Colus Adonis*".
Sysoev & Kantor (2002: 115) listed the type material of *Fusus* (*Euthria*) *conulus*, mentioned the record by Sherborn and concluded that *Anomalosipho conulus* is not preoccupied by Risso. However we could not answer the above two questions without doubt, we follow Monterosato and others in their opinion about Risso's *Fusus conulus* and we use *Sipho martensi* in favor of *Fusus* (*Euthria*) *conulus*, tentatively.

Type material. Holotype of *Sipho martensi* in MNHU Moll 37794, figured by Merkuljev, 2015: fig. 1B. 5 syntypes of *Fusus* (*Euthria*) *conulus* in SMNH type 1330 and type 5639 (Sysoev & Kantor, 2002: 115), not studied. Type of *Anomalisipho conulus* monstr. *reversa* not traced.

Type localites. *Sipho martensi*: Bering Strait, Metschigme Bay, 8 fathoms (Krause, 1885: 287); *Fusus* (*Euthria*) *conulus*: not specified, the syntypes are from Vega stn 58 (off Cape Schelagskoj, 70°14'N, 170°17'E, 12 m) and stn 1042 (north of Vega winter harbour at Kolyuchinskaya Bay, "66°58'N, 171°35'E [sic]") (Aurivillius, 1885: 354) and, according to I.C.Z.N. 76.1, both localities are included in the type locality; *Anomalisipho conulus* monstr. *reversa*: Maud stn 1055, between Wrangel Island & Cape Chelyuskin (Løyning, 1932: 14).

Material examined. Chukchi Sea: Alaska, NE of Cape Lisburne, 27 m, trawled, on mud, 2 lv, KF-6652 (Fig. 7C–D).

Beaufort Sea: Yukon Territories, near Herschel Island, 69°32'N, 138°57'W, 21–44 m, 3 lv, CMN 36532; 69°32'N, 138°57'W, 36 m, 3 lv, CMN 36537 (Fig. 7E–G); Northwest Territories, Franklin Bay, Langton Bay, beach, 1 dd, CMN 35648; Mackenzie Bay, 70°13'N, 132°36'W, 34 m, 3 lv, CMN 36570 (Fig. 7I).
Arctic Ocean: "Laptev Sea (?), from old collection", 4 lv, KF-4668 (Fig. 7A–B).

Figure 7, si possible.

Range. In the Arctic Ocean, at Chukchi Sea, from the New Siberian Islands in the west (Løyning, 1932: 14) to the Beaufort Sea in the east (northwestern Canada, CMN) and to the northern Bering Sea (Providence Bay "Plover Bay", Dall, 1921: 95) in the south.
Dall (1921: 95) suggested the species (for "*Anomalosipho conulus*") being circumboreal with a question mark.
The shell recorded by Macpherson [1971: 79–80, pl. 5, fig. 6, (Fig. 7I)] as *Anomalosipho* cf. *verkruezeni* from Beaufort Sea (MacKenzie Bay) and the one recorded from Beaufort Sea (Herschel Island) as *A. verkruezeni*, CNM 36532 (Fig. 7H) are *A. martensi* as we could confirm on the basis of recent images provided by CMN (Ottawa), Canada.
We have no confirmation of the exact locality of the 4 specimens from "Arctic Ocean, old collection" (KF-4668) (Fig. 7A–B), but the presence of *Buccinum maltzani* Pfeffer, 1886 in the sample may suggest the Laptev or Kara Sea.
Specimens from Saguenay River (Ha! Ha! Bay, Québec, Canada) formerly assigned to *Anomalisipho* cf. *martensi* belong to other taxa as we could confirm on the basis of recent images provided by MLI (Québec, Canada). So far, we have not pursued their determination further.
The shell figured by Petrov (1966: 173–174, pl. 8, fig. 4) as "*Sipho latericeus*", but in the text spelled as "*Sipho latericius*" (1966: 173), from the Quaternary fauna of Chukchi Sea, looks more similar to *Anomalisipho martensi*. We have not studied the North Pacific fossils, nevertheless we may include this record.

Bathymetric range. This species has a much shallower bathymetric range than the Atlantic *Anomalisipho* species. The life collected specimens we studied were found between 27 m (Chukchi Sea, KF-6652) and 44 m (Beaufort Sea, CMN 36532). Løyning (1932: 14) listed the species between 0 and 60 meters. An empty shell washed up on the beach of Cape Smythe near Point Barrow is recorded by Dall (1885a: 525; 1885b: 180, 184) and Murdoch (1885: 185–186).

Habitat. *Anomalisipho martensi* lives on clay and sandy-clay (Aurivillius, 1885: 315–316), occasionally with stones (Aurivillius, 1885: 315), the ones from Chucki Sea on mud (KF-6652).

Remarks. *Anomalisipho martensi* is characterized by its accentuated spiral sculpture in combination with a thick, dark brown coloured periostracum.
The wide range of variability within the species was already discussed by Løyning (1932: 14) who observed "*the spiral ribs are much narrower than in the "Maud"-specimen, the interspaces between them being 2-3 times as broad as the ribs themselves; in the "Maud"-specimen, however, the condition is nearly reverse.*"
Anomalisipho virgata differs from *A. martensi* by its thin shell, the finer spiral sculpture, the usually stronger axial ribs on the upper spire whorls, the convex whorls and the thin, greenish periostracum.
Anomalisipho verkruezeni differs from *A. martensi* by its smoother shell and the thin periostracum.

Excluded species
Murex pullus Woodward, 1833

Fig. 8A–B

Murex pullus Woodward, 1830: 30. Nomen nudum.
Murex pullus Woodward, 1833: 45, pl. 3, fig. 27. (Fig. 8A).
Fusus altus Wood, 1842: 541 (Fig. 8B).
Trophon altum Wood, 1848: 47–48, pl. 6, fig. 13a–b.
Trophon altus var. *costellatus* Wood, 1872: 23, pl. 2, fig. 17a.
Trophon altus var. *bucciniformis* Wood, 1872: 23, pl. 2, fig. 17b.

Figure 8, si possible.

Chresonymy
Trophon (*Tritonofusus*) *altus* – Wood, 1879: 8–9.
Trophon altus – Wood, 1879: pl.1, fig. 11.
Anomalosipho altus – Harmer, 1914: 150, pl. 15, fig. 6.

Wood (1842: 541) produced a valid description and that date has to be used for authorship. Wood (1848: 47) placed *Murex pullus* with a question mark in the references under his *Trophon altum* but later he suggested (1848: 48) that Woodward's name may be conspecific and, in that case, will be valid in favor of his species.
Wood (1872: 23) suggested that *Murex pullus* Woodward would be preoccupied by both Linnaeus and Pennant, but we could not find any name with this combination in these publications.
Harmer (1914: 150–151), in his work on the Pliocene Mollusca, was the first to include both "*Trophon altus*" and "*Sipho virgata*" in the genus *Anomalisipho*. Together with the citation by Friele (1882: 14) (see below, under remarks), this is the starting point in literature for unifying both species. Harmer was, as far as we can find out, also the first to use the spelling "*Anomalosipho*".

