A report on the biostratigraphy of charophyte assemblages from offshore Ireland

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Introduction

Dr. N. R. Ainsworth and Dr. P. Copestake got in contact with me through e-mail by the end of 2017 in order to arrange a collaboration with the purpose of determining and providing an age to a number of Late Jurassic charophyte assemblages from exploration wells offshore Ireland. They valued my leading experience in charophyte taxonomy and biostratigraphy especially from the Iberian Peninsula.

I received the samples on the 8th May 2018 and began their study both at an optical stereomicroscope connected to an image analysis device and at the scanning electron microscope. The latter was necessary in order to clarify some important morphological characters with taxonomic implications, since the gyrogonites were extremely small and difficult to study only under optical microscopy.

The four gyrogonite assemblages studied by the present author belong to four different basins: (1) The Slyne Basin assemblages with samples from 9 exploration well levels, (2) The Fastnet Basin assemblage with samples from 4 exploration well levels, (3) The North Celtic Basin assemblage, from a single exploration well and (4) The Porcupine Basin assemblage with samples from 4 exploration wells. The gyrogonites were generally well-preserved, sometimes laterally compressed. Only a few specimens were available from each level. In summary they belong to 8 species distributed in 2 families and 3 subfamilies. These species were mainly determined on the basis of the monograph by Schudack (1993), which provides also the single biostratigraphic chart based on charophytes from the Upper Jurassic of Western Europe.

Systematic Paleontology

Family Porocharaceae Grambast Subfamily Porocharoidae Grambast

Porochara westerbeckensis (Mädler) Mädler (Figure 1A-B)

Gyrogonites are medium in size, 495-522 µm high and 413-418 µm wide with an Isopolarity Index (ISI= 100xH/W) of 120-125, resulting in an ellipsoidal subprolate shape. Maximum width is close to the equator. Laterally, 8-9 convolutions are visible. Spiral cells are convex. Apex is truncate. The spiral cells turn slightly down to outline a large, rounded-pentagonal apical pore. Base is round and with a small basal pore.

This species has been mainly documented from the Oxfordian and Kimmeridgian of western Europe, mainly in Northwest Germany, France, Spain, Switzerland and Portugal. Isolated finds are reported from the Bathonian from Spain and the Tithonian of Ucrania (Schudack 1993, Martín-Closas, 2000).

Porochara fusca (Mädler) Mädler (Figure 1C)

Gyrogonites are small, 251-370 µm high and 194-297µm wide with an Isopolarity Index of 125-134, resulting in an ellipsoidal subprolate shape. Maximum width is close to the equator. Laterally, 6-7 convolutions are visible. Spiral cells are convex. Apex is truncate and displays a large apical pore. Base is round and with a small basal pore.

This species has been mainly reported from the Oxfordian to Berriasian of Western Europe, mainly from Northwest Germany, France, Spain and Switzerland. Isolated finds were recorded in the Bathonian of Spain and the Berriasian of Sardinia (Schudack, 1993 and references therein).

Porochara sp. 1 (Figure 1D)

The only gyrogonite available is medium in size 441 µm high and 231 µm wide with an Isopolarity Index of 190, resulting in a subcylindrical prolate shape. Laterally, 8

convolutions are visible. Spiral cells are convex. Apex is truncated and shows the spiral cells going down to outline a large apical pore. Base is tapering with a small basal pore.

No affinity with a presently described species of *Porochara* has been found and the single gyrogonite available limits providing a precise determination and age. However it shows affinities with "*Aclistochara" longiformis* Wang ex Yang in Hao *et al.* (1983), which has been reported from the Middle Jurassic of China (Hao *et al*., 1983) and from the Oxfordian of Portugal (Pereira *et al*., 2003). This similarity needs to be confirmed with more material and only the whole range of the genus has been taken into account for biostratigraphic purposes.

Family Characeae Agardh

Subfamily Nitelloidae Braun

Aclistochara bransoni Peck, Figure 2A-B

Gyrogonites are very small, 246-303 µm high and 175-242 µm wide with an Isopolarity Index (ISI= 100xH/W) of 115-134, resulting in an ellipsoidal subspherical to subprolate shape. Maximum width is close to the equator. Spiral cells concave, separated by intercellular ridges, sometimes bicarinate. Laterally 6-8 (normally 8) convolutions are visible. Apex truncated showing a wide periapical depression. The spiral cells join at the centre forming a small prominent tip. However this is rarely visible in the studied specimens which are generally germinated. Base is round and showing a small round basal pore.

