First record of *Calliostoma caroli* Dautzenberg, 1927 (Gastropoda: Calliostomatidae) alive in Icelandic waters

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ABSTRACT. A live specimen of *Calliostoma caroli* Dautzenberg, 1927 was found at the depth of 1150 meters west of Iceland. This constitutes the first record for Icelandic waters. Together with the holotype described from the Azores (-1250 m) and the two records reported from the Reykjanes Ridge (-1125 m and -1170 m), this notification establishes for this Calliostomatidae a Northeast Atlantic range in deep waters around the Mid-Atlantic Ridge from Iceland to the Azores.

RESUME. Un spécimen vivant de *Calliostoma caroli* Dautzenberg, 1927 a été récolté par 1150 m de profondeur à l'ouest de l'Islande. Ceci représente la première signalisation dans les eaux islandaises. Ensemble avec l'holotype décrit des Açores (-1250 m) et les deux récoltes rapportées du Reykjanes Ridge (-1125 m et -1170 m), cette notification établit pour ce Calliostomatidae une aire de répartition nord-est atlantique, dans les eaux profondes aux abords de la dorsale médio-atlantique de l'Islande aux Açores.

INTRODUCTION

a) Deep water and Seamounts located *Calliostoma* in the Northeast Atlantic.

At the end of the nineteenth century and the beginning of the twentieth, multiple scientific cruises were conducted to inventory life on the seabed in the Northeast Atlantic Ocean and adjacent waters: "Travailleur" and "Talisman" expeditions 1880-1889, "Hirondelle" and "Princesse-Alice" expeditions 1888-1914 and others. Among the gastropods collected, many new species of *Calliostoma* Swainson, 1840 were found and subsequently described. Two came off Mauritania [*C. milneedwardsi* (Locard, 1898) and *C. triporcatum* (Locard, 1898)], one off Western Morocco [*C. maurolici* (Seguenza, 1876) (= *Gibbula obesula* Locard, 1898)], one from the Seine Seamount *C. lithocolletum* Dautzenberg, 1925 and six in the surroundings of the Azores [*C. caroli* Dautzenberg, 1927, *C. cleopatra* (Locard, 1896), *C. grimaldii* Dautzenberg & Fischer, 1896, *C. hirondellei* Dautzenberg & Fischer, 1896, *C. leptophyma* Dautzenberg & Fischer, 1896 and *C. normani* (Dautzenberg & Fischer, 1897)]. All were collected in the bathyal zone (between 454 and 2165 meters), with the exception of *C. lithocolletum* caught at shallower depth (185 m), at the top of the Seine Seamount in the northeast of Madeira and of *C. hirondellei* in the Azores, Strait of Pico - Fayal, collected at 130 m. One has to add to this group of shells *C. occidentale* (Mighels & C.B. Adams, 1842) which is probably the most commonly found species in the North Atlantic between 19 and 1000 meters deep (Graham 1988) and mentioned among others up to 1099 meters around the Faroe Islands (Sneli et al. 2005). On top of these "old" described species, Vilvens & Swinnen (2003) described *Calliostoma heugteni* from the Great Meteor Seamount at a depth of 340 meters (paratype 1 and 2) bringing the Northeast Atlantic species of *Calliostoma* to twelve. As reported in WoRMS, the depth and location of the holotype seem to be questionable (MolluscaBase 2019). Beck et al. (2006) extended the presence of *C. hirondellei*, *C. leptophyma*, and *C. lithocolletum* to the Seine, Ampère and Gettysburg Seamounts. Some mentions were made about *C. leptophyma* in the Banco de Galicia (Rolán & Suárez 2007), in Madeira (Segers et al. 2009) and in the Bay of Biscay (Le Duff 2015). Hoffman et al. (2011) published the presence of *C. cleopatra, C. leptophyma, C. maurolici* and *C. occidentale* in the Hatton and Rockall Banks. Vilvens & Swinnen (2017) described a thirteenth species *C. delonguevilleae* from the Gorringe Bank, off Sagres, West of Portugal. Among the *Calliostoma* species from the Iberian waters (including the Canary Islands), Gofas et al. (2017) listed *C. leptophyma*, *C. lithocolletum* and *C. maurolici*. Recently, Hoffman et al. (2019) reported specimens of *C. bullatum* (Philippi, 1844) alive off

