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Late Asbian to Brigantian (Mississippian) foraminifera from southeast Ireland: comparison with northern England assemblages

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ABSTRACT – Foraminiferal assemblages from platform carbonates in the Carlow district (SE Ireland) are analysed. This platform contains a near-continuous succession of Upper Asbian to lower Upper Brigantian strata. Detailed sampling of several quarry and borehole sections allows characterization of foraminiferal assemblages throughout the succession. Assemblages typifying the Late Asbian, Early Brigantian and Late Brigantian are described, with the most common genera and species, as well as the guides for the recognition of these substages. In addition, three successive faunal events are recognized within the Early Brigantian. A comparison with northern England foraminiferal assemblages from the Asbian and Brigantian stratotype sections shows a great similarity in the recorded taxa. Furthermore, these taxa have closely comparable stratigraphical ranges, demonstrating the biostratigraphic utility of these foraminifera throughout Ireland and Britain. Taxa proposed here as guides for the basal Brigantian are potentially an alternative to the previously published taxa (which are either unrecorded, or recorded at higher stratigraphic levels in the Brigantian). *J. Micropalaeontol.* **24**(2): 131–144, October, 2005.

KEYWORDS: *Foraminifera, assemblages, Mississippian, SE Ireland, northern England*

INTRODUCTION

In Britain and Ireland some of the best near-continuous successions across the Late Asbian/Brigantian boundary occur in northern England (Janny Wood section (Stainmore Trough; Strank, 1981), Yoredale 'Series' (Askrigg Block; Hallett, 1971) and Rookhope Borehole (Alston Block; Johnson & Nudds, 1996)); in western Ireland (Aran Islands, Somerville, 1999; and the Burren area, Co. Clare, Gallagher, 1992) and in southern Ireland (Buttevant-Ballyclogh district, North Co. Cork, Gallagher, 1992; Gallagher & Somerville, 1997; 2003). The sections in northern England were revised in Cózar & Somerville (2004). The stratigraphic succession of the carbonate platform facies in southeastern Ireland is one of the more variable in Ireland and Great Britain. The succession has been studied in counties Carlow, Kilkenny and Laois (Fig. 1). A near-continuous record of the Upper Asbian to Brigantian rocks, which have been assigned to the Ballyadams and Clogrenan formations, occurs in this region (Tietzch-Tyler *et al*., 1994). These Upper Viséan limestones are unconformably overlain by 'Namurian' siliciclastic sediments. The Ballyadams and Clogrenan formations have been described recently in detail by Cózar & Somerville (2005a, b), and six units were defined in the Carlow district, two units in the upper Ballyadams Formation and four in the overlying Clogrenan Formation (Fig. 2). This work is based mainly on the detailed analysis of seven quarries (including one natural section) and two boreholes (Figs. 1, 2): Ballyadams Quarry (divided into Ballyadams 1 and Ballyadams 2 sections; Irish Grid Reference (IGR) S 621916), Clogrenan B Borehole (IGR S 688720), Clogrenan Quarry (IGR S 688720), Bannagogle Quarry (IGR S 661645), Paulstown Quarry (IGR S 645602), Dunamase Quarry (IGR S 542993), Guileen-1 Borehole (IGR S 572915), Rock of Dunamase (IGR S 527973) (the latter is the only natural outcrop studied in the region) and Aghamaddock Quarry (IGR S 578945). These quarries and boreholes were sampled bed by bed, approximately at every metre, and a total of 1000 thin sections have been examined.

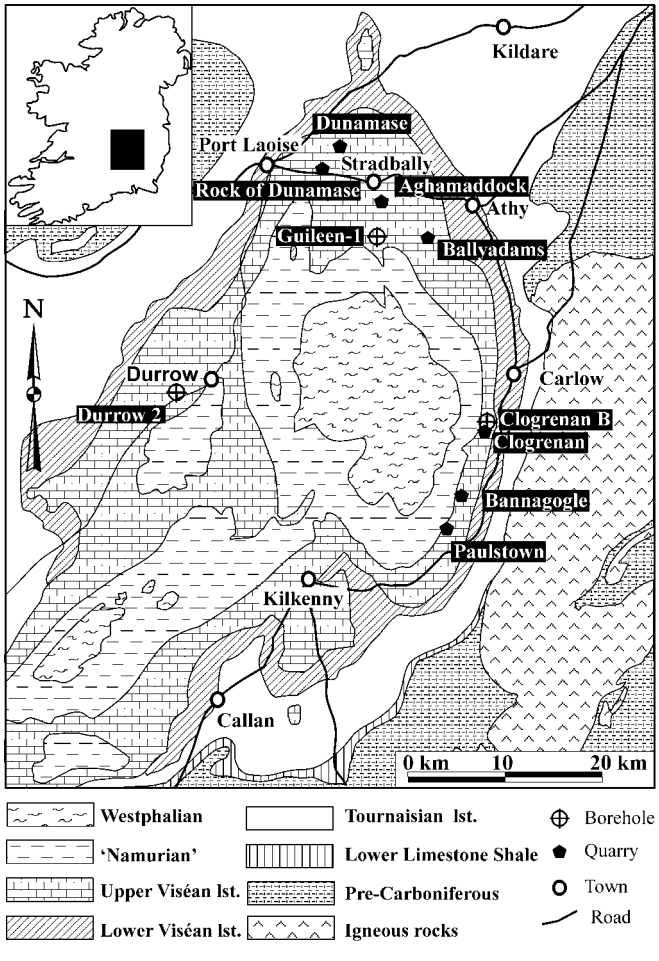


Fig. 1. Location of the studied quarries and boreholes. Irish grid of the sections mentioned in the text (modified from the GSI map, Tietzch-Tyler *et al*., 1994).