Remarks. This species is the most abundant species in many of the studied assemblages, which allows observing the intraspecific polymorphism, the populations from the Slyne Basin being slightly smaller than the populations from the North Celtic Sea. It has been reported and is abundant from the Kimmeridgian of Western Europe, mainly Northwest Germany, France and Switzerland. It has been also reported from the Kimmeridgian of the Morrison Formation in the United States. Isolated finds have been reported from the Upper Oxfordian to the Berriasian from Northwest Germany and Switzerland (Schudack, 1993 and references therein).

Aclistochara polyspirata Mädler, Figures 2C-E

Gyrogonites are small to medium in size 291-536 high and 233-452 wide with an ISI of 118-143, being ellipsoidal subprolate in shape. Spiral cells concave, separated by intercellular ridges. Laterally 8-12 convolutions are visible. Apex truncated showing a wide periapical depression where the spiral cells would join. However, this could not be observed since all gyrogonites were germinated. Base is round or slightly pointed and with a small basal pore. This species is somewhat larger and with more convolutions than *A. bransoni* and in the studied samples it never occurs associated to the latter.

A. polysipirata has been mainly reported from the Kimmeridgian and Tithonian and is less abundant in the Berriasian of Western Europe, mainly Northwest Germanyand Spain (Schudack, 1993 and references therein).

Subfamily Charoidae Braun

Mesochara canellata (Mädler), Figures 2F-G

Gyrogonites are very small, 221-242 µm high and 167-262 µm wide, with an ISI of 105-145, usually 110-125, subspherical to ellipsoidal subprolate in shape. Laterally 6-9 (usually 7-8) convolutions are visible. Spiral cells concave. Apex is slightly pointed and shows the junction of spiral cells without any modification. Base usually round, and with a small basal pore.

This species has been reported from the Kimmeridgian to the Lower Berriasian of Nortwest Germany (Schudack, 1993).

Mesochara voluta (Peck), Figure 2H

Gyrogonites are small to medium in size, 292-402 µm high and 226-301 µm wide, with an ISI of 129-146, being ellipsoidal subprolate in shape. Laterally 7-9 convolutions are visible. Apex and base are round or slightly pointed. In the apex, the spiral cells join without any modification. Base shows a small pentagonal basal pore.

This species has been reported from the Kimmeridgian to Berriasian from Northwest Germany (Schudack, 1993), however, it ranges up to the Barremian in Spain (Martín-Closas, 2000).

Mesochara harrisii (Mädler) Shaikin, Figure 2I-J

Gyrogonites are small, 266-316 µm high and 112-269 µm wide, with an ISI of 120-241, being subprolate oval in shape, since the maximum width is above the equator. Laterally 7-11 (normally 7) convolutions are visible. Spiral cells are concave, showing prominent ridges. Apex is pointed to conical and shows the junction of spiral cells without any modification. Base is tapering.

There are only a few isolated gyrogonites of this shape in the assemblages studied from offshore Ireland. This species has been reported from the upper Oxfordian to the Barremian in Western Europe, mainly Northwest Germany, France and Spain (Schudack 1983; Martín-Closas, 2000)