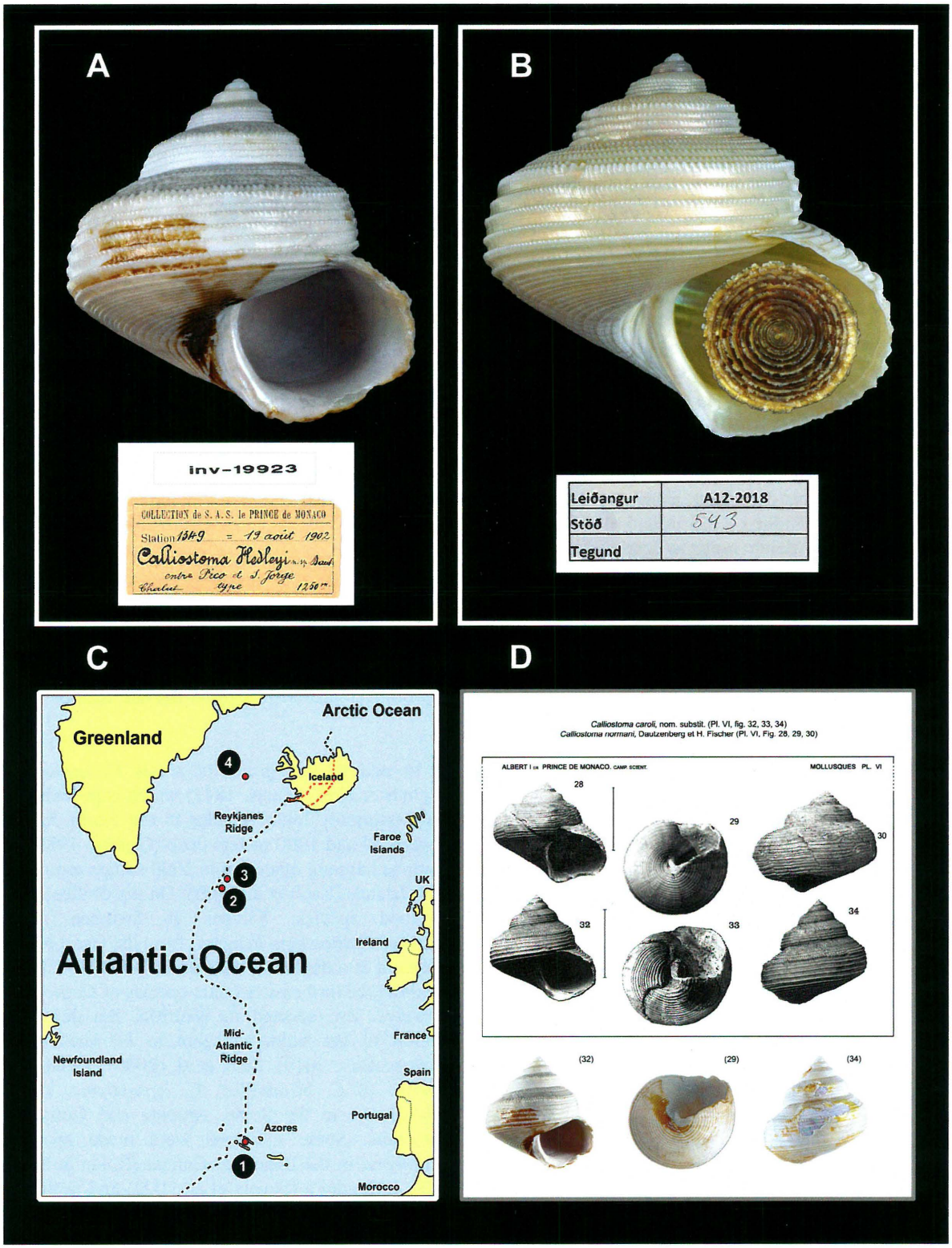

Figure 1

A-B. *Calliostoma caroli* Dautzenberg, 1927
A. Holotype, Oceanographic Museum of Monaco, INV-19923, shell 24.4 x 24.0 mm and original label; B. West Iceland, 26.3 x 27.8 mm and identifying working label.
C. Map showing localization of the records: (1) holotype from the Azores, (2) and (3) specimens from the Reykjanes Ridge, (4) specimen from West Iceland; **D.** Part of plate VI ex Dautzenberg (1927) with original positioning and numbering of *C. normani* (Dautzenberg & Fischer, 1897) and *C. caroli*; out of the box, representation as they should be.