Type localities. *Murex pullus*: "Bramerton" (Woodward, 1830: 30), Plio-Pleistocene Red/Norwich Crag, Bramerton, Norwich, UK; *Fusus altus*: "Butley" (Wood, 1842: 541), specified to "Red Crag, Butley, near Orford" (Wood, 1848: 47), Plio-Pleistocene, Red Crag, Butley, Orford, Suffolk, UK; *Trophon altus var. costellatus* and *Trophon altus var. bucciniformis*: "Red Crag, Butley" (Wood, 1872: 23), Plio-Pleistocene, Red Crag, Butley, Orford, Suffolk, UK.

Habitat. Wood (1848: 47) states that his *Trophon altum* is collected together with *Buccinum undatum* var. *tenerum* (Sowerby, 1825). Both the type figure of *Buccinum tenerum* by Sowerby (1825: pl. 486, fig. 3–4) and the one figured by Harmer (1914: pl. 6, fig. 8) show a shell with incremental ribs that are typical for the shallow water fauna. Similar shells of *B. tenerum* are known from Holocene gravel-pits in the Thames estuary and from the recent fauna. We therefore suspect that *Trophon altum* is a species related with the shallow water fauna rather than to the deep-water fauna.

Remarks. The figure of *Murex pullus* by Woodward (1833, pl. 3, fig. 27) shows a shell that has convex whorls with a constricted suture. Also, the specimen of *Trophon altum* figured by Wood (1848: pl. 6, fig. 13a–b) has convex whorls with a constricted suture and a moderately long siphonal canal. Both those shells have a shape quite distinct from *Anomalisipho* and more similar to *Colus* or *Beringius*. Wood himself already expressed his doubts about the generic placement: "*To whatever genus this shell may belong, …*" [Wood, 1879: 8, when discussing *Trophon* (*Tritonofusus*) *altus*].
Friele (1882: 14) mentioned the difference between his *Neptunea* (*Sipho*) *virgata*, and *Fusus altus*: "*Mr. Robert Bell of London has had the kindness to send me a crag-fossil, named* Fusus altus*, S. Wood, so closely resembling* virgata*, that fig. 22 might almost serve as an accurate*

representation of both. The delicate striature, the peculiar longitudinal folds, and the short canal (the apex is unfortunately broken) are no less characteristic of the fossil than of the recent shell; the only difference lies in the whorls of the former being a trifle more tumescent. S. Wood's description of Trophon altum *(Crag. Moll. I, p. 47) agrees closely, save in "volutions convex," alike with the characters of Mr. Bell's fossil and those of our recent forms; his drawings, on the other hand (l. c., Pl. VI, fig. 13 a, b, and more especially in Supp. Pl. II, fig. 17 a, b), present very little resemblance to either*."

Also, the shells figured by Kantor & Sysoev (2006: 87, fig. E–F) as *Anomalosipho altus* (Wood, 1842) from Kamchatka, Karaginski Island and Kurile Islands, Onekotan, look quite similar to the figures by Woodward (1833: pl. 3, fig. 27) and Wood (1848: pl. 6, fig. 13a–b), and do not belong to *Anomalisipho*.

The shell recorded by Golikov & Sirenko (1998: 114) as *Colus* (*Anomalisipho*) *altus* (Wood, 1848) and figured (1998: fig. 8G) from Onekotan Island (Kurile Islands) is *Aulacofusus esychus* (Dall, 1907).

We have not studied the specimens listed and figured by Harmer (1914). Also, the types of *Anomalisipho bellii* Harmer, 1914 (151–152, pl. 15, fig. 13) (type locality: Butley, England, Butleyan Crag, Pliocene) and *Trophon actoni* Wood, 1872 (25, pl. 2, fig. 13) (type locality: Butley, England; Red Crag, Pliocene to Late Pleistocene) were not studied.

DISCUSSION

It is far beyond the scope of the present paper to discuss biogeographic patterns. But it remains quite a surprise to find *A. verkruezeni* so far to the south, a species that appears to belong to the Arctic fauna more than *A. virgata* does. We therefore believe that oceanographic information and distribution patterns may add some insight in these distributions. In general, the sea along northern Iceland, a coast influenced by the East Greenland Current, is colder than the sea off southern Iceland, a coast influenced by the Atlantic Current (Gulf Stream) that brings warmer and more saline water over the Iceland-Faroe Ridge into the Norwegian Sea. How the Arctic fauna behaves according to such oceanographic differences is discussed and illustrated in Ekman (1953: 163–185, fig. 58–69) where he shows higher water temperatures and salinity around the Faroe Islands at 200 m deep (1953: 104, fig. 34). Moreover, the complex hydrographic situation around the Faroe (Sneli et al., 2005: 17–19) suggests a connection with eastern Icelandic waters rather than with northern waters. The fauna may behave in analogy with it and, indeed, when we interpret our records of *Anomalisipho* species around Iceland then it sounds plausible that only *A. virgata* extended farther south. Moreover, such could be supported by recent studies dealing with the distribution of other marine groups. For example, Dauvin et al. (2012: 20) count 78% similarity between Faroe Islands and Icelandic fauna among Ampeliscidae (Amphipoda). A detailed analysis (Dauvin et al., 2012: 21, table 2) reveals that of the 23 deep-water ampeliscid species (Amphipoda) living around the Faroes at least 17 are in common with the Icelandic fauna of which 8 live mainly off southern Iceland and only 4 mainly off northern Iceland. Nevertheless, not all Arctic animals stay in the Arctic. For example, the copepod *Paraeuchaeta glacialis* (Hansen, 1886) and the pink shrimp (*Pandalus borealis* Krøyer, 1838) show a more southern distribution (Ekman 1953: 337 and 161, fig. 57 respectively), similar to that of *Anomalisipho verkruezeni* that reach south as far as the Faroes (as demonstrated by the BIOFAR material) and of *A. virgata* that reach even farther (Shetlands).

Schiøtte (2005) observed that almost two thirds of the molluscan species found in eastern North Greenland waters also occur at the Faroe Islands.

The question of where and when species will migrate to follow the shifting thermoclines remains elusive for such rare and cryptic species. While *Anomalisipho* species are not useful in analytic studies due to the rarity of specimens and the rather narrow bathymetric range, the presence or absence of these Arctic or sub-Arctic species in future faunal studies may give some indication about the changing ecosystems.

We observed that specimens of *A. virgata* outnumber *A. verkruezeni* in the material we studied. At least two of every three specimens belong to *A. virgata*.
Among the more than 600 localities sampled during the BIOFAR programme (Nørrevang et al.: 165) only 4 stations hold *Anomalisipho* species which is lesser than 0.7%. This confirms our observations when studying the MFRI material. Rarity is not an objective expression for using within a scientific context, but we are tempted to state that *A. virgata* and especially *A. verkruezeni* are rare species.
We found not any sample containing both *A. virgata* and *A. verkruezeni*. The habitat, however, is much similar and the species are found in nearby samples. It appears to us, as far as it is possible to judge from few observations, that both species are not sympatric.
Not all material is studied or retrieved. For example, the specimen from BIOFAR stn 424 couldn't be retrieved yet. The material listed by Zakharov (2013: 119) is not studied and the records on its map not specified.
The importance of studying the original description and type figure of a species, if not the type material itself, is stating the obvious. It is demonstrated again, here, with *Buccinum brucei*. In the case of *A. verkruezeni* versus *A. virgata* however, faunal studies that cover a wide array of classes, statistical analysis and ecological surveys have to manage the data that are available whatever the precision of the determination on the specific level. Luckily, the possibilities offered by open-source databases like WoRMS are increasing almost overnight and one is able to check names and to detect eventual taxonomic complications.

