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Research Article

Image dataset of benthic foraminifera in multicorer and gravity corer sediments from north-western Scotland shelf (North Atlantic Ocean)

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Abstract

Geological studies in the seas and oceans often give preference to the study of benthic foraminifera, which are a widespread and taxonomically diverse group of shell protozoa. In this paper, we present an extensive image dataset produced during the detailed micropaleontological analysis of 146 samples of bottom sediments collected by multicorer and gravity corer AMK-5656 from the Westray Basin on the north-western Scotland shelf (North Atlantic Ocean). In total, 106 taxa (at species and genera level) of benthic foraminifera were identified and photographed using the high-resolution microscope camera. This dataset can aid as a guide for identification of the benthic foraminiferal taxa at the paleoecological studies, stratigraphic works and interregional paleoceanographic correlation in the North Atlantic Ocean.

Keywords

benthic foraminifera, micropaleontology, Scotland shelf, North Atlantic Ocean, Quaternary sediments

Introduction

The North Atlantic (NA) is one of the key areas of the thermohaline circulation system of currents that transfer the heat, salt, dissolved elements and gases and sedimentary matter to the Subarctic and Arctic regions. This circulation being a part of the large-scale circulation of the World Ocean affects the warming and cooling of the global climate and regional oceanography in the NA and Arctic (Morley et al. 2011). The climatic regime sets the marine environments, in particular, the habitat of the microorganisms which are preserved in the bottom sediments. An environmental imprint in the microfossil assemblages provides information on the modern and past oceanographic, climatic and ecological changes. Benthic foraminifers as calcareous microorganisms are one of the leading microfossil groups in the marine geological studies giving the appropriate biostratigraphic and paleoecological data.

In this article, we present a new extensive dataset of the microphotographic illustrations with taxonomic coverage for 106 benthic foraminiferal taxa (mostly as species and genera) from the latest Pleistocene to the the Holocene sediments in the Westray Basin on the north-western Scotland shelf (NWSS). The sediment material was collected in summer 2018 during the 71st cruise of the research vessel Akademic Mstislav Keldysh (Novigatsky et al. 2019). Laboratory treatment and microscopic analysis followed the standard micropaleontological technique for benthic foraminifera. We used the sediment fraction of > 63 μm to count small foraminiferal tests which can be numerous in the high-latitude sediments.

Previous studies described diverse and abundant benthic foraminiferal microfauna in the modern and the the Holocene sediments on and around the Scotland shelf and provided some microphotographs of the typical species (Lo Giudice Cappelli et al. 2019, Mackensen 1987, Mojtahid et al. 2021). Our aim is to continue a research study on the identification and illustration of the benthic foraminifera in the North Atlantic bottom sediments (Kireenko et al. 2022). We present 17 tables with high-quality microphotographs of 106 identified foraminiferal taxa (species and genera) produced using the Nikon microscope SMZ25, equipped with Nikon camera DS-Fi3 and NIS-Elements D software. This work intends to update existing guides on the benthic foraminifers from the European continental margin (like Murray 2003) potentially helping in the future routine micropaleontological studies in the area.

Data Description

We studied the benthic foraminiferal microfauna from the multicorer (MC) and gravity corer (GC) sediments on the AMK-5656 station obtained during the 71st cruise of the Russian research vessel Akademik Mstislav Keldysh in summer 2018 (Novigatsky et al. 2019). The location of the AMK-5656 station is the Westray Basin on the NWSS to the northwest of the Orkney Islands (59°29.469’ N, 3°49.783’ W; 157 m depth). The sediments of the MC (18 cm long) and GC (625 cm long) are the alternating foraminiferal light-brown sandy and muddy silts (Fig. 1).

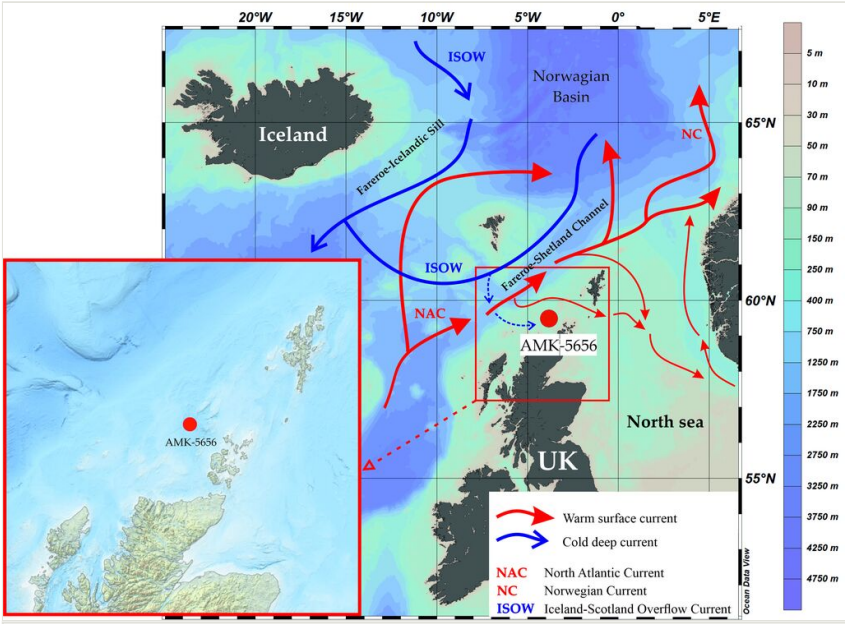

Figure 1. doi

Location of studied sediment cores AMK-5656 MC and GC. Map sources are GEBCO at https://download.gebco.net and EMODnet at https://portal.emodnet-bathymetry.eu.

The NWSS is a shallow water region of western North Atlantic Ocean dominated by the warm saline surface water of the North Atlantic Current branch crossing the NWSS from west to east between Orkney and Shetland (Anonymous 2022a). The cold deep water of Iceland-Scotland Overflow Current coming from the north via the Faroe-Iceland Channel can also influence the local bottom environments (Rasmussen et al. 2002, Sejrup et al. 2004). A prevailing sediment type in the Westray Basin is muddy sand or slightly gravelly sandy mud (Anonymous 2022b) which, in general, is similar to what we found in the AMK-5656 MC and GC.

Bio-monitoring studies, based on the living fauna, indicate that the taxonomically diverse benthic foraminifers densely populate the high-latitude shelf areas (Schönfeld et al. 2012). They sensitively react to environmental change and reflect the conditions occurring both at the bottom (factors of direct habitat on and in sediments) and the surface (e.g. phytoplankton production as food source) (Bauch et al. 2001).

Table 1 presents a list of the identified benthic foraminiferal species. We found in the samples of the AMK-5656 MC and GC, 106 taxa all in all identified mostly at species level, partly as genera. Amongst them, four species have the agglutinated shells and the rest are calcareous-secretive. The microphotographs on Figs 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 present high-resolution images of all identified benthic foraminifers showing the shell morphology of every taxa in details from two-three views (apertural, lateral, side, umbilical and spiral).

Table 1.

List of benthic foraminiferal taxa in station AMK-5656 from north-western Scotland shelf in North Atlantic.

Ammonia falsobeccarii (Rouvillois, 1974)
Amphicoryna scalaris (Batsch, 1791)
Amphicoryna separans (Brady, 1884)
Astrononion gallowayi Loeblich & Tappan, 1953 = *Astrononion hamadaense* Asano, 1950
Bolivina albatrossi Cushman, 1922
Bolivina earlandi Parr, 1950
Bolivina inflata Heron-Allen & Earland, 1913
Bolivina limbata (Brady, 1881) = *Loxostomina limbata* (Brady, 1881)
Bolivina pseudoplicata Heron-Allen & Earland, 1930
Bolivina spathulata (Williamson, 1858)
Bolivina striatula Cushman, 1922
Bolivina subspinescens Cushman, 1922
Bolivina tortuosa (Brady, 1881) = *Sigmavirgulina tortuosa* (Brady, 1881)
Bolivina sp. d'Orbigny, 1839
Bolivinellina pseudopunctata (Höglund, 1947)
Brizalina alata (Seguenza, 1862) = *Bolivina alata* (Seguenza, 1862)
Brizalina pygmaea (Brady, 1881) = *Bolivina pygmaea* (Brady, 1881)
Buccella frigida (Cushman, 1922) = *Buccella calida* (Cushman & Cole, 1930)
Bulimina aculeata d'Orbigny, 1826
Bulimina elongata d'Orbigny, 1846
Bulimina marginata d'Orbigny
Cassidulina carinata Silvestri, 1896
Cassidulina laevigata d'Orbigny, 1826
Cassidulina obtusa Williamson, 1858
Cassidulina reniforme Nørvang, 1945
Cassidulina teretis Tappan, 1951 = *Cassidulina neoteretis* Seidenkrantz, 1995
Cassidulina sp. d'Orbigny, 1826
Cassidulinoides bradyi (Norman, 1881)
Cornuspira involvens (Reuss, 1850)
Cibicides refulgens Montfort, 1808
Cibicides lobatulus (Walker & Jacob, 1798) = *Lobatula lobatula* (Walker & Jacob, 1798)
Cibicidoides wuellerstorfi (Schwager, 1866)
Cibicides sp. Montfort, 1808
Discorbis sp. Lamarck, 1804