Mauritania in deep water coral habitats (450-642 m depth), which brings the amount of Northeast Atlantic deep water and seamounts *Calliostoma* to fourteen. Before the discovery of these specimens *C. bullatum* was only known as fossil from Plio-Pleistocene deposits cropping out in the Messina and Reggio di Calabria area (Italy) (La Perna & d'Abramo 2010). Hoffman et al. (2019) reported also the wide distribution range of *C. maurolici* and *C. leptophyma* (live specimens for both up to 876 m depth) in DWC habitats [*Lophelia pertusa* (Linnaeus, 1758) and *Madrepora oculata* Linnaeus, 1758] in the Northeast Atlantic from the Rockall Bank in the north to off the continental slope of Morocco in the south and the Azorean Seamounts in the west. These two species are unknown from the Mauritanian slope. *C. bullatum*, *C. maurolici* and *C. leptophyma* were observed alive in their specific environment as confirmed by pictures taken by various Remotely Operated Vehicles.

b) *Calliostoma caroli* Dautzenberg, 1927

At the occasion of the 1902 scientific campaign of Prince Albert I of Monaco in the Atlantic Ocean, one empty specimen of *Calliostoma* was caught at a depth of 1250 meters on mud and volcanic sand between Pico and São Jorge (38°35'30" N, 28°05'45" W) in the Azores Archipelago (Figs 1A, C1) It was described by Dautzenberg (1925) and named *Calliostoma hedleyi*. Realising that this name was preoccupied by a *Calliostoma* from New Zealand (*Calliostoma hedleyi* Pritchard & Gatliff, 1902), Dautzenberg (1927) gave it the new name *Calliostoma caroli*. The original description mentions:
"Coquille solide, turbinée, imperforée, mais présentant, derrière le bord columellaire, un très léger sillon. Spire médiocrement élevée composée de 7 tours étagés dont 3 embryonnaires lisses et convexes, les autres traversés par une carène médiane, déclives au dessus de cette carène et descendant abruptement au-dessous. Dernier tour anguleux à la périphérie, ce qui rend son profil bianguleux. Surface des 4 derniers tours traversée par des cordons décurrents finement granuleux. On compte sur le dernier tour, au dessus de la carène, six cordons très rapprochés et au dessous 4 cordons plus espacés. La carène elle-même est accompagnée de deux cordons juxtaposés dont les granulations sont plus saillantes. Base convexe couverte d'une vingtaine de cordons concentriques aplatis, contigus et non granuleux. Ouverture arrondie-subquadrangulaire. Columelle peu épaissie, légèrement arquée. Labre arrondi à peine bianguleux. Coloration blanchâtre uniforme, à l'exception des tours embryonnaires qui sont luisants et nacrés, de même que le bord columellaire et l'intérieur de l'ouverture".

The shell is illustrated in Dautzenberg (1925: 3, fig. 12, frontal view) and in Dautzenberg (1927: pl VI, fig. 32-34, frontal, basal and dorsal views). However, in 1927 two photos are inverted (see further below).

Finlay (1930), apparently not aware that Dautzenberg himself corrected the wrong name, renamed *Calliostoma hedleyi* Dautzenberg, 1925 as *Calliostoma dautzenbergi* Finlay, 1930 introducing thus a synonym to this new species. Since then nothing has been published concerning *C. caroli*, at the exception of a mention in Hoffman (2019) just to declare that this species has not been encountered in the DWC habitats in the NE Atlantic during their studies. A mention of the presence of *C. caroli* in the Black Sea, together with seven other Atlantic deep sea *Calliostoma* can be found in Teaca et al. (2016) without any supporting data. Consequently, it is difficult to consider this occurrence in the present distribution of *C. caroli*.

Abbreviations

DWC: Deep Water Coral.
GBIF: Global Biodiversity Information Facility.
MFRI: Marine and Fresh Water Research Institute, Reykjavik, Iceland.
SMNH: Swedish Museum of Natural History, Stockholm.
WoRMS: World Register of Marine Species.