Figure 9, si possible.

CONCLUSIONS

We ascertain two *Anomalisipho* species living in the Atlantic Ocean, based on morphology of the shell, relative size of the operculum, colour of the living specimens, colour of the periostracum and erosion pattern: *A. verkruezeni* (Kobelt, 1876) and *A. virgata* (Friele, 1879). Although we cannot prove that *A. verkruezeni* is a single species, with the information at hand it is likely that this species is highly variable as many other Colinae.
The range of the two species in the Atlantic Ocean is clarified. While *Anomalisipho verkruezeni* occurs in the colder waters (Newfoundland, north of Iceland, Spitsbergen Sea, …) and seems to be absent in warmer water southeast of Iceland, it nevertheless appears off the Faroes. *Anomalisipho virgata* occurs also in southern Iceland, along the Greenland-Iceland-Faroe Ridge and in the south as far as the Faroes and Shetlands. That both *A. verkruezeni* and *A. virgata* have been found south of the Iceland-Faroe Ridge (BIOFAR stn 080 and 425 respectively) is quite in agreement with the biodiversity patterns along the Greenland-Iceland-Faroe Ridge explained by Egilsdottir et al. (2019). With the data we have at hand it appears that *A. verkruezeni* occurs at both sides of the Atlantic while *A. virgata* lives more towards the Northeast Atlantic. The southernmost localities for *A. verkruezeni* (BIOFAR stn 080 at 60°38.89'N) and *A. virgata* (BIOFAR stn 95 at 60°41.51'N) are recorded south off the Faroe Islands.
Fusus altus Wood, 1842 (= *Trophon altum* Wood, 1848) regularly used for recent species over a span of more than 100 years is confirmed as exclusively fossil. Although the correct interpretation of what may be *F. altus* remains uncertain, excluding this fossil from the genus throws another light on the paleontological past of *Anomalisipho*. With the absence of a Pliocene member in the Atlantic, it is more likely that further study of the Pacific fossils will reveal that the genus has expanded from the northern Pacific into the Atlantic. No alternative is proposed, its placement being still uncertain.
Apart from excluding the name *Fusus altus*, we also exclude the name *Anomalisipho verkruezeni* (exclusively Atlantic) from the Pacific fauna lists. As a result, the North Pacific species formerly named as such are in need of revision.
We couldn't confirm records of *Anomalisipho martensi,* a species that occurs in the adjacent Arctic Ocean, in the Atlantic Ocean or adjacent waters but we cannot predict that *A. martensi* may appear at the northern borders of the area.

We demonstrate erosion patterns as a useful, additional tool for determination. However rarely used in scientific studies as a method for differentiating taxa, it may be taken into account when all other shell layers are eroded (Fraussen & Stahlschmidt, 2016: 442–443, fig. 110). When the diagnostic characters of the outer shell layer have disappeared, the remaining shell layers may offer morphological information about similarities and differences between species, as demonstrated here for *Anomalisipho verkruezeni* and *A. virgata*. Because of erosion, however, we were not able to study an intact protoconch on (sub)adult specimens or to confirm the identification of the juvenile specimens in SMNH.
The importance of preserving recognizable individual specimens, instead of merely citing a name, is demonstrated thanks to the BIOFAR and SMNH material. To clarify whether *Anomalisipho verkruezeni* or *A. virgata* is recorded in certain taxonomic and biogeographical studies could have been solved by the presence of a brief description, an illustration or a voucher specimen in an institute. Not only for precise identification, also for the deeper importance in understanding the biodiversity and biogeography.