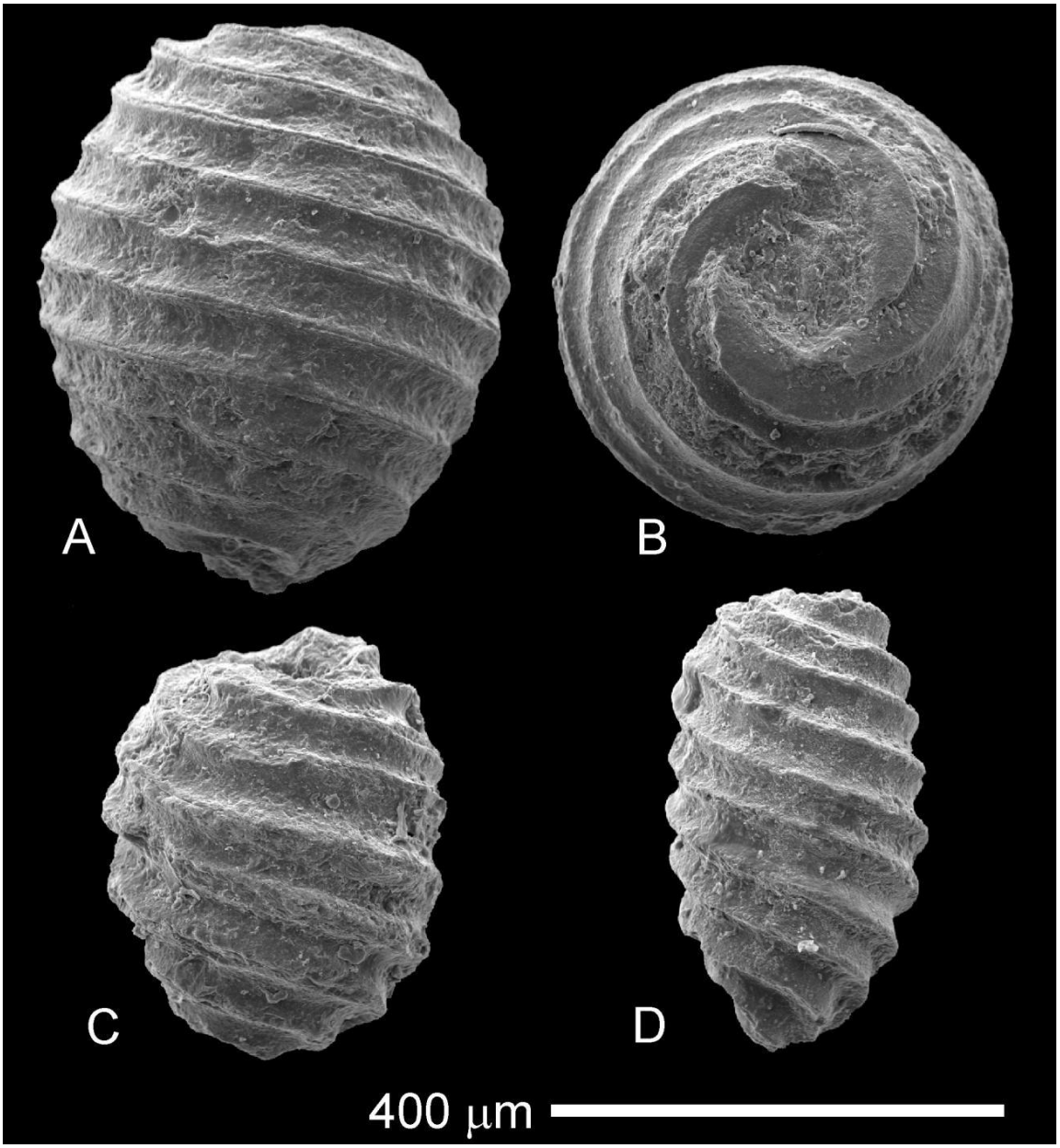

Figure 1. Porocharaceae from the Jurassic offshore Ireland. A-B. *Porochara westerbeckensis*, A. lateral view, B. apex with apical pore, North Celtic Sea. C. *Porochara fusca*, lateral view, Fastnet Basin; D. *Porochara* sp. 1 (aff. *"Aclistochara" longifolia*), lateral view, Fastnet Basin.