Material

The Marine and Freshwater Research Institute in Reykjavik (Iceland) conducts campaigns each year in order to evaluate fish stocks around the country. On October 09th 2018 molluscs were collected during a trawl of the Research vessel "Árni Friðriksson" at station A12-2018-543, net set at 65°17.67'N, 28°31.10'W at a depth of 1150 meters; net hauled at 65°19.41'N, 28°28.73'W at a depth of 1148 meters (West Iceland) (Fig. 1C4), bottom temperature 4.1°C. Among other Gastropoda the sample contained 1 live specimen of *Calliostoma caroli*, height 26.3 mm, width 27.8 mm (Figs 1B, 2A-H, 5F-J). The operculum (Figs 1B, 2C) was in place on the animal and material was removed for genetic analysis.
The holotype of *C. caroli* was localized in the Oceanographic Museum in Monaco (INV-19923) and the specimen (24.4 x 24.0 mm) was kindly lent to us. Copies of the original labels were also provided (Figs 1A, 3D-E). On one of them written instructions from Dautzenberg's hand indicate how the photos should be taken for the 1927 publication (Fig. 3E). When in our possession, new shots were taken with modern equipment (Figs 1A, 3A-C, 3F-H, 5A-E). Comparing these photos with those of 1927 (Fig. 1D) force is to note that the shell was damaged because after being glued on a support it lost part of the outer layer from its dorsal surface as the result of old manipulations (Fig. 3B). This empty shell was taken at station 1349 on 19th August 1902 between Pico and São Jorge (Azores - 38°35'30" N, 28°05'45" W) during the cruise of "Le Prince Albert 1er de Monaco". In the Dautzenberg (1927) publication, the specimen had as