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Légendes pour les figures

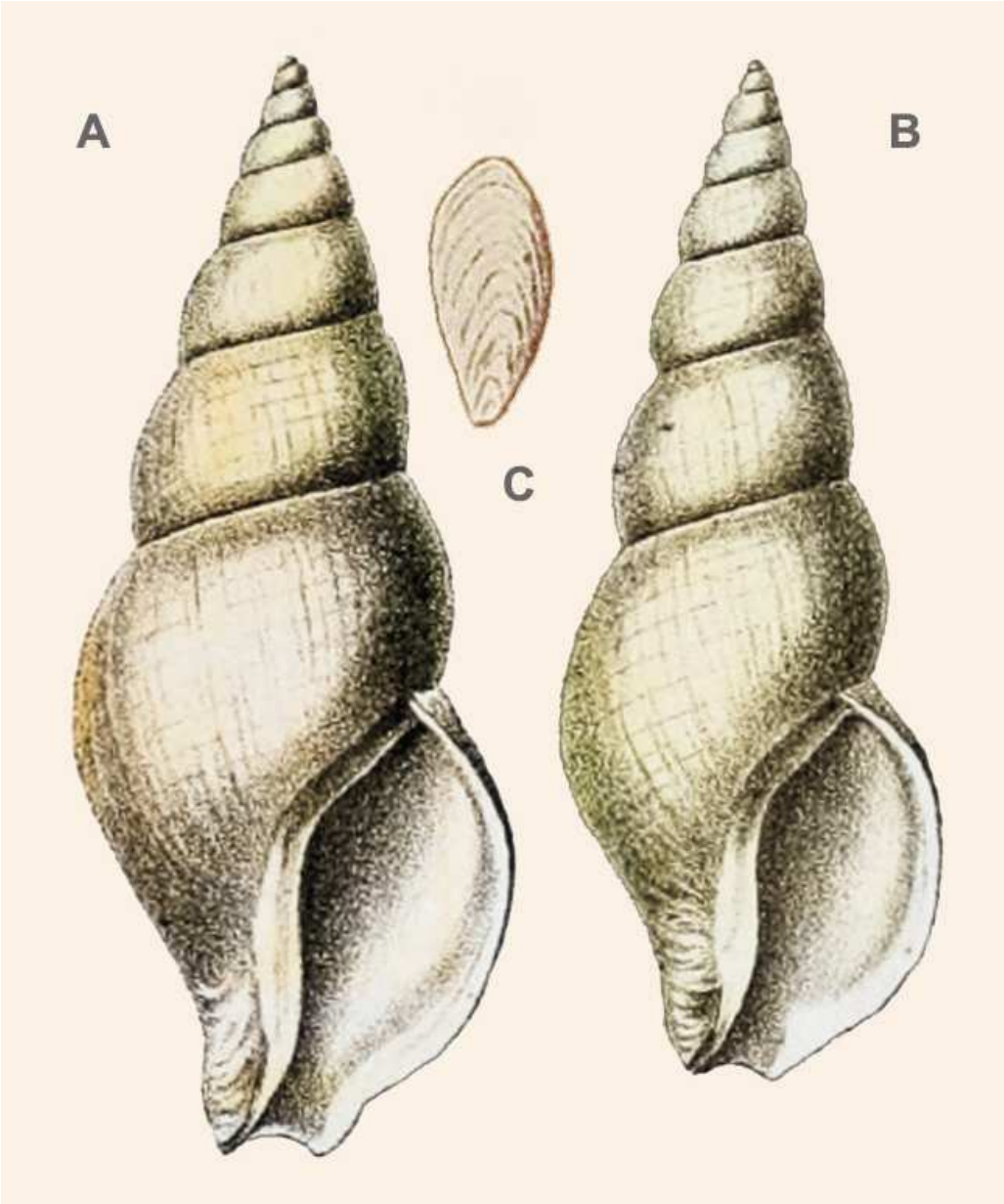

Figure 1. A–C. *Anomalosipho verkruezeni* (Kobelt, 1876). Type material.
A. Lectotype, 49.7 mm, type figure of *Sipho Verkrüzeni* Kobelt, 1876 in Kobelt, 1876: pl. 2, fig. 1 left. B. Paralectotype, 46.0 mm, type figure of *Sipho Verkrüzeni* Kobelt, 1876 in Kobelt, 1876: pl. 2, fig. 1 right. C. Operculum of *Anomalosipho verkruezeni* in Kobelt, 1876: pl. 2, fig. 1b

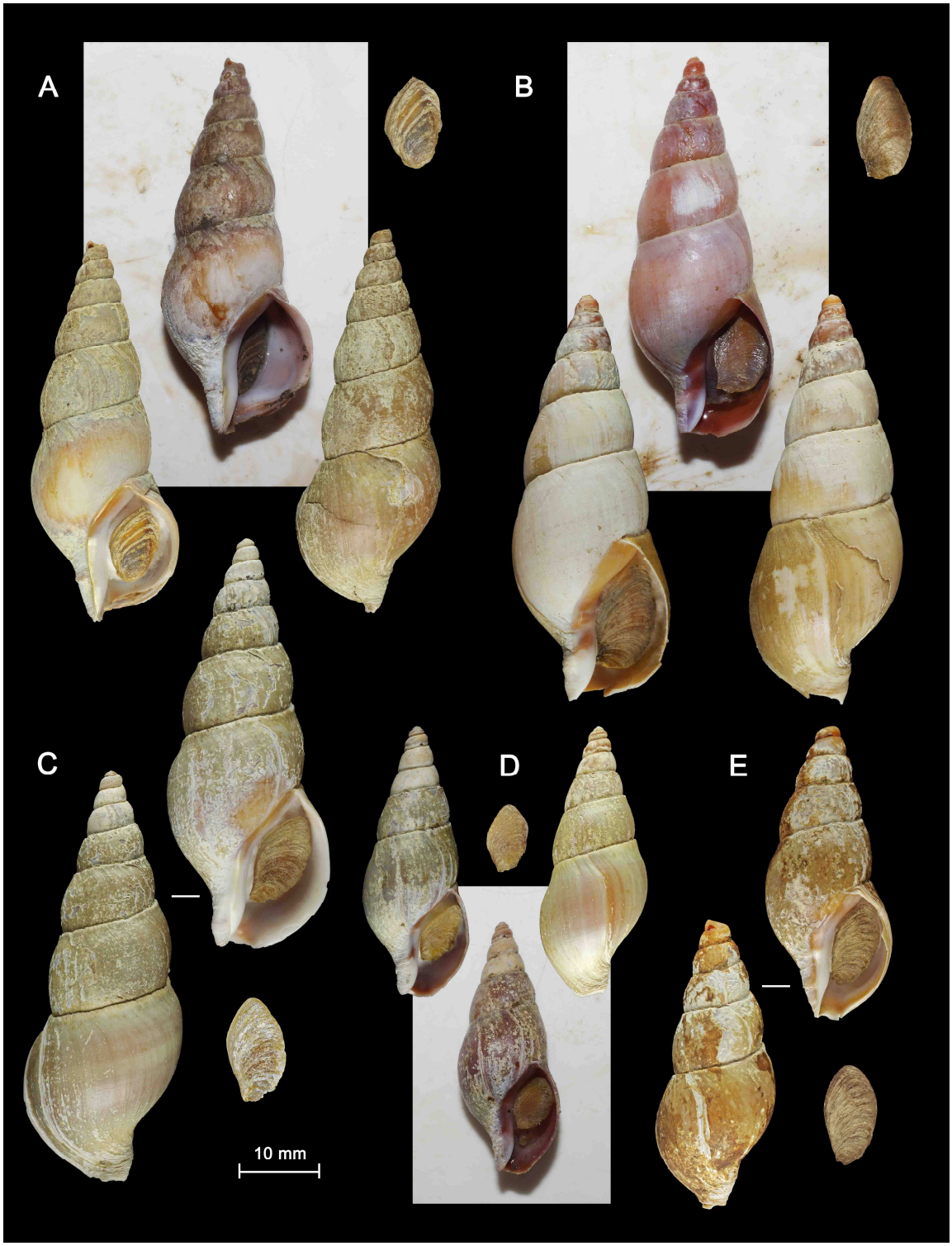

Figure 2. A–E. *Anomalisipho verkruezeni* (Kobelt, 1876).
Off Iceland (Pictures on white background taken on fresh specimens) MFRI – CDRS. A. stn A3-2016-109, 67°06.02'N, 23°32.00'W - 67°08.94'N, 23°38.88'W, 228–250 m, 58.0 x 22.4 mm. B. stn A10-2015-601, 66°28.60'N, 26°24.26'W - 66°31.41'N, 26°26.79'W, 595–560 m, 61.4 x 23.3 mm. C. stn A4-2018-76, 67°06.09'N, 23°13.63'W - 67°04.09'N, 23°22.42'W, 246–246 m, 61.5 x 24.3 mm. D. stn A3-2016-93, 66°54.25'N, 22°57.42'W - 66°56.75'N, 22°49.51'W, 203–212 m, 40.3 x 16.3 mm. E. stn A3-2016-90, 66°51.00'N, 23°19.66'W - 66°51.94'N, 23°09.93'W, 216–194 m, 43.4 x 18.5 mm.