Eggerelloides scaber (Williamson, 1858)
Elphidium clavatum Cushman, 1930 = *Elphidium excavatum* subsp. *clavatum* Cushman, 1930
Elphidium earlandi Cushman, 1936
Elphidium gerthi van Voorthuysen, 1957 = *Cribroelphidium gerthi* (van Voorthuysen, 1957)
Elphidium sp. Montfort, 1808
Epistomaroides polystomelloides (Parker & Jones, 1865)
Epistominella exigua (Brady, 1884)
Epistominella vitrea Parker, 1953 = *Eilohedra vitrea* (Parker, 1953)
Facetocochlea pulchra (Cushman, 1933)
Fissurina sp. Reuss, 1850
Fursenkoina fusiformis (Williamson, 1858) = *Stainforthia fusiformis* (Williamson, 1858)
Fursenkoina complanata (Egger, 1893) = *Stainforthia loeblichi* (Feyling-Hanssen, 1954)
Fursenkoina texturata (Brady, 1884)
Geminospira bradyi Bermúdez, 1952
Glabratella altispira Buzas, Smith & Beem, 1977
Globobulimina pacifica Cushman, 1927 = *Laryngosigma lactea* (Walker & Jacob, 1798)
Globocassidulina subglobosa (Brady, 1881)
Hyalinea balthica (Schröter, 1783)
Islandiella norcrossi (Cushman, 1933)
Lagena sp. Walker & Jacob, 1798
Lamarckina haliotidea (Heron-Allen & Earland, 1911)
Lenticulina gibba (d'Orbigny, 1839)
Massilina secans (d'Orbigny, 1826) = *Quinqueloculina secans* d'Orbigny, 1826
Melonis barleeanus (Williamson, 1858) = *Melonis affinis* (Reuss, 1851)
Melonis pompilioides (Fichtel & Moll, 1798)
Melonis sp. Montfort, 1808
Miliolinella subrotunda (Montagu, 1803)
Mychostomina revertens (Rhumbler, 1906)
Neoglabratella wiesneri (Parr, 1950)
Neolenticulina variabilis (Reuss, 1850)
Nonion pauperatum (Balkwill & Wright, 1885) = *Subanomalina pauperata* (Balkwill & Wright, 1885)
Nonion sp. Montfort, 1808
Nonionella auricula Heron-Allen & Earland, 1930
Nonionella iridea Heron-Allen & Earland, 1932
Nonionoides turgidus (Williamson, 1858)
Oolina sp. d'Orbigny, 1839
Patellina corrugata Williamson, 1858

Planorbulina mediterranensis d'Orbigny, 1826
Planulina sp. d'Orbigny, 1826
Procerolagena clavata (d'Orbigny, 1846)
Pyrgo murrhina (Schwager, 1866)
Pyrgo williamsoni (Silvestri, 1923)
Quinqueloculina seminulum (Linnaeus, 1758)
Quinqueloculina sp. d'Orbigny, 1826
Robertinoides bradyi (Cushman & Parker, 1936)
Robertinoides sp. Höglund, 1947
Rosalina araucana d'Orbigny, 1839 = *Valvulineria araucana* (d'Orbigny, 1839)
Rosalina auberii d'Orbigny, 1839 = *Discorbis auberii* (d'Orbigny, 1839) = *Rotorbis auberii* (d'Orbigny, 1839)
Rosalina bertheloti d'Orbigny, 1839 = *Discorbinella bertheloti* (d'Orbigny, 1839)
Rosalina bradyi (Cushman, 1915) = *Rosalina anomala* Terquem, 1875
Rosalina globularis d'Orbigny, 1826
Rosalina opercularis d'Orbigny, 1826 = *Rosalina opercularis* d'Orbigny, 1839 = *Discorbina opercularis* (d'Orbigny, 1839)
Rosalina vilardeboana d'Orbigny, 1839 = *Discorbis vilardeboanus* (d'Orbigny, 1839)
Rosalina sp. d'Orbigny, 1826
Sahulia conica (d'Orbigny, 1839) = *Textularia conica* d'Orbigny, 1839
Siphotextularia concava (Karrer, 1868)
Spiroloculina depressa d'Orbigny, 1826
Spiroloculina excavata d'Orbigny, 1846
Spiroloculina sp. d'Orbigny, 1826
Spirillina viviparina Saidova, 1975
Spiroplectinella wrighti (Silvestri, 1903)
Textularia sagittula Defrance, 1824
Triloculina elongata d'Orbigny in Fornasini, 1905
Triloculina trigonula (Lamarck, 1804)
Triloculina trihedra Loeblich & Tappan, 1953
Trifarina angulosa (Williamson, 1858)
Trifarina bradyi Cushman, 1923
Trifarina fluens (Todd in Cushman & McCulloch, 1948)
Uvigerina peregrina Cushman, 1923
Uvigerina mediterranea Hofker, 1932
Valvulineria minuta (Schubert, 1904) = *Discorbis minuta* (Schubert, 1904)
Valvulineria rugosa (d'Orbigny, 1839) = *Discorbis rugosa* (d'Orbigny, 1839) = *Rosalina rugosa* d'Orbigny, 1839

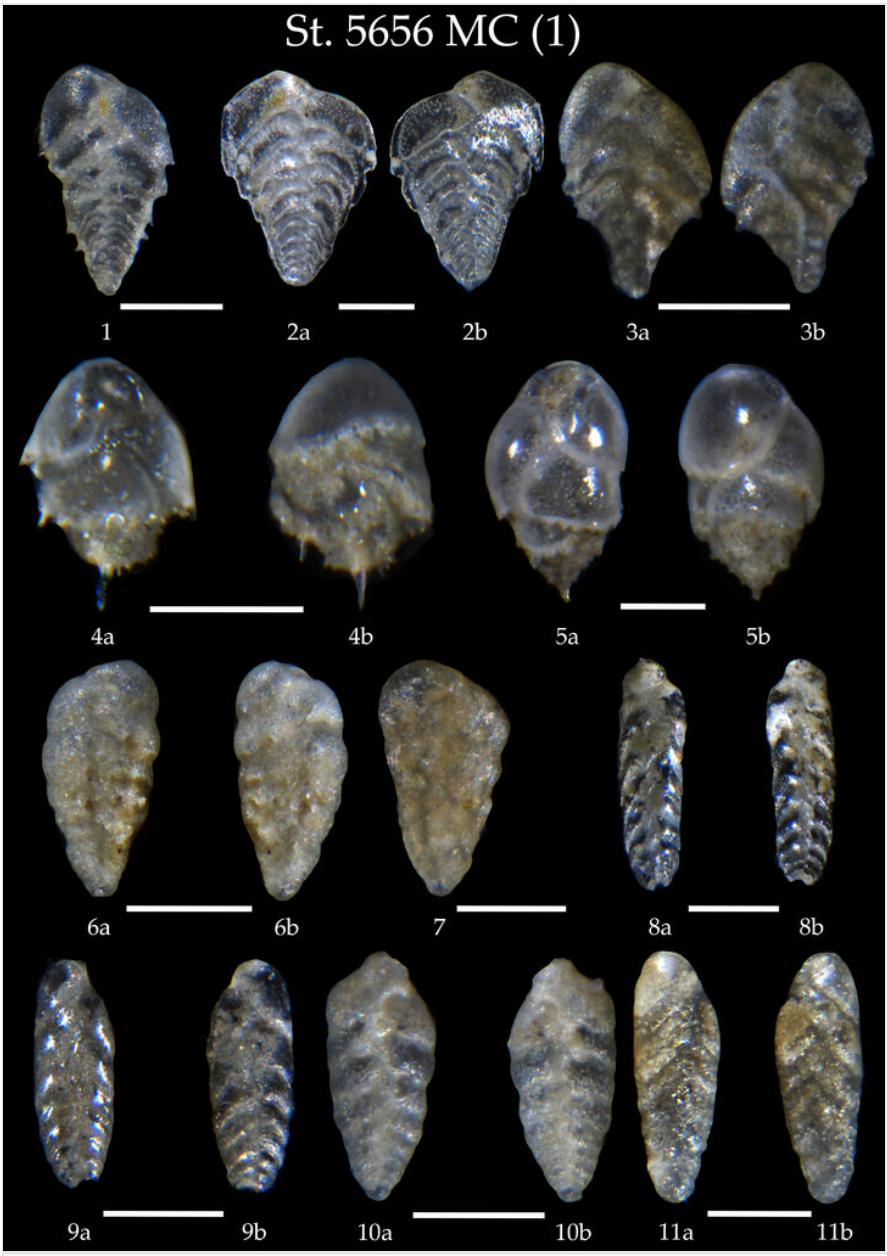

Figure 2. doi

Station 5656 **MC**. **1** *Brizalina pygmaea*; **2** *Brizalina alata*, **a**,**b** lateral view; **3** *Bolivina tortuosa*; **4** *Bulimina aculeata*, **a** apertural view, **b** lateral view; **5** *Bulimina marginata*, **a** apertural view, **b** lateral view; **6** *Bolivina pseudoplicata*, **6a** side view, **6b** lateral view; **7** *Bolivina pseudoplicata*; **8** ,**9** *Bolivina earlandi*, **a** side view, **b** lateral view; **10**,**11** *Bolivina striatula*, **a** side view, **b** lateral view. Scale 100 µm.