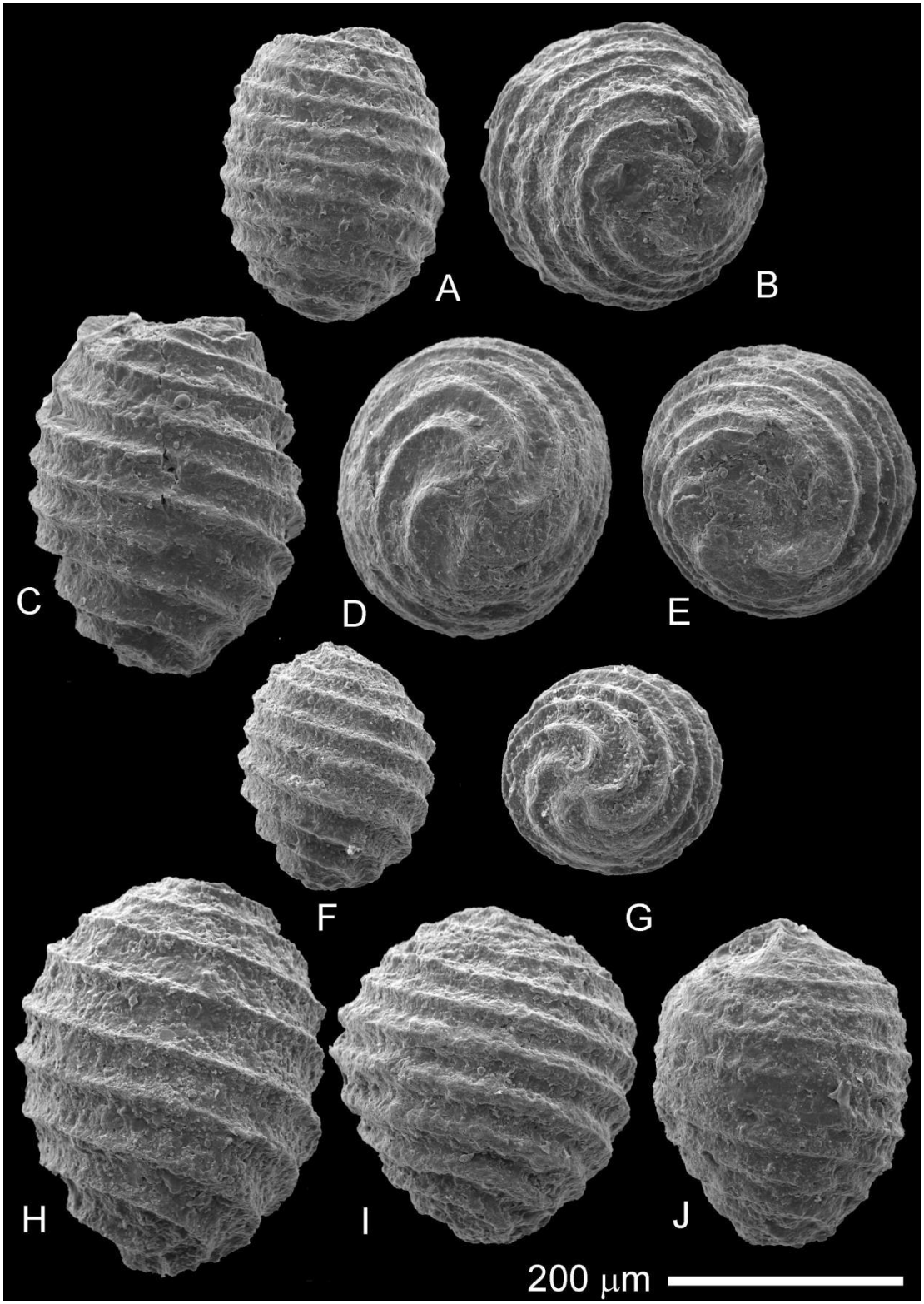

Figure 2. Fossil Characeae from the Jurassic offshore Ireland. A-B. *Aclistochara bransoni*, A. lateral view (Slyne basin), B closed apex with periapical depression (N Celtic Sea). C-E *Aclistochara polyspirata*, C lateral view, D. basal view, E. germinated apex (all from Slyne Basin); F-G *Mesochara canellata*, F. lateral view, E. closed apex (all from Slyne Basin); H. *Mesochara voluta*, H. lateral view (Slyne Basin), I.-J. *Mesochara harrisii*, lateral view (I. Fastnet Basin, J. Slyne Basin).

Species distribution and biostratigraphy

The occurrence of species in each basin and its chronostratigraphic attribution is shown in Figure 3. See also the attached Excel document "Charophytes Offshore Ireland" for the detailed composition of each bed ("hole"). The biostratigraphic range of each species is mainly based in the studies of Schudack (1993).

Most of the assemblages studied belong to the Kimmeridgian – Berriasian, but more probability is given for the Kimmeridgian in most of them. The flora studied from the exploration wells offshore Ireland shows many similarities with the flora from Western Europe (mainly Northwest Germany, France, Switzerland, Portugal and Spain) and the Morrison Formation (Western Interior, United States) and is considered to belong to the same biogeographic area. In the Upper Jurassic there were only a few differences between the Boreal and the Tethyan charophyte floras and these differences are still poorly known, but have probably less influence in biostratigraphy (Schudack *et al*., 1998; Martín-Closas *et al.*, 2008).

The detailed biostratigraphic distribution of each charophyte assemblage studied from expluration wells offshore Ireland is provided next.

Slyne Basin. The assemblage would indicate a Kimmeridgian-lower Berriasian age by superposition of the distribution of *M. canellata* with associated species. However the dominance of *Aclistochara bransoni* in many samples (beds) suggests more probability for the Kimmeridgian.