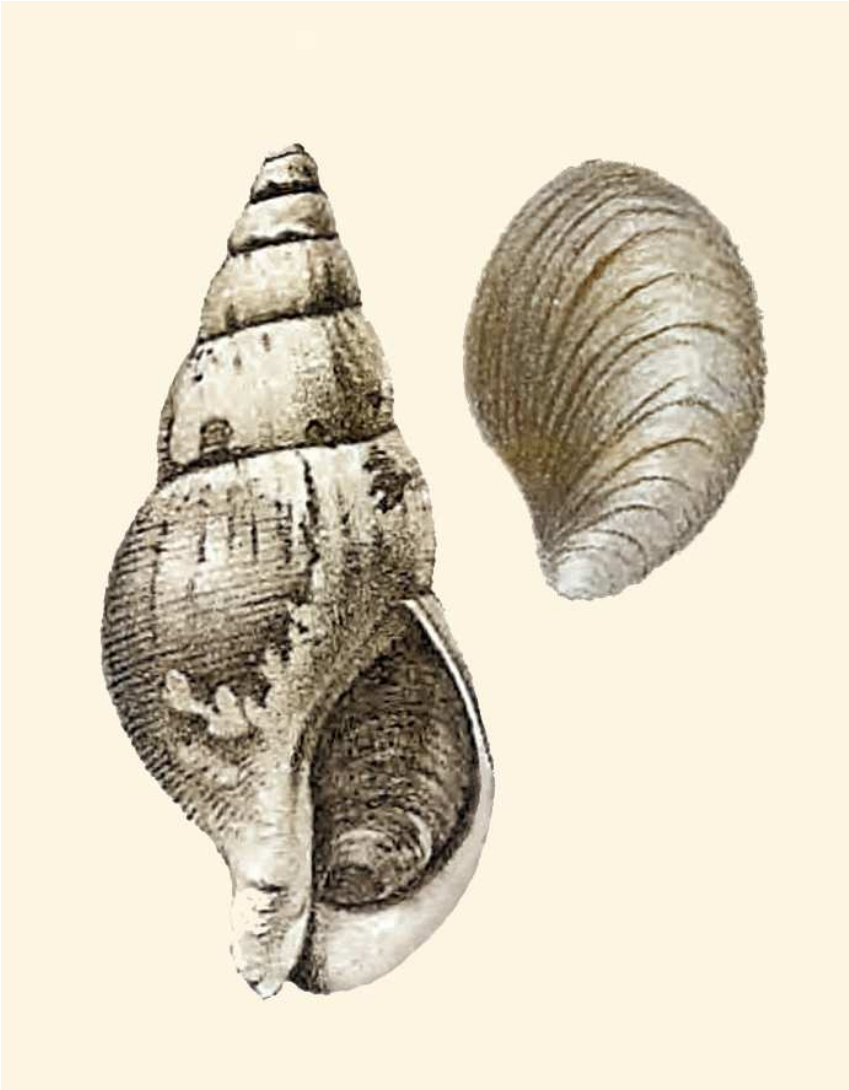

Figure 3. Holotype of *Anomalisipho virgata* (Friele, 1879), 30.0 mm, type figure of *Neptunea (Sipho) virgata* Friele 1879, taken from Friele 1882: pl. 1 fig. 22.

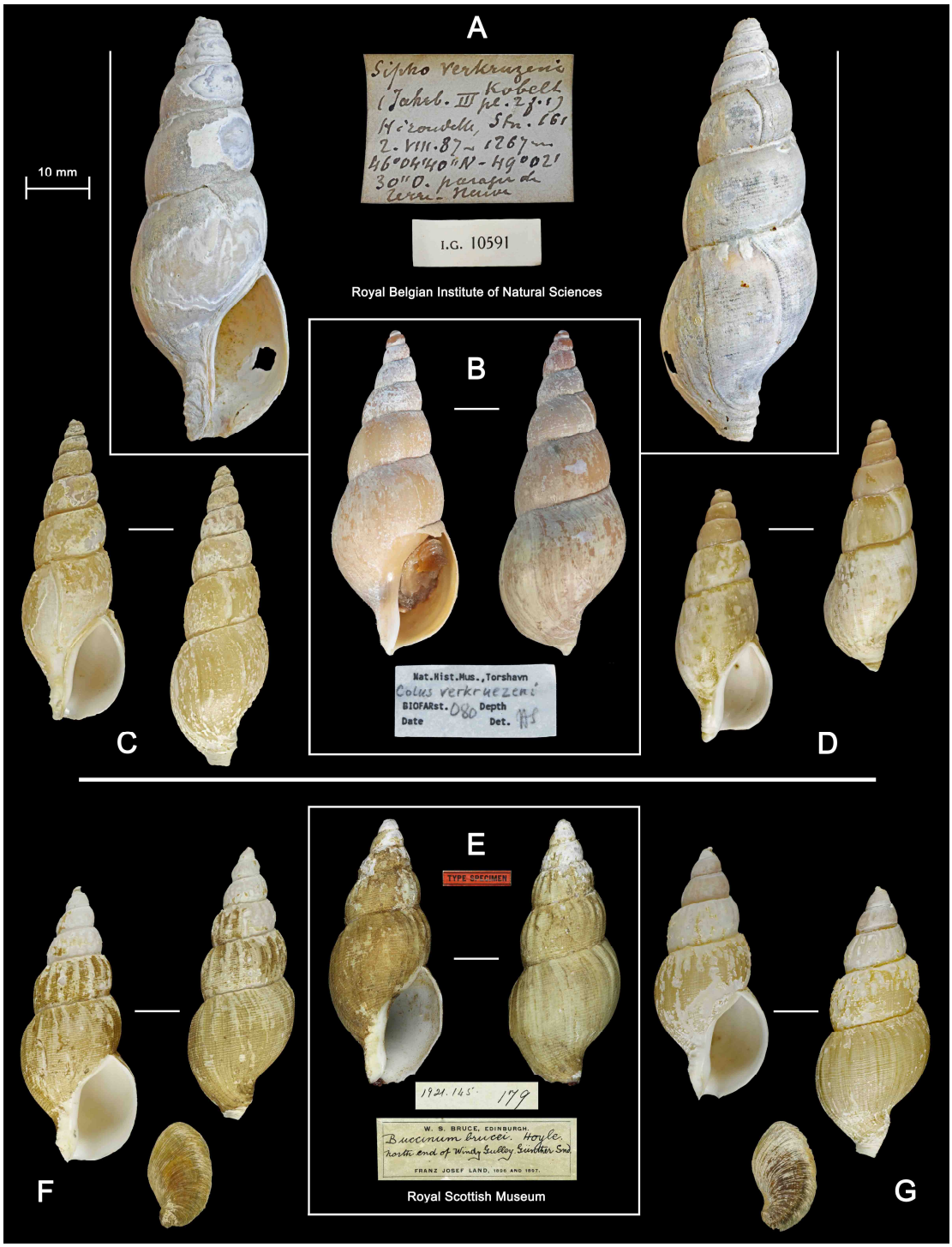

Figure 4. A–G. *Anomalisipho verkruezeni* (Kobelt, 1876) and *A. virgata* (Friele, 1879). **A–D.** *Anomalisipho verkruezeni* (Kobelt, 1876). A. Off Canada (Newfoundland), stn 161 (L'Hirondelle 1887), 46°04'40''N, 49°02'30''W, 1267 m, Coll. Dautzenberg, RBINS I.G. 10591, 65.8 x 23.0 mm. B. Off Faroe, stn BIOFAR 80, 60°38.89'N, 08°27.93'W, 678 m, 50.0 x 20.0 mm, FINM. C. Off Canada (Newfoundland), Flemish Cap, 285 m, 44.1 x 15.7 mm, KF. D. Barents Sea, 38.2 x 17.3 mm, KF. **E–G.** *Anomalisipho virgata* (Friele, 1879). E. *Buccinum brucei* Melvill & Standen, 1900. Off Russia (Franz Josef Land), North end of Windy Gulley, Günther Sound, RSM 1921.145.179, Type specimen, 39.3 x 16.7 mm. F–G. Off Svalbard (E-SE Hopen Island), 75°40'N – 76°20'N, 27°50'E – 32°10'E, 350–400 m, KF-1537. F. 42.0 x 18.6 mm. G. 41.5 x 18.4 mm. Photo courtesy: B. Jan Sørensen. E. Sankurie Pye, taken from Ablett et al. (under Creative Commons, CCO 1.0 and CC BY 4.0).