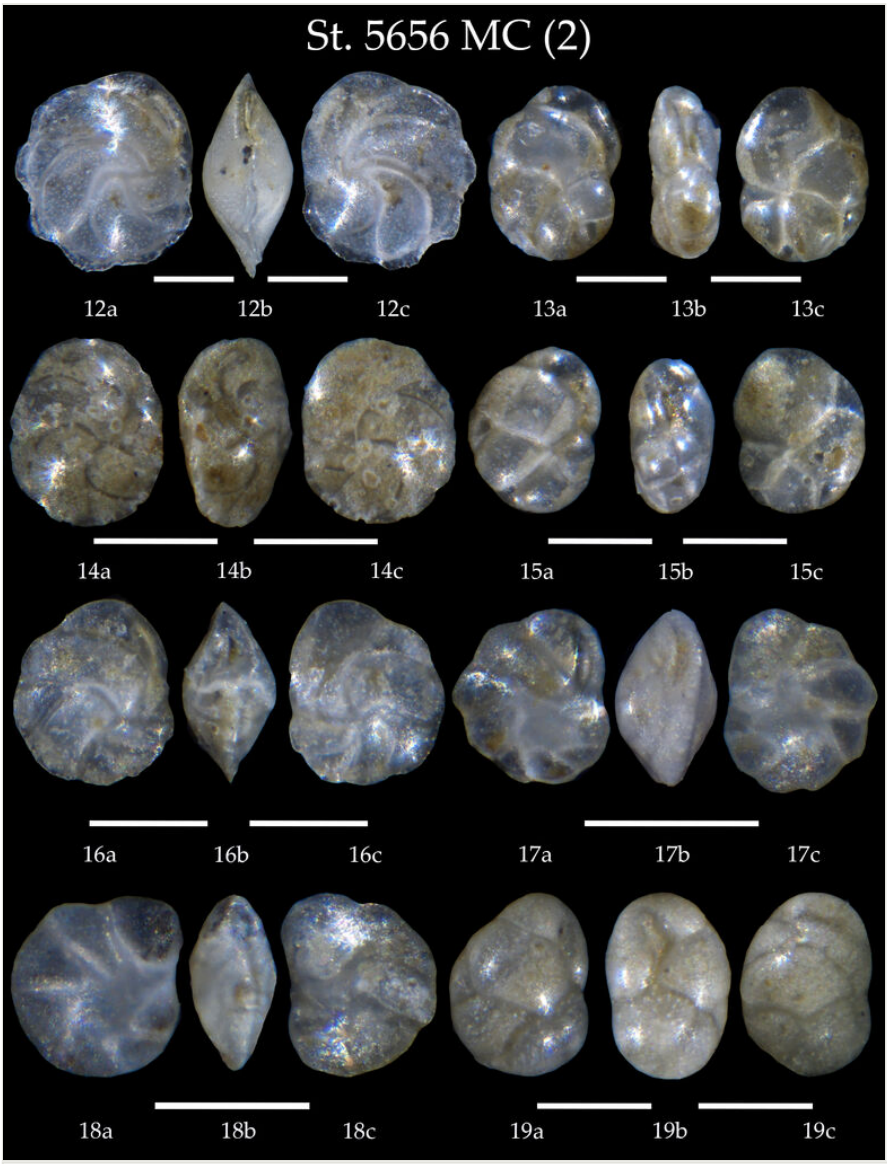

Figure 3. doi

Station 5656 **MC** (continued). **12** *Cassidulina carinata*, **a, b** apertural view, **c** lateral view; **13** *Cassidulina obtusa*, **a, b** apertural view, **c** lateral view; **14** *Cassidulina laevigata*, **a, b** apertural view, **c** lateral view; **15** *Cassidulina reniforme*, **a, b** apertural view, **c** lateral view; **16** *Cassidulina* sp., cf. *C. laevigata*, **a, b** apertural view, **c** lateral view; **17** *Cassidulina teretis*, **a, b** apertural view, **c** lateral view; **18** *Islandiella norcrossi*, **a, b** apertural view, **c** lateral view; **19** *Globocassidulina subglobosa*, **a** side view, **b** apertural view, **c** lateral view. Scale 100 μm.

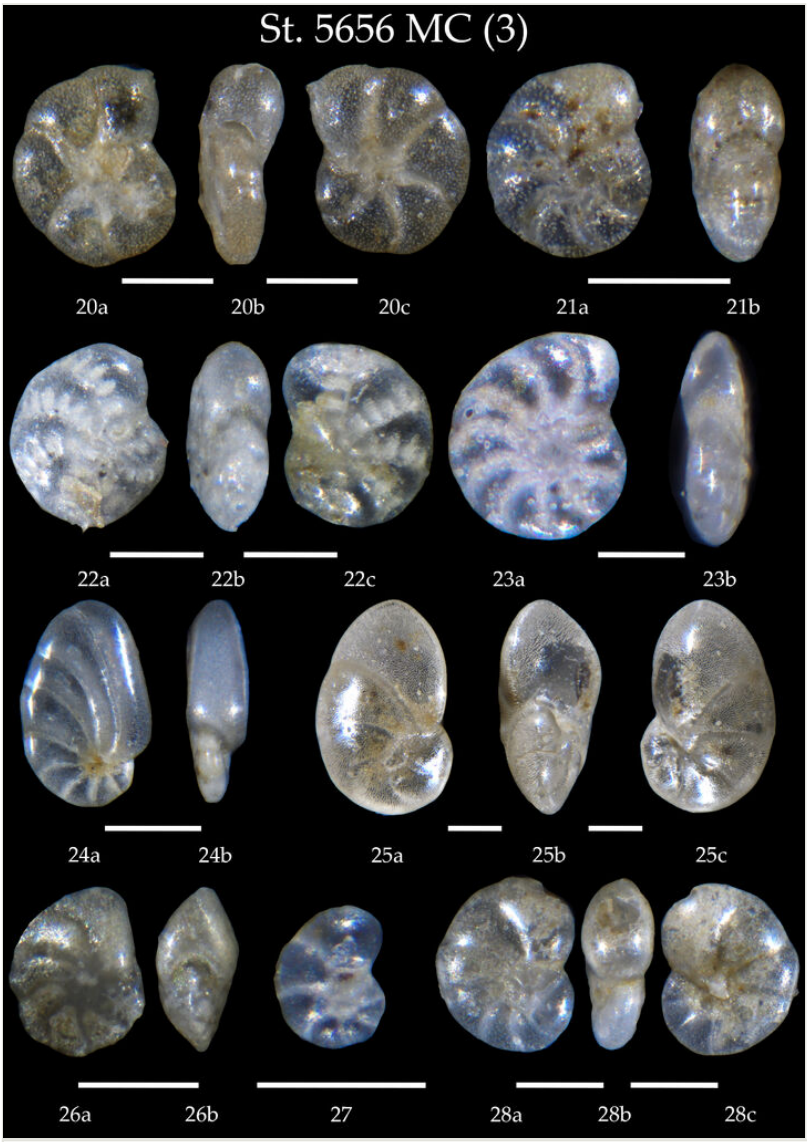

Figure 4. doi

Station 5656 **MC** (continued). **20** *Astrononion gallowayi*, **a** side view, **b** apertural view, **c** lateral view; **21** *Elphidium clavatum*, **a** side view, **b** apertural view; **22** *Elphidium earlandi*, **a** side view, **b** apertural view, **c** lateral view; **23** *Elphidium gerthi*, **a** side view, **b** apertural view; **24** *Nonionoides turgidus*, **a** side view, **b** apertural view; **25** *Nonionella iridea*, **a** spiral view, **b** apertural view, **c** umbilical view; **26** *Nonion pauperatum*, **a** side view, **b** apertural view; **27** *Nonionella auricula*; **28** *Nonion* sp. cf. *N. faba*, **a** spiral view, **b** apertural view, **c** umbilical view. Scale 100 µm.