Fastnet Basin. The assemblage indicates a Kimmeridgian – Tithonian age (Berriasian not excluded), as indicated by the biostratigraphic range of *A. polyspirata.*

North Celtic Sea Basin. The assemblage would indicate a Kimmeridgian – Tithonian age, mainly by superposition of the distributions of *P. westerbeckensis* and *M. canellata*. However the dominance of *Aclistochara bransoni* in the sample suggests more probability for the Kimmeridgian.

Porcupine Basin. The assemblage would indicate a Kimmeridgian – early Berriasian age age, as indicated by the distribution of *M. canellata*. However the dominance of *Aclistochara bransoni* suggests again more probability for the Kimmeridgian.

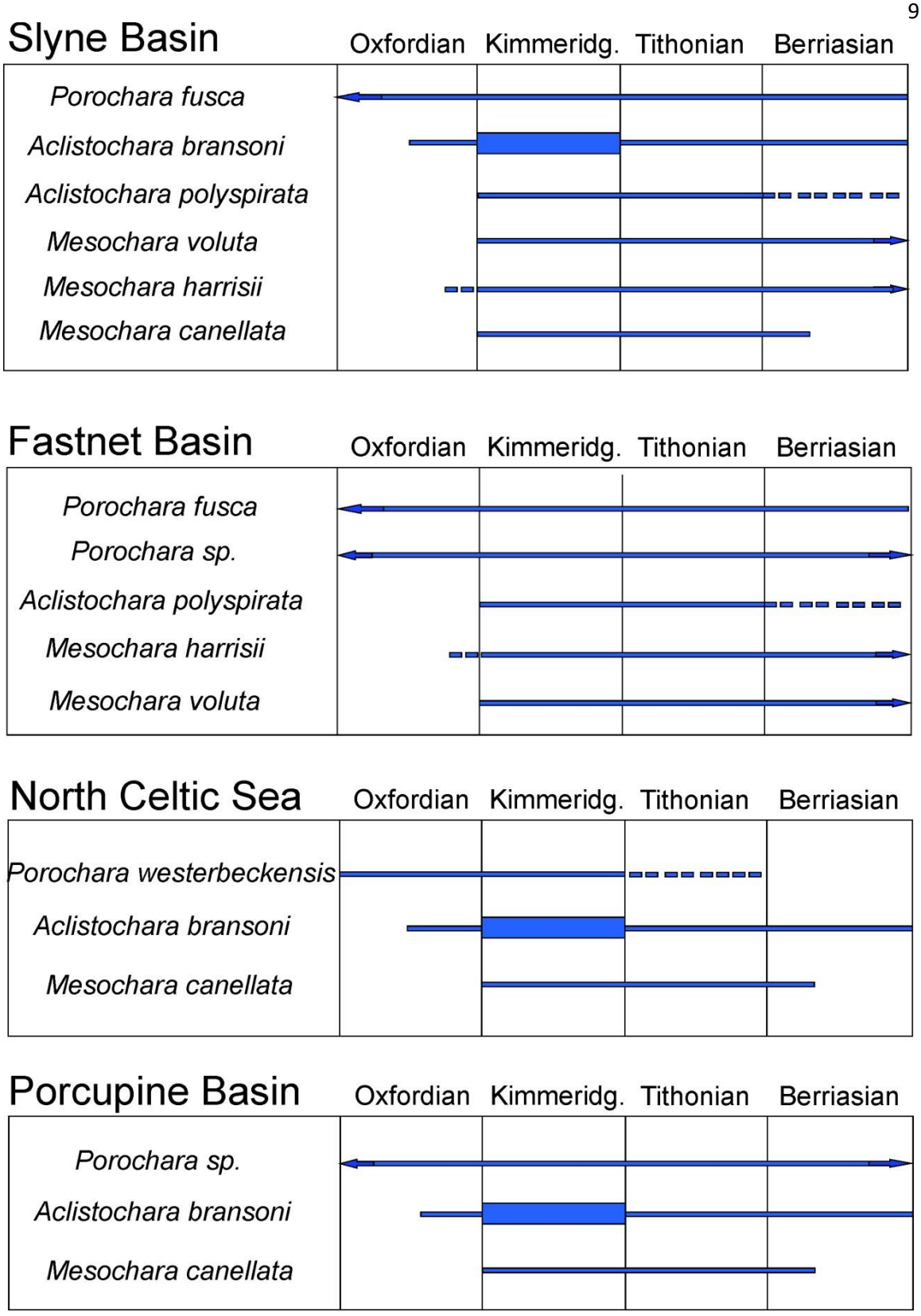

Figure 3. Distribution of species in each study area with their biostratigraphic range. Ranges mainly according to Schudack (1993).

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