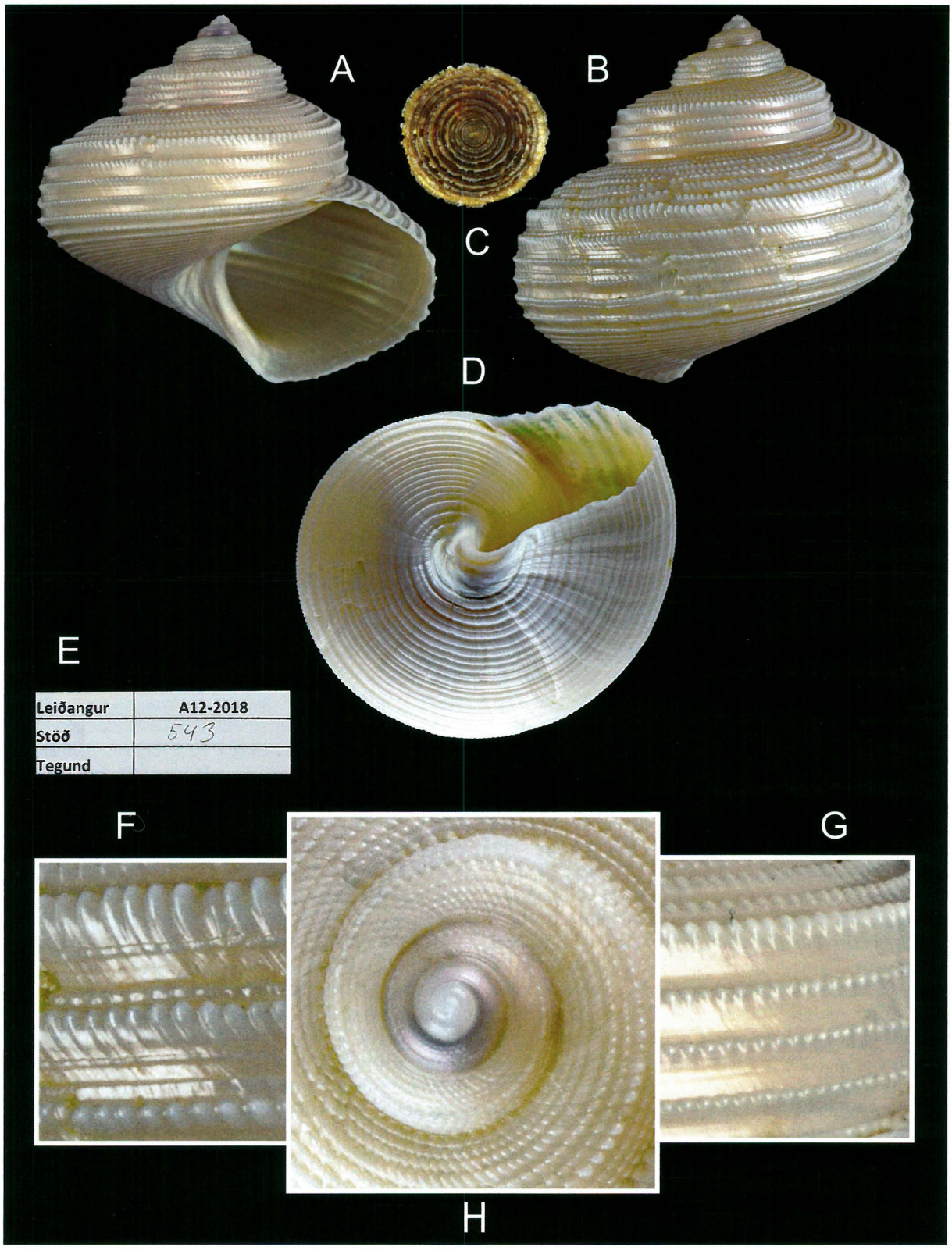

Figure 2

A-H. *Calliostoma caroli,* West Iceland, 26.3 x 27.8 mm.
A. Frontal view; B. Dorsal view; C. Operculum; D. Basal view; E. Working label; F. Detail of the microsculpture; G. Detail of the cord's arrangement; H. Upper view.