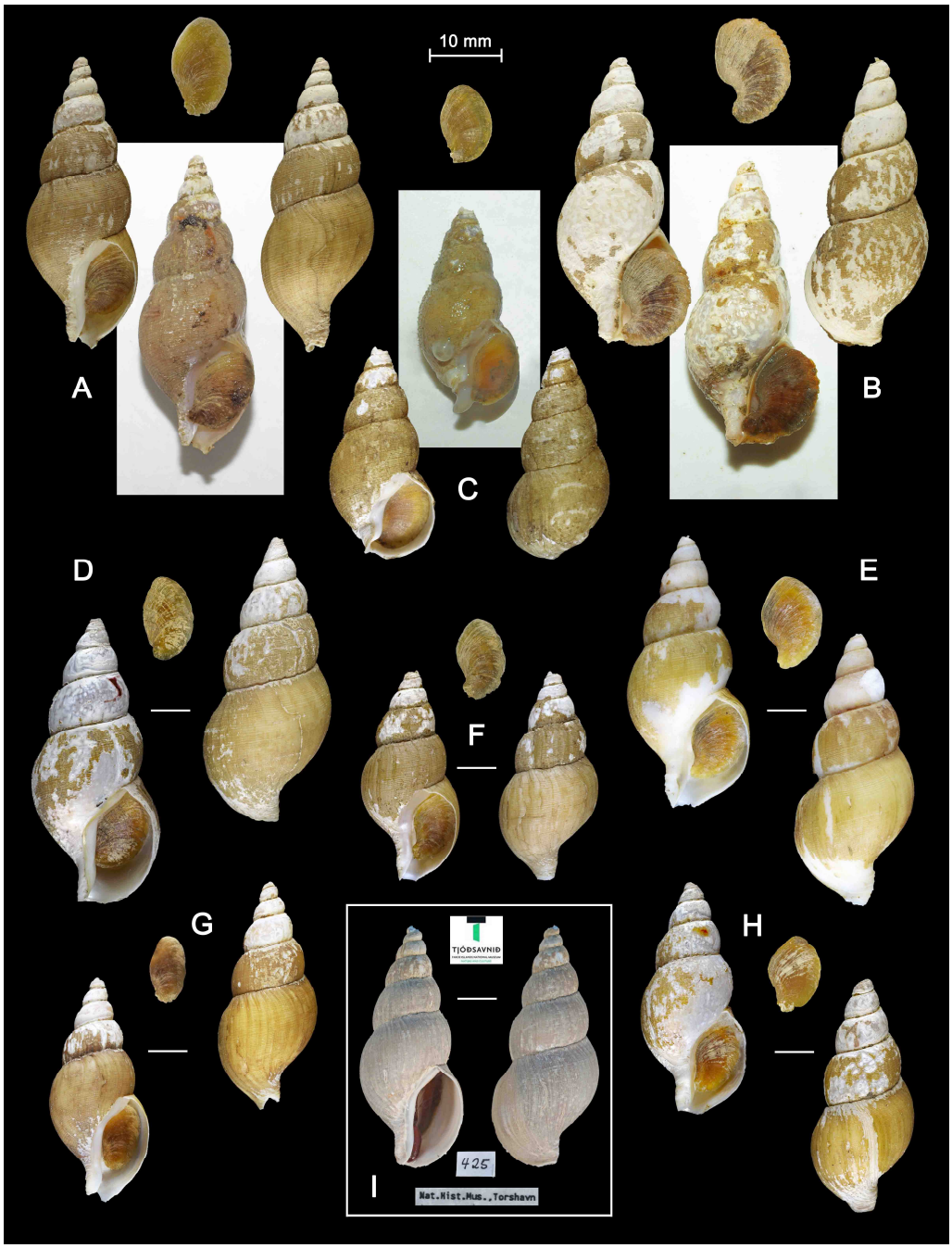

Figure 5. A–I. *Anomalisipho virgata* (Friele, 1879).
A–H. Off Iceland (Pictures on white background taken on fresh specimens) MFRI - CDRS. A. fstn A5-2017-71, 67°14.99'N, 22°06.23'W - 67°14.98'N, 22°16.46'W, 372–346 m, 43.9 x 16.9 mm. B. stn A3-2014-67, 67°15.04'N, 22°15.47'W - 67°14.98'N, 22°05.19'W, 344–374 m, 42.5 x 20.8 mm. C. stn A10-2013-616, 67°37.30'N, 20°43.81'W - 67°35.37'N, 20°37.63'W, 540–477 m, 31.9 x 15.4 mm. D. stn A10-2015-671, 63°58.08'N, 09°37.21'W - 64°00.75'N, 09°39.79'W, 712–724 m, 42.1 x 18.8 mm. E. stn A10-2015-669, 64°34.17'N, 10°28.03'W - 64°31.61'N, 10°31.61'W, 467–440 m, 41.5 x 18.5 mm. F. stn A2-2015-90, 67°15.06'N, 22°05.54'W - 67°15.03'N, 22°15.80'W, 371–341 m, 32.6 x 15.5 mm. G. stn A5-2017-71, 67°14.99'N, 22°06.23'W - 67°14.98'N, 22°16.46'W, 372–346 m, 32.9 x 14.4 mm. H. stn A13-2017-637, 64°34.46'N, 11°27.88'W - 64°35.33' N, 11°21.30' W, 439–430 m, 33.9 x 15.1 mm.
I. Off Faroe, Stn BIOFAR 425, 62°56.03'N, 09°28.12'W, 509 m, 36.0 x 15.0 mm, FINM. Photo courtesy. I. Jan Sørensen.