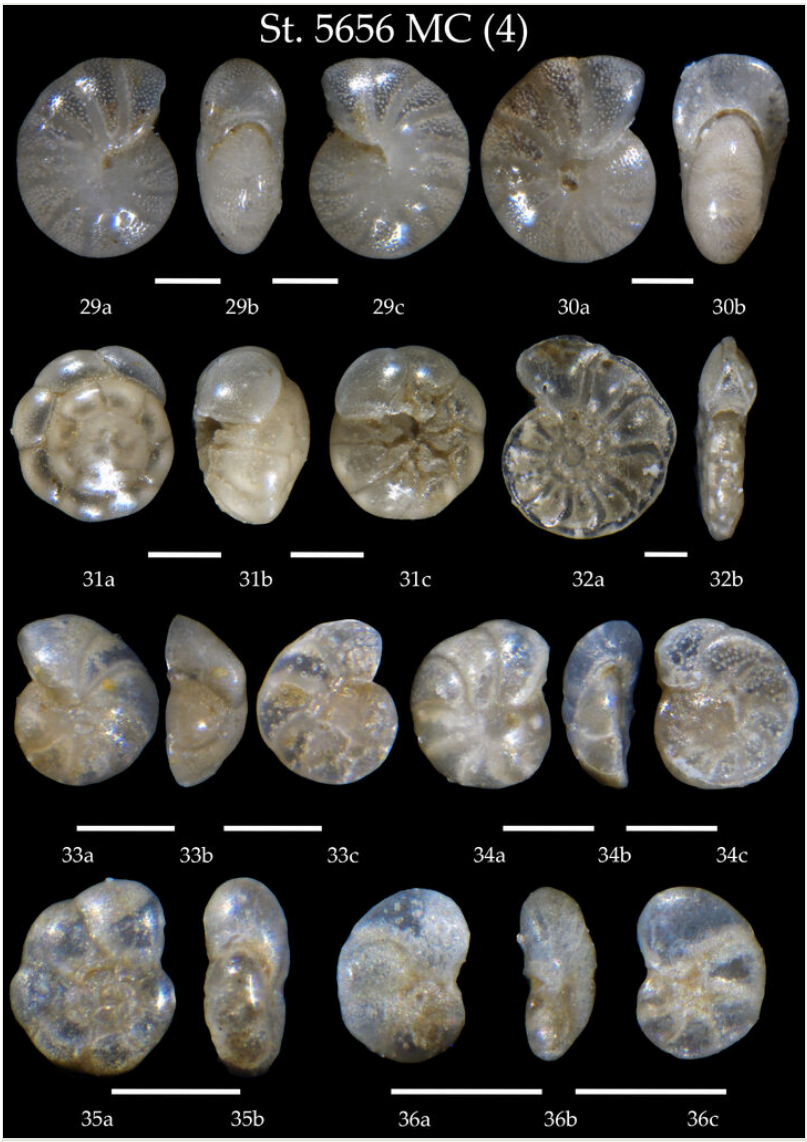

Figure 5. doi

Station 5656 **MC** (continued). **29** *Melonis barleeanus*, **a** side view, **b** apertural view, **c** lateral view; **30** *Melonis pompilioides*, **a** side view, **b** apertural view; **31** *Ammonia falsobeccarii*, **a** spiral view, **b** apertural view, **c** umbilical view; **32** *Hyalinea balthica*, **a** side view, **b** apertural view; **33** *Cibicides refulgens*, **a** spiral view, **b** apertural view, **c** umbilical view; **34** *Cibicides lobatulus*, **a** spiral view, **b** apertural view, **c** umbilical view; **35** *Epistomaroides polystomelloides* , **a** side view, **b** apertural view; **36** *Planulina ariminensis*, **a** spiral view, **b** apertural view, **c** umbilical view. Scale 100 µm.

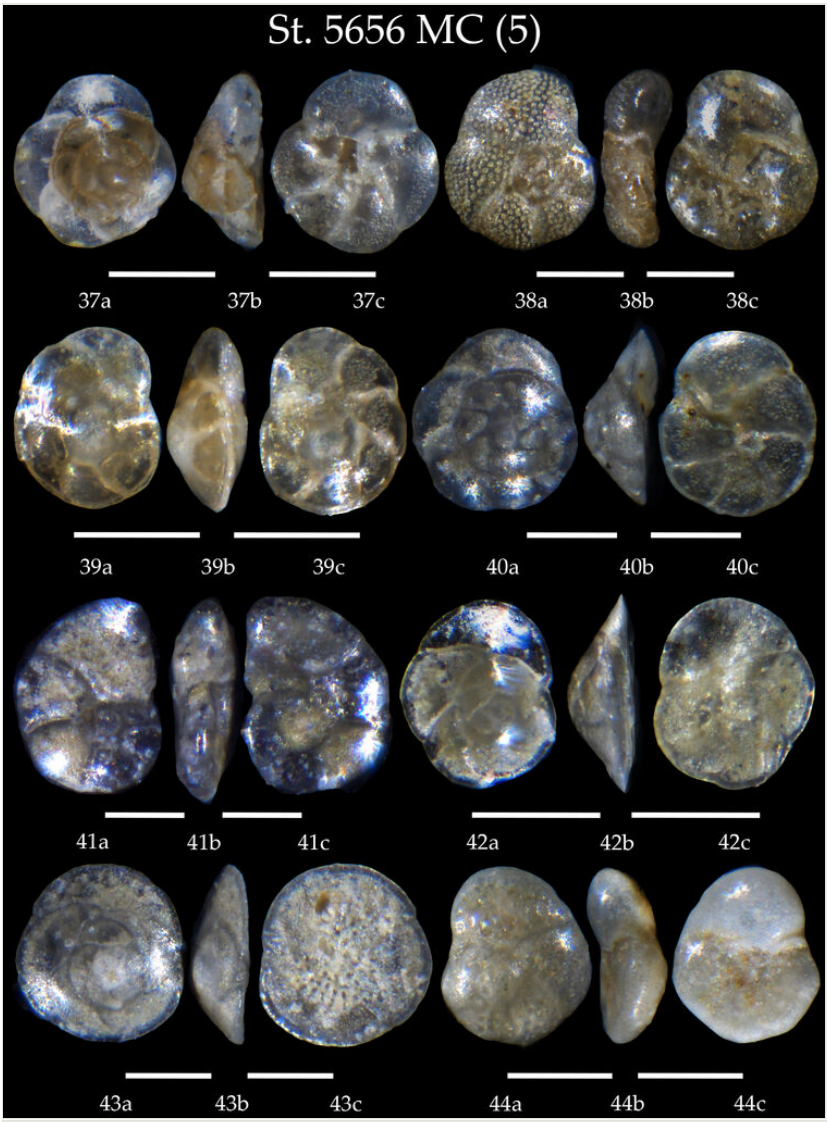

Figure 6. doi

Station 5656 **MC** (continued). **37** *Rosalina vilardeboana*, **a** spiral view, **b** apertural view, **c** umbilical view; **38** *Rosalina bradyi*, **a** spiral view, **b** apertural view, **c** umbilical view; **39** *Rosalina araucana*, **a** spiral view, **b** apertural view, **c** umbilical view; **40** *Rosalina auberii*, **a** spiral view, **b** apertural view, **c** umbilical view; **41** *Lamarckina haliotidea*, **a** spiral view, **b** apertural view, **c** umbilical view; **42** *Rosalina bertheloti*, **a** spiral view, **b** apertural view, **c** umbilical view; **43** *Rosalina opercularis*, **a** spiral view, **b** apertural view, **c** umbilical view; **44** *Rosalina globularis*, **a** spiral view, **b** apertural view, **c** umbilical view. Scale 100 µm.