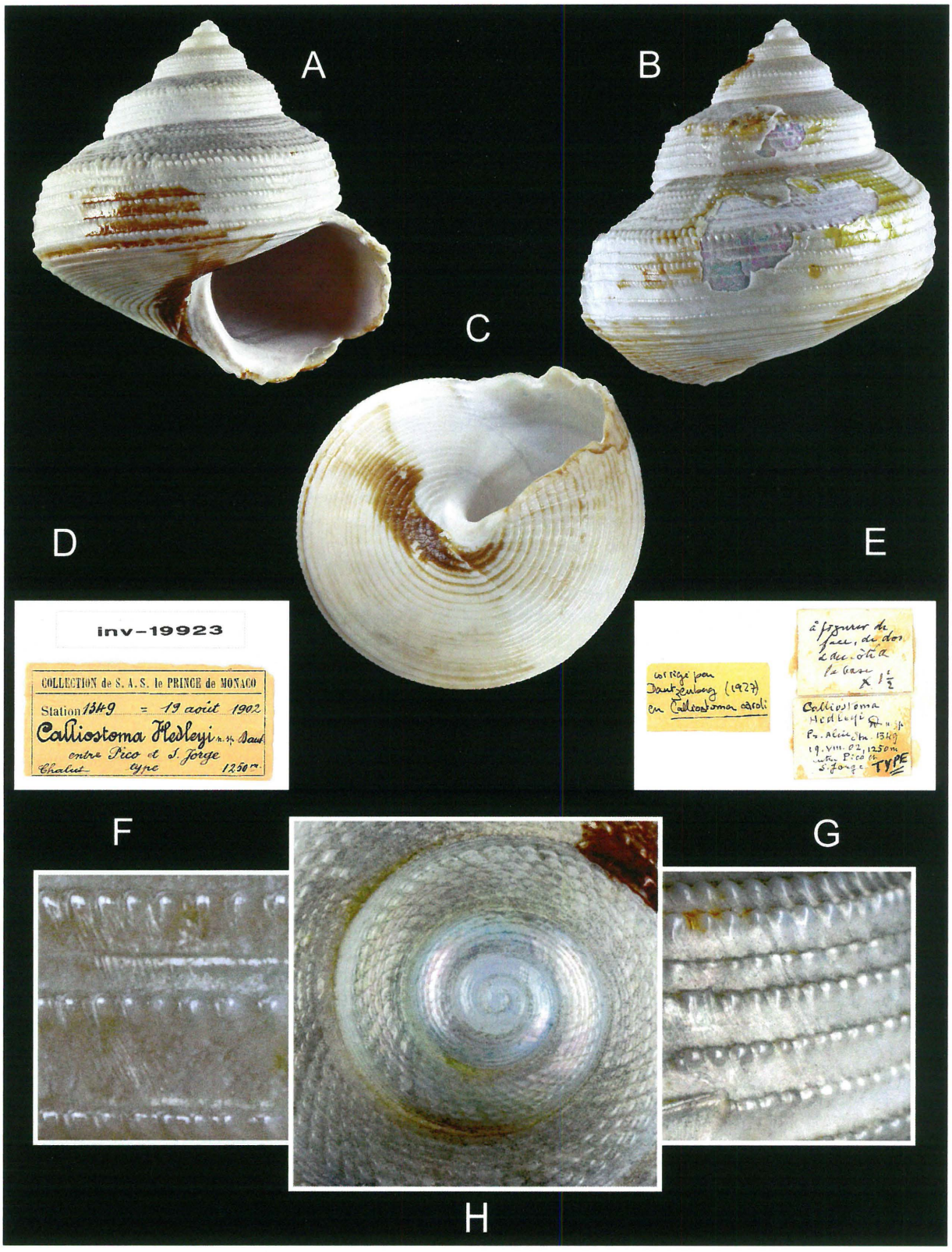

Figure 3

A-H. *Calliostoma caroli*, holotype, Oceanographic Museum of Monaco, INV-19923, shell 24.4 x 24.0 mm. A. Frontal view; B. Dorsal view; C. Basal view; D. Original label; E. Dautzenberg's hands instructions to the photograph for taking the photos; F. Detail of the microsculpture; G. Detail of the cord's arrangement; H. Upper view.

measures 25 x 25 mm. The original label refers to *Calliostoma hedleyi* and later a new label changed the specimen to *Calliostoma caroli*.
Consultation of the GBIF website (2019) revealed that two specimens of *C. caroli* were caught on the Reykjanes Ridge (North Atlantic Ocean) (Fig 1C2&3) in 1993 and kept at the SMNH of Stockholm. The specimens determined by Anders Warén were alive, shells and soft parts kept separately. The specimen SMNH 76365 (25.3 x 27.7 mm) caught at 1125m depth (59°2'12" N, 30°48' W) (Fig. 1C3), was localized in the collection of the Museum, and photos (Figs 4A-G, 5K-O) were provided to us by the Museum staff. The second specimen SMNH 76362 coming from 1170 m depth (58°33'12" N, 31°33'12" W) (Fig. 1C2) could not be traced back in the museum collection.

RESULTS, COMPARATIVE ANALYSIS AND DISCUSSION

A first observation was to realize that an error was introduced during the assembly of the plate VI in Dautzenberg (1927): the figure 33 meant to represent the base of *C. caroli* is that of a resembling species *C. normani* (shell slightly umbilicated) while figure 29 meant to represent the base of *C. normani* is that of *C. caroli* (shell not umbilicated). This inversion that had gone unnoticed until today could be the cause of confusion and misidentification. For the sake of accuracy, this leads us to say that in plate VI in Dautzenberg (1927) *C. caroli* is represented by the figures 32, 29 and 34 and *C. normani* by figures 28, 33 and 30 (Fig. 1D).
The newly provided photos of the *C. caroli* holotype objectify point by point the macroscopic characteristics identified by Dautzenberg in its original description (see above), namely the biangular profile of the post-embryonic whorls linked to the presence of a median carina formed of two granular juxtaposed cords delimiting above it a gently sloping surface which drops abruptly below it; the upper part of the whorls covered by 6 (to 8) very closely set together granulated cords and the descending part covered by 4 more spaced granulated cords; the convex base presenting only a very slight furrow at the base of the columella and covered with above 20 non-granulated flat concentric cords. Close-up shots of the holotype (Figs 3F-G, 5D-E) reveal the occasional presence of fine secondary cords on the descending part of the whorls and micro-sculpture made of thin prosocline striations that prolong and separate the elongated drop-like granules.
When comparing the mid-Atlantic shell from the SMNH with the *C. caroli* holotype one can identify a slight variation in the profile which is more rounded and less angulated (Figs 4A-B). This is probably due to the many growth accidents suffered by this specimen during its life. The same goes for the main cords that sometimes split and lose their continuity (Figs 4E-F, 5N-O).
By its frontal side the Icelandic specimen has a much more regular appearance than the mid-Atlantic one and appears to have undergone less breakage during its growth. Its profile is more in agreement with that of the holotype. It differs slightly in its carina which is not divided or only very slightly, as indicated by the presence of a weak secondary cord at the base of its granulated part when seen by its back side. In some places there are sometimes two juxtaposed cords which also have their origin in growths accidents, they do not necessarily extend over the entire surface of the whorl. The external surface of the specimen is pearly and in perfect condition and the internal part of the mouth shows also some iridescent reflects. New observations and pictures reveal the delicacy and regularity of the circular and vertical microsculpture that could only be guessed on the other two known specimens (Figs 2F-G, 5I-J).
All specimens were adult of very similar size, average height 25.3 mm, average width 26.5 mm.