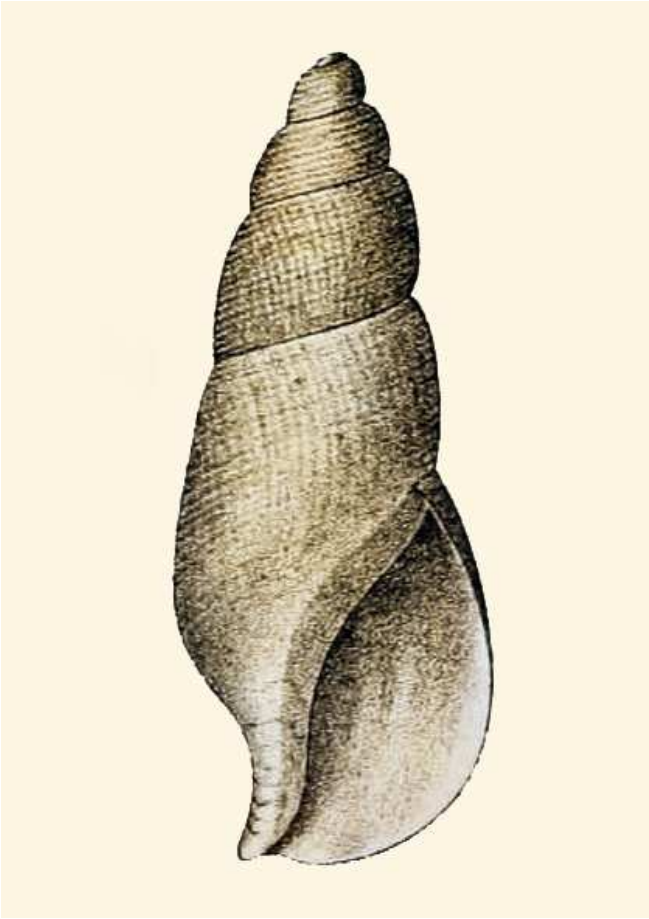

Figure 6. *Anomalisipho martensi* (Krause, 1885), 38.0 mm, type figure of *Sipho martensi* in Krause 1885: pl. 18, fig. 18.

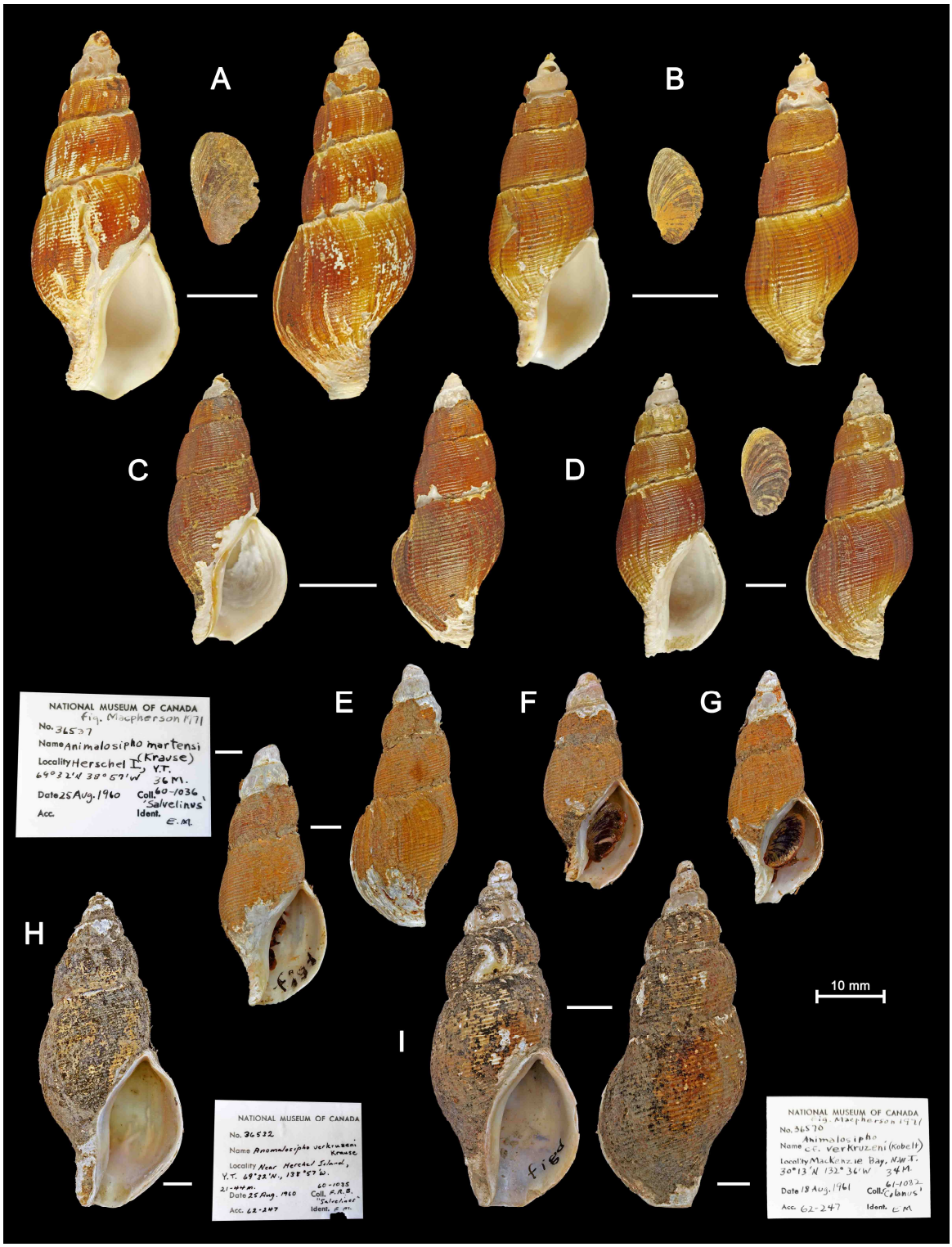

Figure 7. A–I. *Anomalisipho martensi* (Krause, 1885).
A–B. Off Russia, Laptev Sea (?), KF-4668. A. 57.3 x 22.5 mm. B. 47.9 x 18.0 mm. **C–D.** Off USA, Alaska, Chukchi Sea, NE of Cape Lisburne, 27 m, KF-6652. C. 41.2 x 18.6 mm. D. 43.4 x 16.7 mm. **E–H.** Off Canada (Yukon). E–G. Herschel Island, 69°32'N, 138°57'W, 36 m, CMN 36537. E. 38.9 mm. F. 33.2 mm. G. 35.9 mm. H. Near Herschel Island, 69°22'N, 138°57'W, 21–44 m, CMN 36532, 48.0 mm. **I**. Off Canada (Northwest Territories), MacKenzie Bay, 70°13'N, 132°36'W, 34 m, CMN 36570, 51.6 mm, specimen figured by Macpherson (1971: pl. 5, fig. 6). Photo courtesy. E–I. Philippe Ste-Marie.