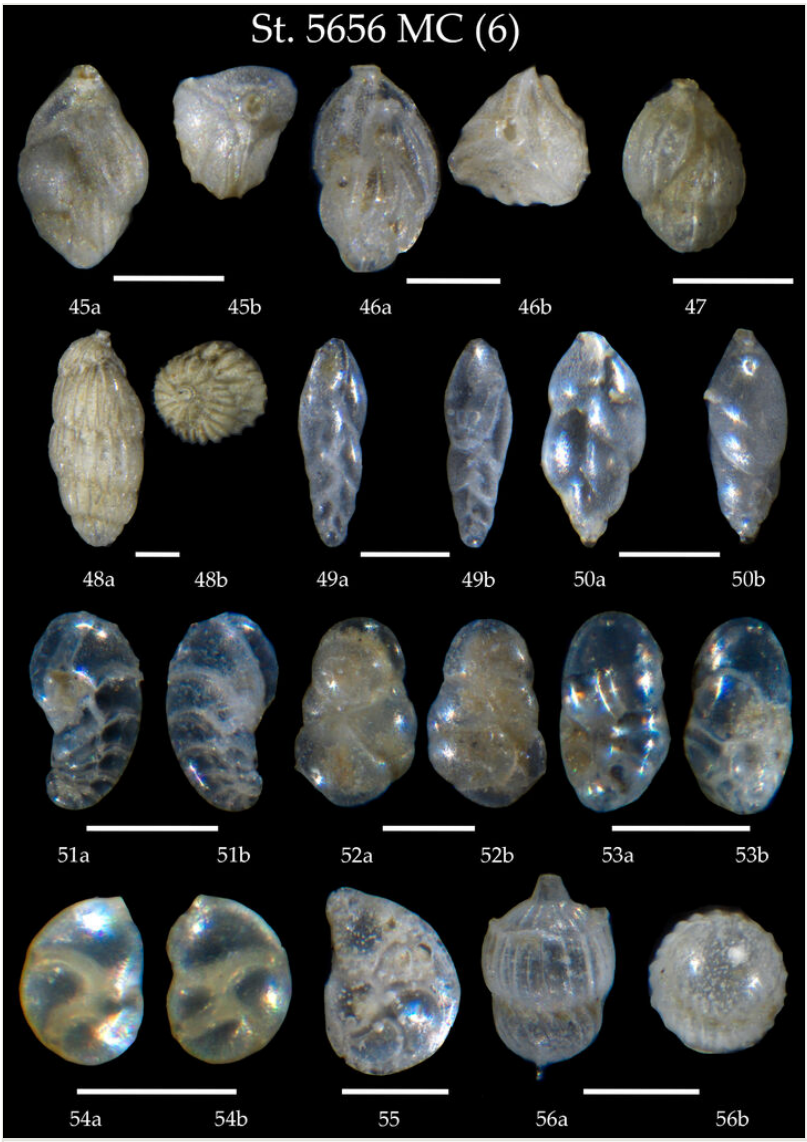

Figure 7. doi

Station 5656 **MC** (continued). **45** *Trifarina angulosa*, **a** side view, **b** apertural view; **46** *Trifarina bradyi*, **a** side view, **b** apertural view; **47** *Uvigerina mediterranea*; **48** *Uvigerina peregrina*, **a** side view, **b** apertural view; **49** *Fursenkoina fusiformis*, **a** apertural view, **b** side view; **50** *Fursenkoina complanata*, **a** apertural view, **b** side view; **51** *Geminospira bradyi*, **a** apertural view, **b** side view; **52** *Robertinoides* sp., **a** side view, **b** lateral view; **53** *Robertinoides bradyi*, **a** apertural view, **b** side view; **54** *Neolenticulina variabilis*, **a** side view, **b** lateral view; **55** *Lenticulina gibba*; **56** *Amphicoryna scalaris*, **a** side view, **b** apertural view. Scale 100 μm.

Figure 8. doi

Station 5656 **MC** (continued). **57 – 60** *Fissurina* sp.; **61,62** *Lagena* sp., **a** side view, **b** apertural view; **63** *Oolina* sp.; **64** *Globobulimina pacifica*, **a** side view, **b** apertural view; **65** *Pyrgo williamsoni*, **a** apertural view, **b** side view; **66** *Quinqueloculina seminulum*, **a-c** side view, **d** apertural view. Scale 100 µm.

Figure 9. doi

Station 5656 **MC** (continued). **67** *Miliolinella subrotunda*, **a** side view, **b** apertural view, **c** lateral view; **68** *Triloculina elongata*, **a** side view, **b** apertural view; **69** *Spiroloculina excavata*, **a, b** side view, **c** apertural view; ***70*** *Massilina secans*, **a, b** side view, **c** apertural view; **71** *Cornuspira involvens*, **a** side view, **b** lateral view; **72** *Epistominella exigua*, **a** spiral view, **b** umbilical view; **73** *Glabratella altispira*, **a** spiral view, **b** umbilical view; **74** *Patellina corrugate*, **a** spiral view, **b** apertural view, **c** umbilical view. Scale 100 μm.

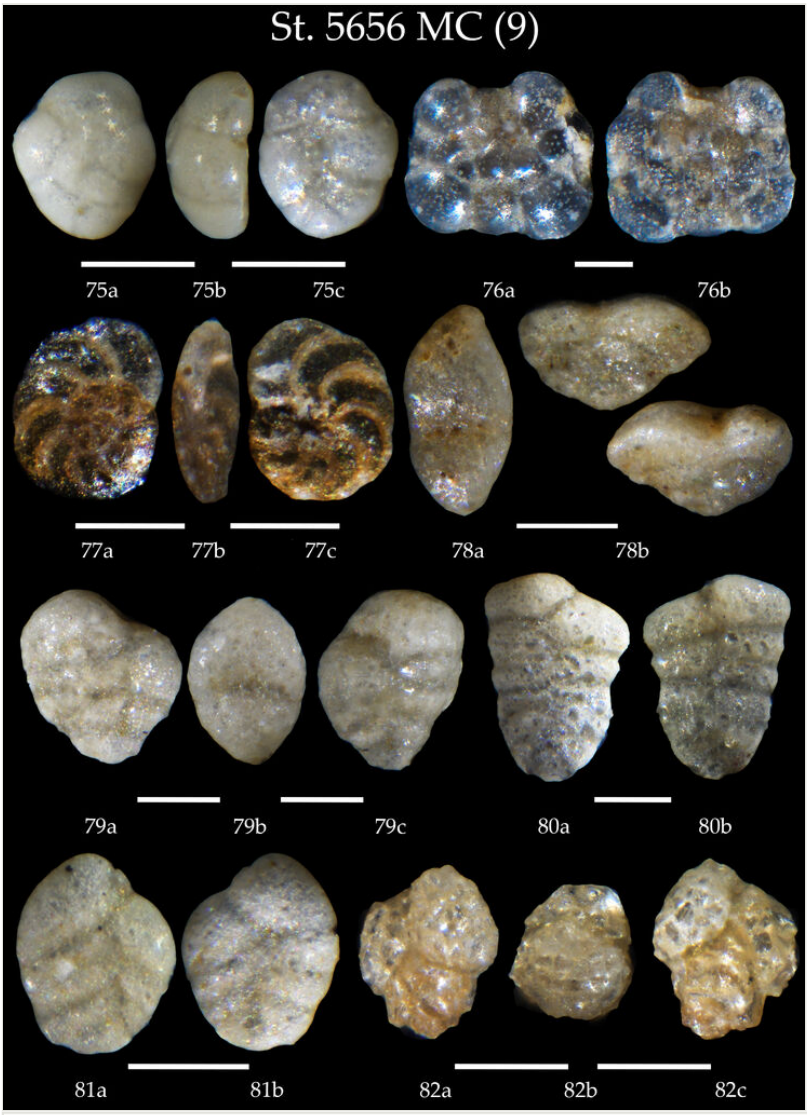

Figure 10. doi

Station 5656 **MC** (continued). **75** Sp. cf. *C. lobatulus* juvenile test, **a** spiral view, **b** apertural view, **c** umbilical view; **76** *Planorbulina mediterranensis*, **a** spiral view, **b** umbilical view; **77** *Discorbis* sp., **a** spiral view, **b** apertural view, **c** umbilical view; **78** *Sahulia conica*, **a** apertural view, **b** side view; **79** *Sahulia conica*, **a, c** side view, **b** apertural view; **80** *Textularia sagittula*, **a** side view, **b** lateral view; **81** *Siphotextularia concava*, **a** side view, **b** lateral view; **82** *Eggerelloides scaber*, **a, c** side view, **b** apertural view. Scale 100 µm.