CONCLUSIONS

The observation of the three specimens of *C. caroli* investigated here allowed to provide a modern iconography of the holotype, to identify an error in the plate VI in Dautzenberg (1927), to appreciate the variability of the profile and the arrangement of the circular cords imposed by shells growth accidents and to reveal the delicacy of the upper surface microsculpture. Even if great distances separate the collecting stations of these specimens, namely Azores, Mid-Atlantic Ridge and west of Iceland, and even if they differ by minor details in the sculpture or in the profile, they are overall very similar and belong to *Calliostoma caroli*. The vast area of distribution originates in the environmental conditions that are particularly constant at great depths. We can conclude that, until further discoveries, *Calliostoma caroli* has a Northeast Atlantic deep-sea distribution on and around the mid-Atlantic Ridge, from Iceland to the Azores.

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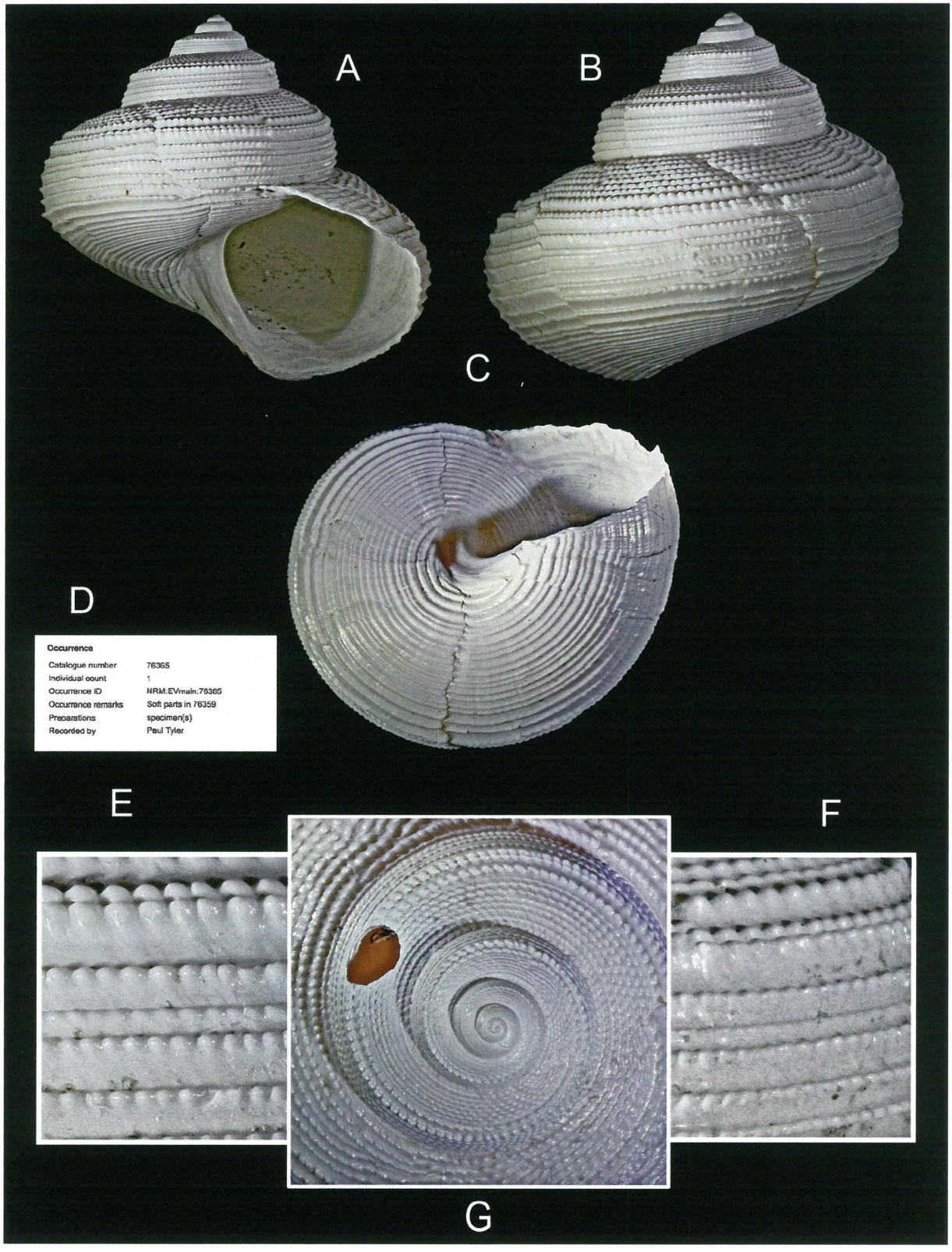

Figure 4

A-G. *Calliostoma caroli*, SMNH 76365, Reykjanes Ridge, 25.3 x 27.7 mm.
A. Frontal view; B. Dorsal view; C. Basal view; D. Sample identification information; E. Detail of the microsculpture; F. Detail of the cord's arrangement; G. Upper view.