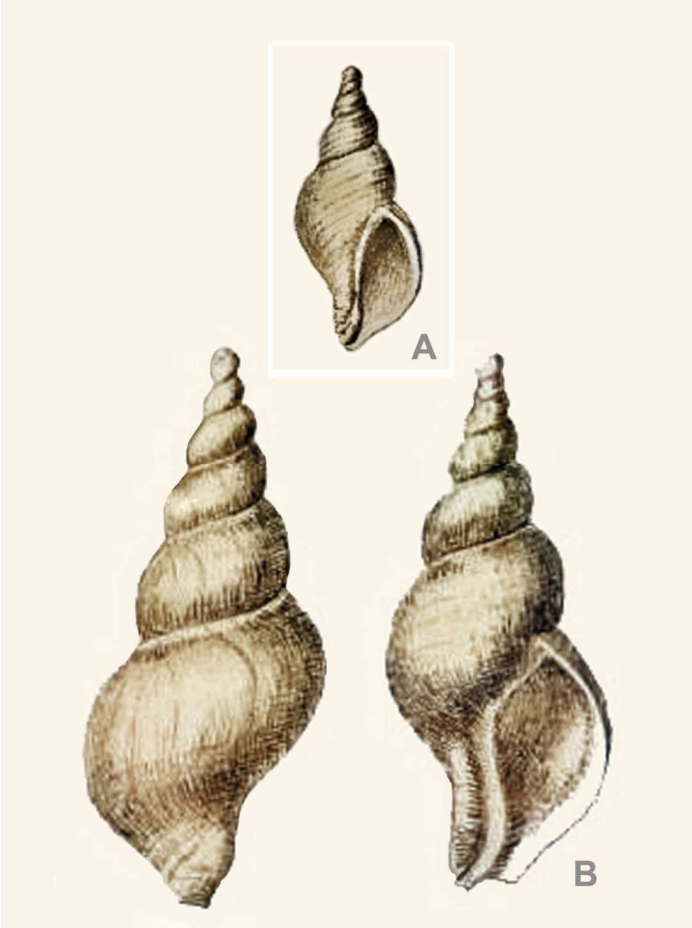

Figure 8. A–B.
A. Type figure of *Murex pullus* Woodward, 1833, taken from Woodward, 1833: pl. III, fig. 27.
B. Type figure of *Fusus altus* Wood, 1842, taken from Wood, 1848: pl. VI, fig. 13a–b as *Trophon altum*, “nearly 2 inches”, “almost 50 mm”.

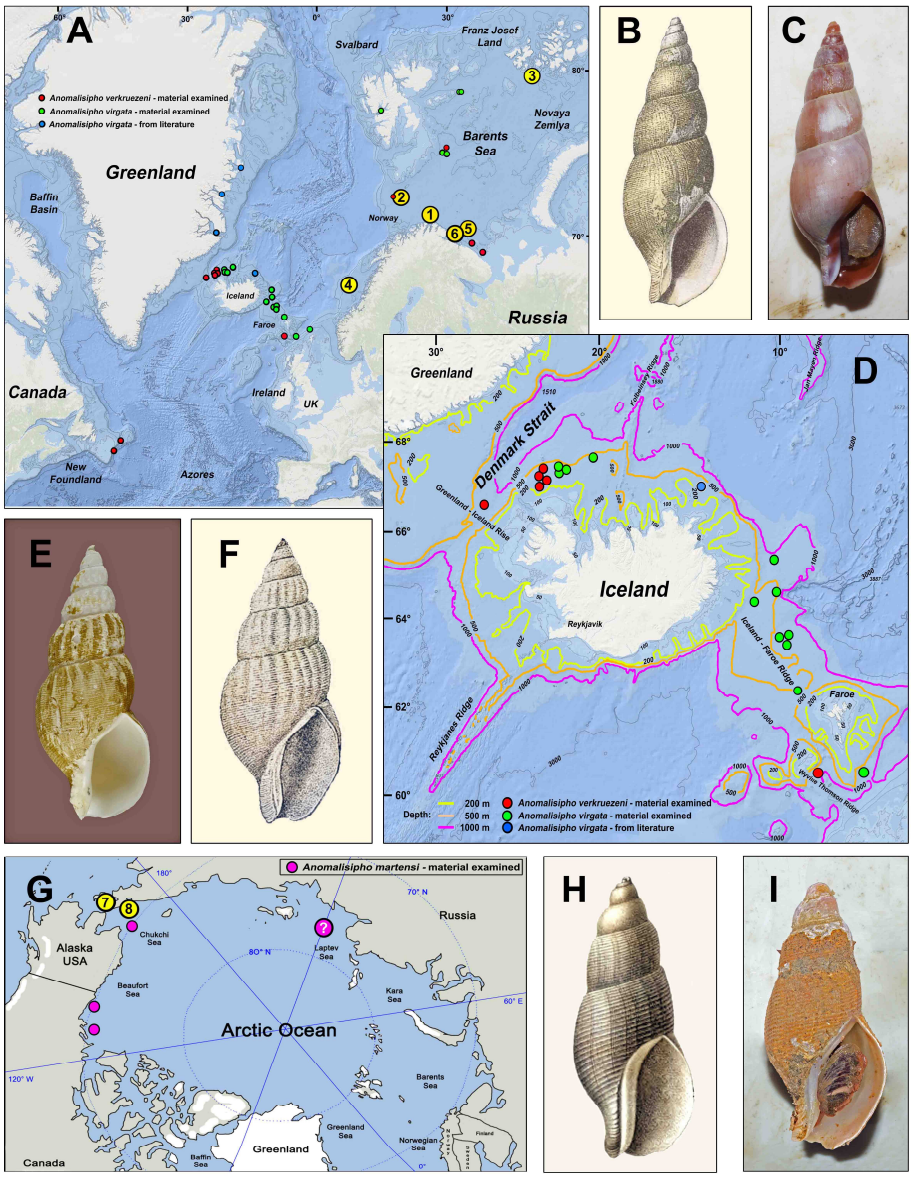

Figure 9.
A. North Atlantic locations for *Anomalisipho*: material examined for *A. verkruezeni* (Kobelt, 1876) (red circles); for *A. virgata* (Friele, 1879) material examined (green circles) and material from literature (blue circles). Type localities (yellow circles): 1. *Sipho Verkrüzeni* in Kobelt 1876; 2. *Sipho (Anomalisipho) Verkrüzeni* in Dautzenberg & H. Fischer 1912; 3. *Buccinum brucei* in Melvill & Standen 1900; 4. *Neptunea (Sipho) virgata* in Friele 1879; 5. *Anomalosipho frielei* in Kantor, 1981; 6. *Helicofusus paraelatior* in Kantor, 1981. **B.** *Sipho (Anomalisipho) Verkrüzeni*, type figure of *Colus dautzenbergi* Dall, 1916, after Dautzenberg & H. Fischer 1912, pl. IV, fig. 8. **C.** *A. verkruezeni*, West Iceland, 61.4 x 23.3 mm (595–560m), CDRS. **D.** Icelandic and Faroese locations for *Anomalisipho*: material examined for *A. verkruezeni* (red circles); for *A. virgata*, material examined (green circles) and material from literature (blue circles). **E.** *A. virgata*, E-SE Hopen Island (Svalbard), 42.0 x 18.6 mm (250–400m), KF-1537. **F.** Type figure of *Buccinum brucei* Melvill & Standen, 1900, taken from Melvill & Standen, 1900: 9, (fig.), 41.0 mm. **G.** Arctic Ocean locations for *A. martensi*, material examined (purple circles). Type localities (yellow circle): 7. *Sipho martensi* in Krause 1885; 8. *Fusus (Euthria) conulus* in Aurivillius 1885. **H.** Type figure of *Fusus (Euthria) conulus* Aurivillius 1885, taken from Aurivillius 1885: pl. 13, fig. 6, 44.0 mm. **I.** *A. martensi*, Canada (Yukon), Herschel Island, CMN 36537 (36m), 33.2 mm. (36m). Photo courtesy. I. Philippe Ste-Marie.