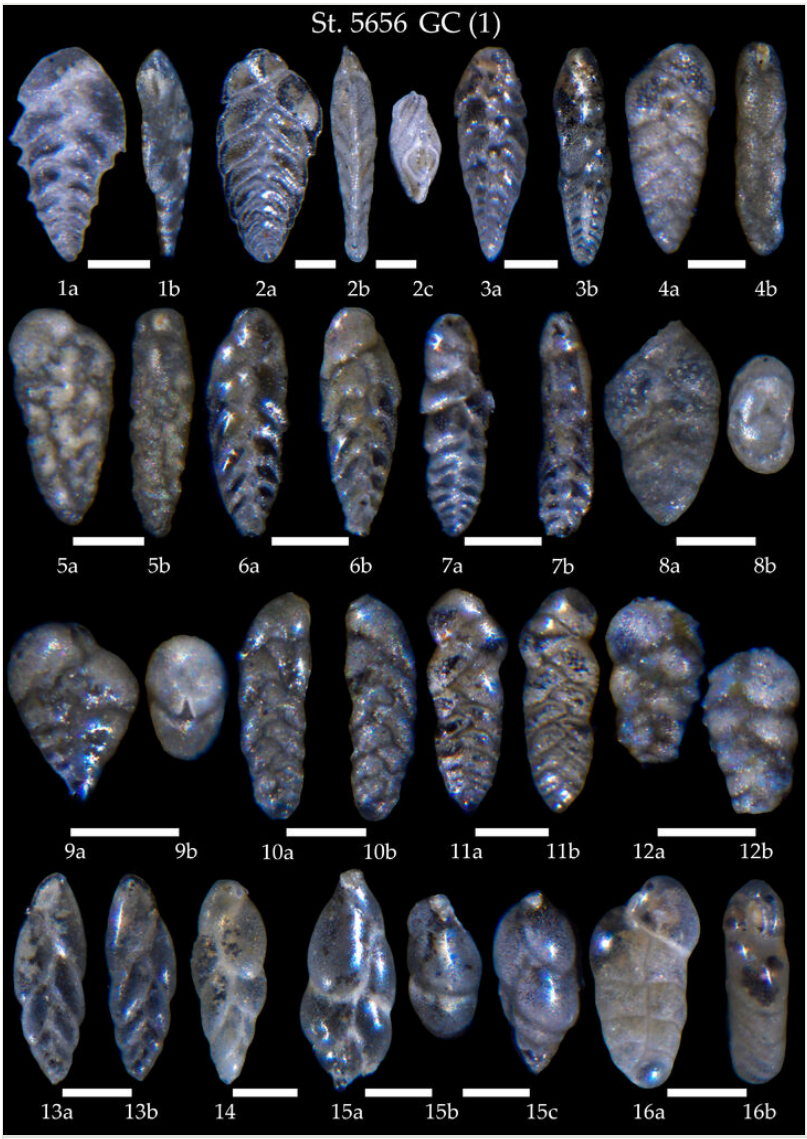

Figure 11. doi

Station 5656 **GC**. **1** *Brizalina pygmaea*, **a** side view, **b** apertural view; **2** *Brizalina alata*, **a, b** side view, **c** apertural view; **3** *Bolivina spathulata*, **a** side view, **b** apertural view; **4** *Bolivina striatula*, **a** side view, **b** apertural view; **5** *Bolivina pseudoplicata*, **a** side view, **b** apertural view; **6** *Bolivina earlandi*, **a** side view, **b** lateral view; **7** *Bolivinellina pseudopunctata*, **a** side view, **b** apertural view; **8** *Bolivina albatrossi*, **a** side view, **b** apertural view; **9** *Bolivina inflata*, **a** side view, **b** apertural view; **10** *Bolivina limbata*, **a** side view, **b** lateral view; **11** *Bolivina* sp., **a** side view, **b** lateral view; **12** *Bolivina subspinescens*, **a** side view, **b** lateral view; **13,14** *Fursenkoina complanata*, **13a** apertural view, **13b** side view; **15** *Fursenkoina fusiformis*, **a** side view, **b, c** apertural view; **16** *Fursenkoina texturata*, **a** side view, **b** apertural view. Scale 100 μm.

Figure 12. doi

Station 5656 **GC** (continued). **17** *Bulimina marginata*, **a** side view, **b** apertural view; **18** *Bulimina elongata*, **a** side view, **b** apertural view; **19** *Bulimina aculeata*, **a** side view, **b** apertural view; **20** *Bulimina aculeata*, **a** side view, **b** apertural view; **21** *Trifarina angulosa*, **a** side view, **b** apertural view; **22** *Trifarina fluens*, **a** side view, **b** apertural view; **23** *Trifarina bradyi*, **a** side view, **b** apertural view; **24** *Uvigerina peregrina*, **a** side view, **b** apertural view; **25** *Uvigerina mediterranea*, **a** side view, **b** apertural view; **26** *Amphicoryna scalaris*, **a** side view, **b** apertural view; **27** *Amphicoryna separans*, **a** side view, **b** apertural view; **28** *Neolenticulina variabilis*, **a** side view, **b** apertural view; **29** *Lenticulina gibba*, **a** side view, **b** apertural view. Scale 100 µm.

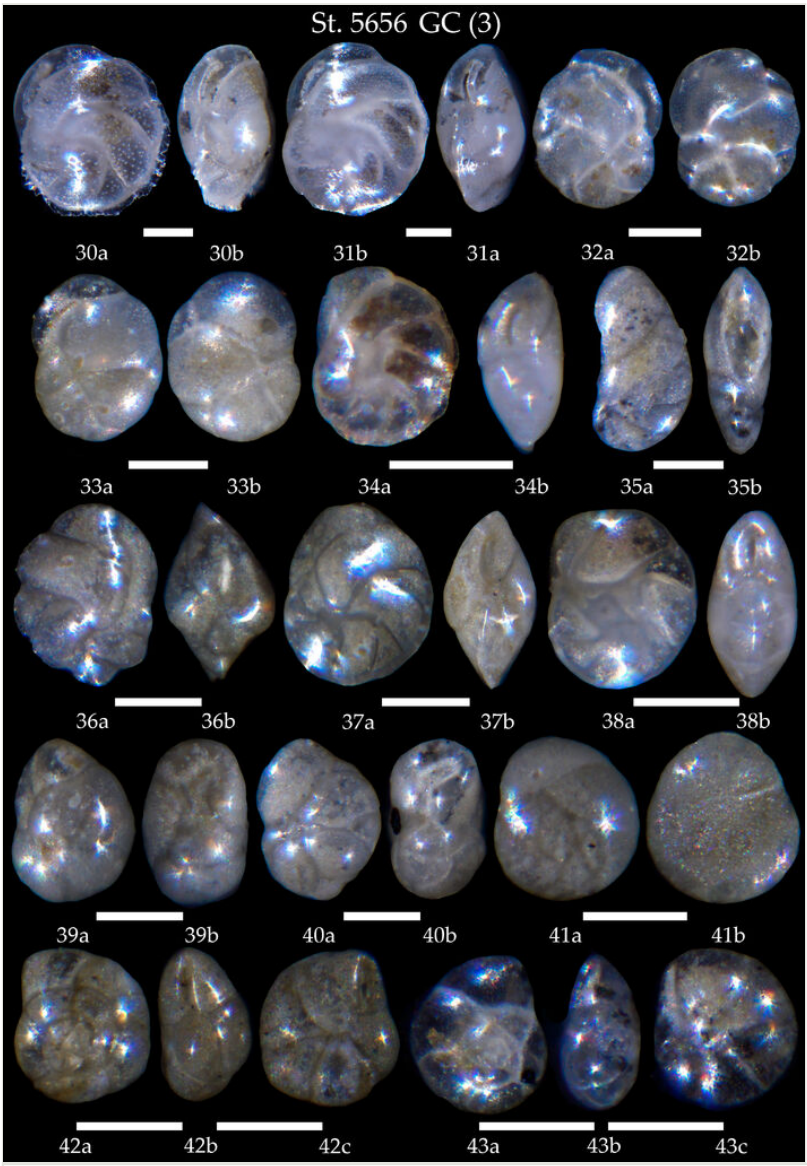

Figure 13. doi

Station 5656 **GC** (continued). **30** *Cassidulina carinata*, **a** side view, **b** apertural view; **31** *Cassidulina laevigata*, **a** side view, **b** apertural view; **32** *Cassidulina obtusa*, **a** apertural view, **b** lateral view; **33** *Cassidulina reniforme*, **a** apertural view, **b** lateral view; **34** *Cassidulina teretis*, **a** side view, **b** apertural view; **35** *Cassidulinoides bradyi*, **a** side view, **b** apertural view; **36,37** *Cassidulina* sp. cf *C. laevigata* **a** side view, **b** apertural view; **38** *Islandiella norcrossi*, **a** side view, **b** apertural view; **39,40** *Globocassidulina subglobosa*, **a** side view, **b** apertural view; **41** *Buccella frigida*, **a** spiral view, **b** umbilical view; **42** *Epistominella vitrea*, **a** spiral view, **b** apertural view, **c** umbilical view; **43** *Epistominella exigua*, **a** spiral view, **b** apertural view, **c** umbilical view. Scale 100 µm.