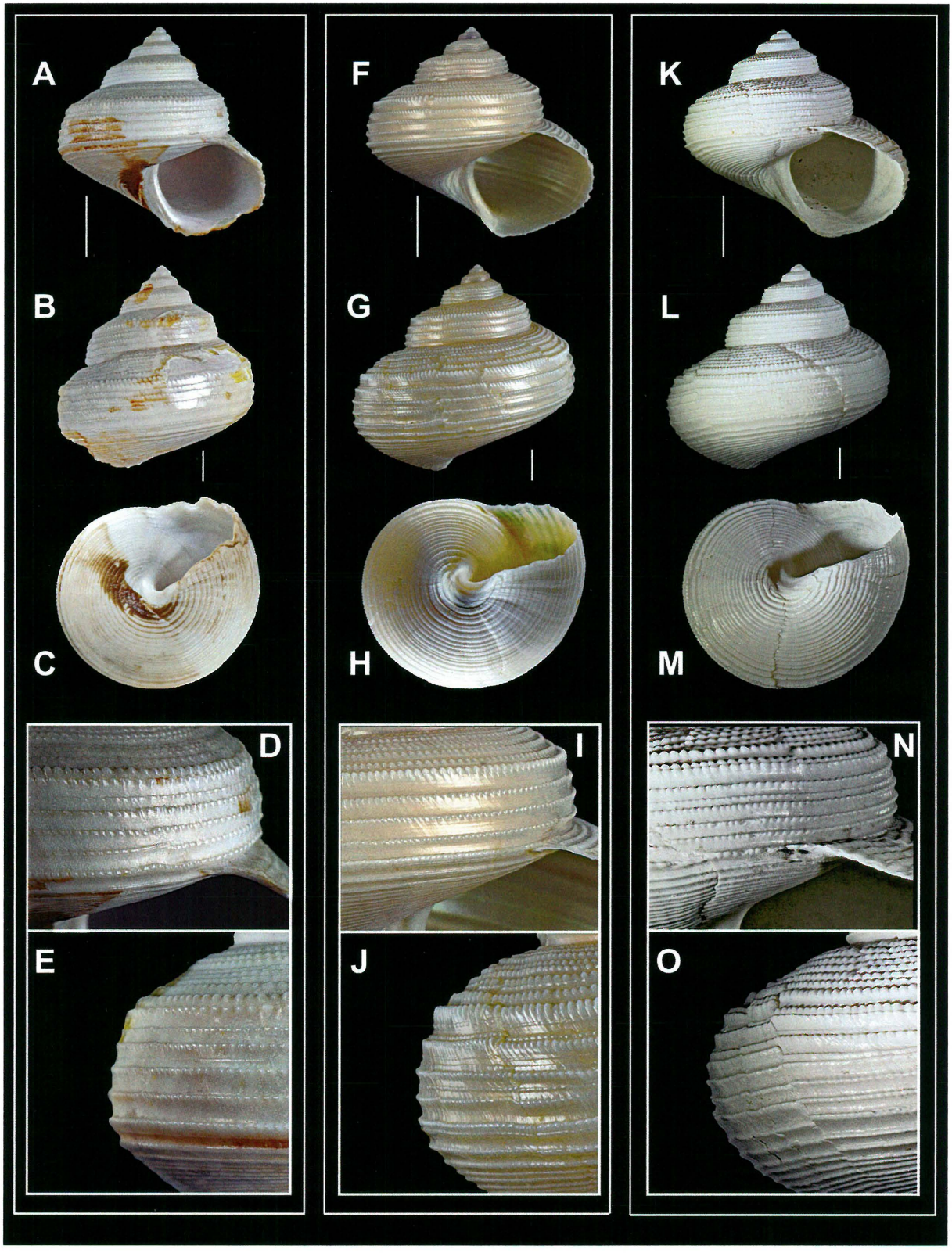

Figure 5

A-O. Comparative illustration of the three observed *Calliostoma caroli* specimens.
A-E. Holotype, Oceanographic Museum of Monaco, INV-19923; F-J. A12-2018-543, specimen from West Iceland; K-O. SMNH 76365, specimen from Reykjanes Ridge.

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