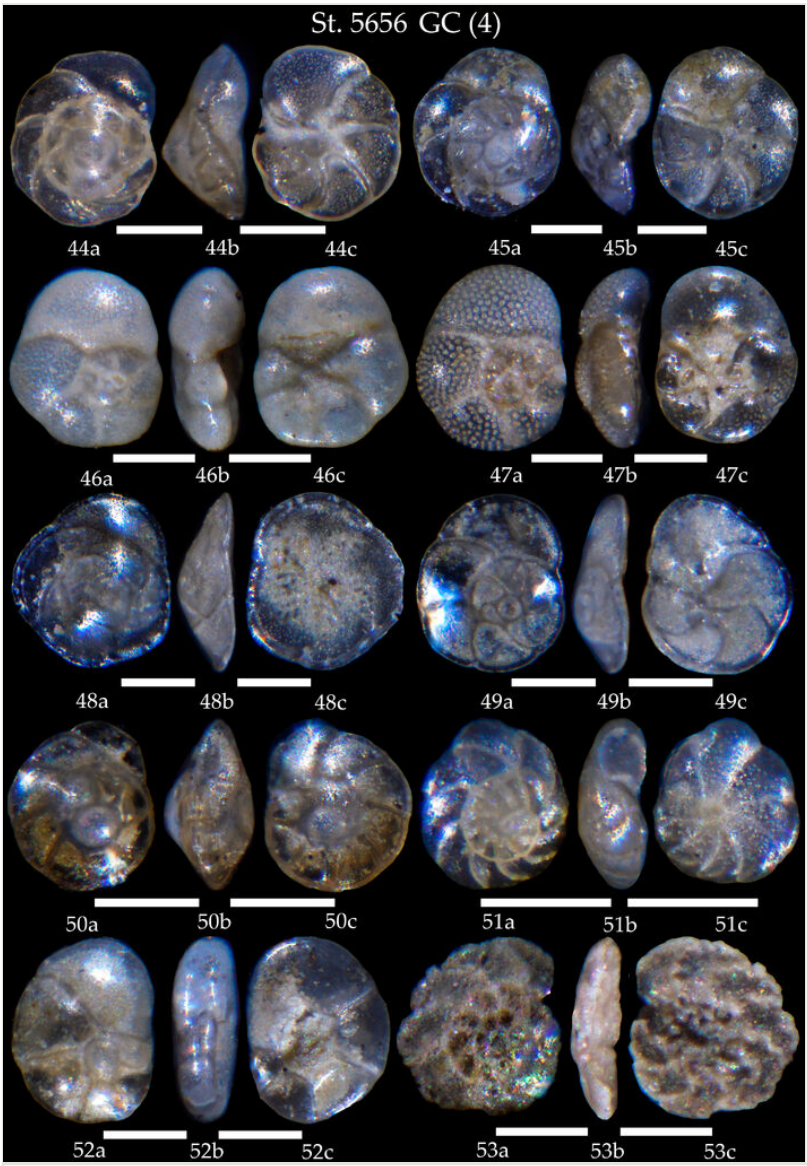

Figure 14. doi

Station 5656 **GC** (continued). **44,45** *Rosalina vilardeboana*, **a** spiral view, **b** apertural view, **c** umbilical view; **46** *Rosalina globularis*, **a** spiral view, **b** apertural view, **c** umbilical view; **47** *Rosalina bradyi*, **a** spiral view, **b** apertural view, **c** umbilical view; **48** *Rosalina opercularis*, **a** spiral view, **b** apertural view, **c** umbilical view; **49** *Rosalina bertheloti*, **a** spiral view, **b** apertural view, **c** umbilical view; **50** *Rosalina araucana*, **a** spiral view, **b** apertural view, **c** umbilical view; **51** *Rosalina* sp., **a** spiral view, **b** apertural view, **c** umbilical view; **52** *Lamarckina haliotidea*, **a** spiral view, **b** apertural view, **c** umbilical view; **53** *Discorbis* sp., **a** spiral view, **b** apertural view, **c** umbilical view. Scale 100 µm.

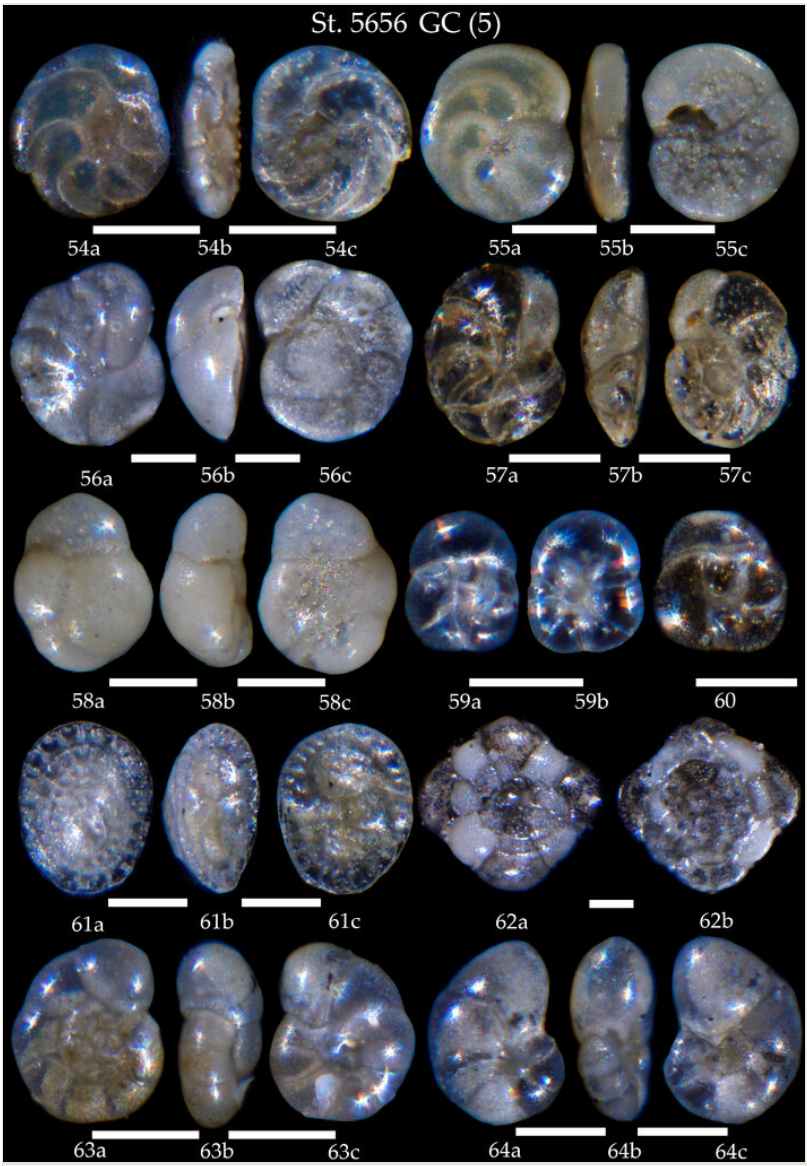

Figure 15. doi

Station 5656 **GC** (continued). **54** *Discorbis* sp., **a** spiral view, **b** apertural view, **c** umbilical view; **55** *Neoglabratella wiesneri*, **a** spiral view, **b** apertural view, **c** umbilical view; **56** *Cibicides lobatulus*, **a** spiral view, **b** apertural view, **c** umbilical view; **57** *Cibicidoides wuellerstorfi*, **a** spiral view, **b** apertural view, **c** umbilical view; **58** Sp. cf. *C. lobatulus* juvenile test, **a** spiral view, **b** apertural view, **c** umbilical view; **59,60** *Glabratella altispira*, **59a** spiral view, **59b** umbilical view; **61** *Patellina corrugata*, **a** spiral view, **b** apertural view, **c** umbilical view; **62** *Planorbulina mediterranensis*, **a** spiral view, **b** umbilical view; **63** *Valvulineria rugosa*, **a** spiral view, **b** apertural view, **c** umbilical view; **64** *Valvulineria minuta*, **a** spiral view, **b** apertural view, **c** umbilical view. Scale 100 μm

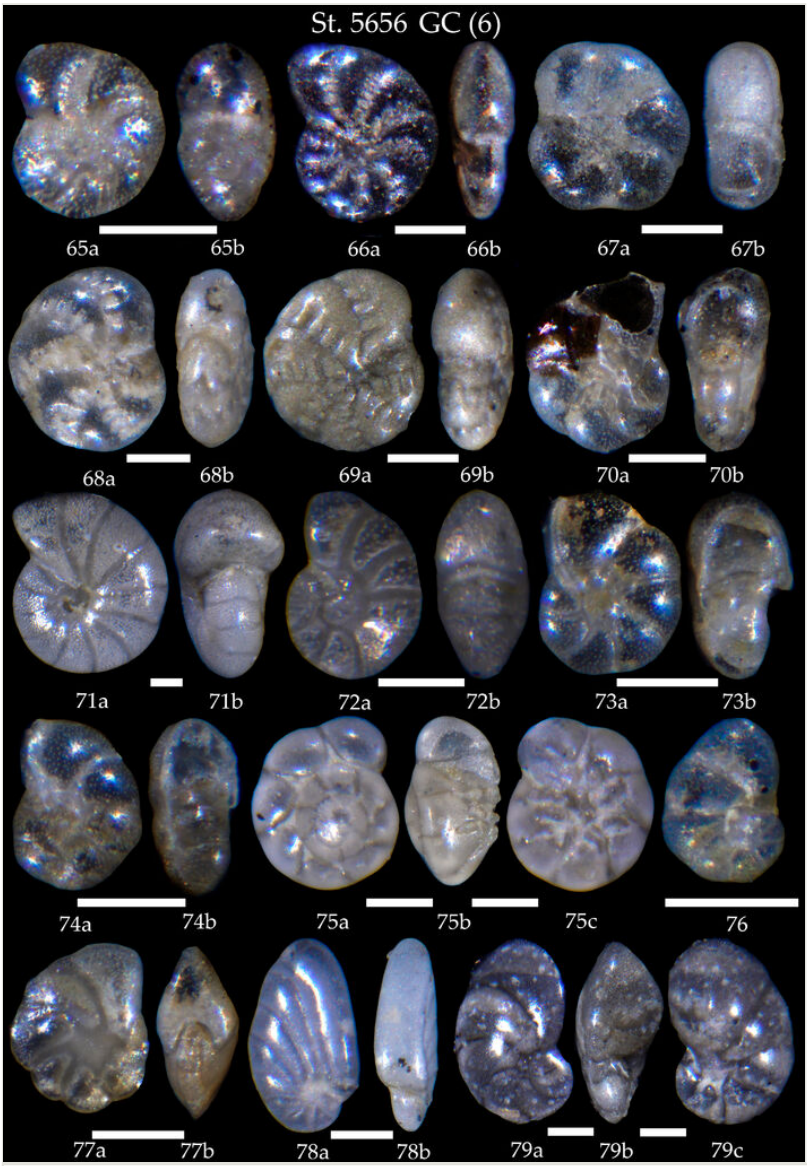

Figure 16. doi

Station 5656 **GC** (continued). **65** *Elphidium clavatum*, **a** side view, **b** apertural view; **66** *Elphidium gerthi*, **a** side view, **b** apertural view; **67** *Elphidium* sp. cf. *E. magellanicum*, **a** side view, **b** apertural view; **68** *Elphidium earlandi*, **a** side view, **b** apertural view; **69** *Elphidium* sp. cf. *E. williamsoni*, **a** side view, **b** apertural view; **70** *Astrononion gallowayi*, **a** side view, **b** apertural view; **71** *Melonis pompilioides*, **a** side view, **b** apertural view; **72** *Melonis barleeanus*, **a** side view, **b** apertural view; **73,74** Sp. cf. *Haynesina depressula*, **a** side view, **b** apertural view; **75** *Ammonia falsobeccarii*, **a** spiral view, **b** apertural view, **c** umbilical view; **76** *Nonionella auricula*; **77** *Nonion pauperatum*, **a** side view, **b** apertural view; **78** *Nonionoides turgidus*; **79** *Nonionella iridea*, **a** spiral view, **b** apertural view, **c** umbilical view. Scale 100 µm.

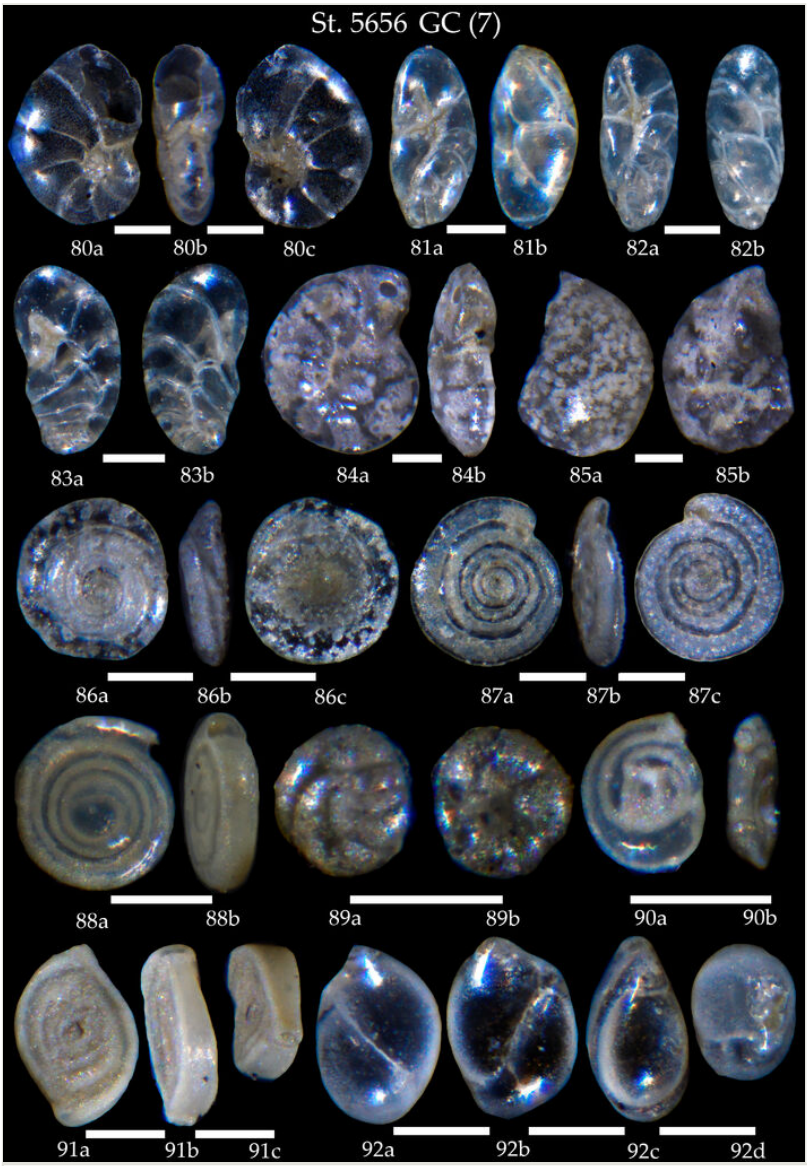

Figure 17. doi

Station 5656 **GC** (continued). **80** *Nonion* sp., cf. *N. faba*, **a** spiral view, **b** apertural view, **c** umbilical view; **81,82** *Robertinoides bradyi*, **a** apertural view, **b** lateral view; **83** *Geminospira bradyi*, **a** apertural view, **b** lateral view; **84** *Hyalinea balthica*, **a** side view, **b** apertural view; **85** Sp.; **86** *Mychostomina revertens*, **a** spiral view, **b** apertural view, **c** umbilical view; **87** *Spirillina viviparina*, **a** spiral view, **b** apertural view, **c** umbilical view; **88** *Cornuspira involvens*, **a** side view, **b** apertural view; **89** *Facetocochlea pulchra*, **a** spiral view, **b** umbilical view; **90** *Spiroloculina* sp., **a** side view, **b** apertural view; **91** *Spiroloculina depressa*, **a, b** side view, **c** apertural view; **92** *Globobulimina pacifica*, **a-c** side view, **d** apertural view. Scale 100 µm.

Figure 18. doi

Station 5656 **GC** (continued). **93** *Pyrgo murrhina*, **a** side view, **b** apertural view; **94** *Pyrgo williamsoni*, **a** side view, **b** apertural view; **95** *Triloculina elongata*, **a** side view, **b** apertural view; **96** *Triloculina trigonula*, **a-c** side view, **d** apertural view; **97** *Triloculina trihedra*, **a, b** side view, **c** apertural view; **98** *Miliolinella subrotunda*, **a, b** side view, **c** apertural view; **99** *Massilina secans*, **a-c** side view, **d** apertural view; **100** *Quinqueloculina seminulum*, **a, b** side view, **c** apertural view; **101** *Quinqueloculina* sp. cf. *Q. seminulum*; **102-106** *Quinqueloculina* sp. Scale 100 µm.

Figure 19. doi

Station 5656GC (continued). **107-111** *Fissurina* sp.; **112,113** *Lagena* sp., **a** side view, **b** apertural view; **114** *Procerolagena clavata*, **a** side view, **b** apertural view; **115,116** *Oolina* sp. **a** side view, **b** apertural view; **117** Sp. cf. *Asterorotalia pulchella*, **a, b** side view; **118** *Textularia sagittula*, **a, b** side view, **c** apertural view; **119,120** *Spiroplectinella wright*, **119a, b** side view, **119c** apertural view, **120a** side view, **120b** apertural view; **121** *Siphotextularia concava*, **a, b** side view, **b** apertural view; **122,123** *Sahulia conica*, **a** side view, **b** apertural view. Scale 100 μm.

Studies of the radiocarbon dated sediment cores in Shetland-Orkney area of the NWSS (Bradwell et al. 2021) concluded that the ice-sheet withdrawal from the Westray Basin could occur just before 17.5 calendar ka. After this time level, we can expect starting marine sedimentation in the area. Therefore, our cores AMK-5656 MC and GC may contain records of the deglaciation and the Holocene. The radiocarbon datings on the AMK-5656 cores are not yet ready. There is a prominent change in the main parameters of the sedimentology, geochemistry and benthic foraminifera at the GC core level of 295 cm. Under the level: the content of terrigenous matter increases, $CaCO_3$ content is between 25 and 40%, total abundance of benthic foraminifers is low and the infaunal shelf/slope species *Bulimina marginata* and *Fursenkoina fusiformis* have increased concentrations indicating the high fluxes of the total organic carbon and oxygen-depleted conditions (Alve 1994, Eichler et al. 2014). Above the level: opposite distribution of these parameters with a significant rise of $CaCO_3$ and total foraminiferal content and sharp decline of the above-mentioned species abundance. Possible explanation of such change could be a transition from deglacial to the Holocene environments, but this will be proven by the radiocarbon dating.

Methods

Onboard, the retrieved MC and GC sediments were subsampled through every 1 cm and stored in the refrigerator. In the shore laboratory, we analysed 19 samples from the MC (every 1 cm) and 127 samples from the GC (every 5 cm). All samples were freeze-dried, weighed, washed in the distilled water through a sieve with mesh size of 63 μm as recommended in Fatela and Taborda 2002, Klootwijk and Alve 2022, dried and weighed again. We routinely counted 150-300 benthic foraminiferal tests per one sample under the microscope Nikon SMZ800N with a magnification of 80x. The microphotographs were made using the Nikon microscope SMZ25, equipped with Nikon camera DS-Fi3 and NIS-Elements D software. Then, microphotograph tables were edited by the computer software Adobe Photoshop CC 2019. To identify benthic foraminiferal taxa, we used publications by Feyling-Hanssen et al. 1971, Holbourn et al. 2013, Jones 1994, Tikhonova et al. 2019.

Usage notes

The microphotograph tables with images of benthic foraminifers can be used in the practical micropaleontological work with the modern and Quaternary sediment samples from the high-latitude areas of the North Atlantic. They will help the species identification, description of the foraminiferal assemblages and interpretation of the micropaleontological data for the biostratigraphy and paleoecology.

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Author contributions

Conceptualisation, L.K., A.T., N.K. and A.M.; Methodology, L.K.; Investigation, L.K. A.T. and N.K.; Resources, A.T. and N.K.; Data Curation, L.K.; Writing – Original Draft Preparation, L.K.; Writing – Review & Editing, A.T., N.K. and A.M; Visualisation, L.K.; Supervision, L.K.; Funding Acquisition, L.K. and A.M. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses or interpretation of data; in the writing of the manuscript or in the decision to publish the results.

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