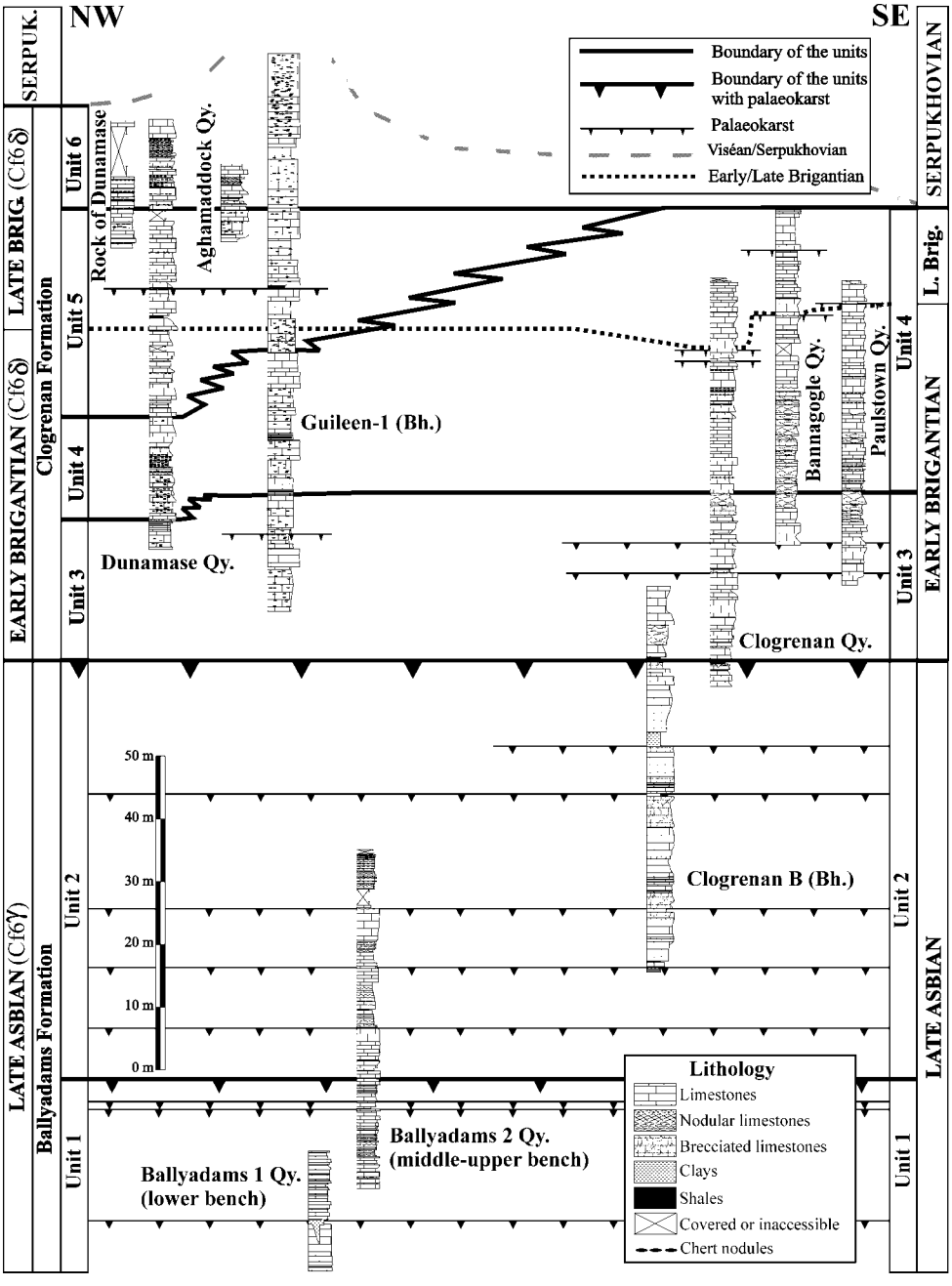


Fig. 2. Bio- and lithostratigraphical correlation in the Carlow district (modified from Cózar & Somerville, 2005b).

The foraminiferal records from the Carlow district presented here represent a comprehensive database as a tool for comparison with other less well-exposed or discontinuous outcrops in Ireland. Moreover, some of the foraminiferal stratigraphic ranges documented in Ireland and Britain are revised, thereby increasing their utility for wider correlations with western Palaeotethyan basins. Biostratigraphically significant taxa are summarized in Figure 3 and illustrated in Plates 1 to 3. Species determinations of biostratigraphically less important taxa are simplified in most cases to open nomenclature, and listed in Appendix A. The suprageneric and familial classification of foraminifera used in this section follows the classification scheme described in Cózar (2003), modified from Vachard (1977), Conil *et al*. (1980), Loeblich & Tappan (1988), Rauzer-Chernousova *et al*. (1996), Pinard & Mamet (1998) and Cózar & Vachard (2001).

TAXONOMIC REMARKS

Three foraminiferal families (Archaediscidae, Palaeotextulariidae and Loeblichiidae) in the Upper Viséan warrant special mention, because they contain biostratigraphically important taxa, and a fourth family, the Tetrataxidae, contain taxa which have controversial assignations. Some primitive Archaediscidae are still present in these Upper Viséan sections, but the genus

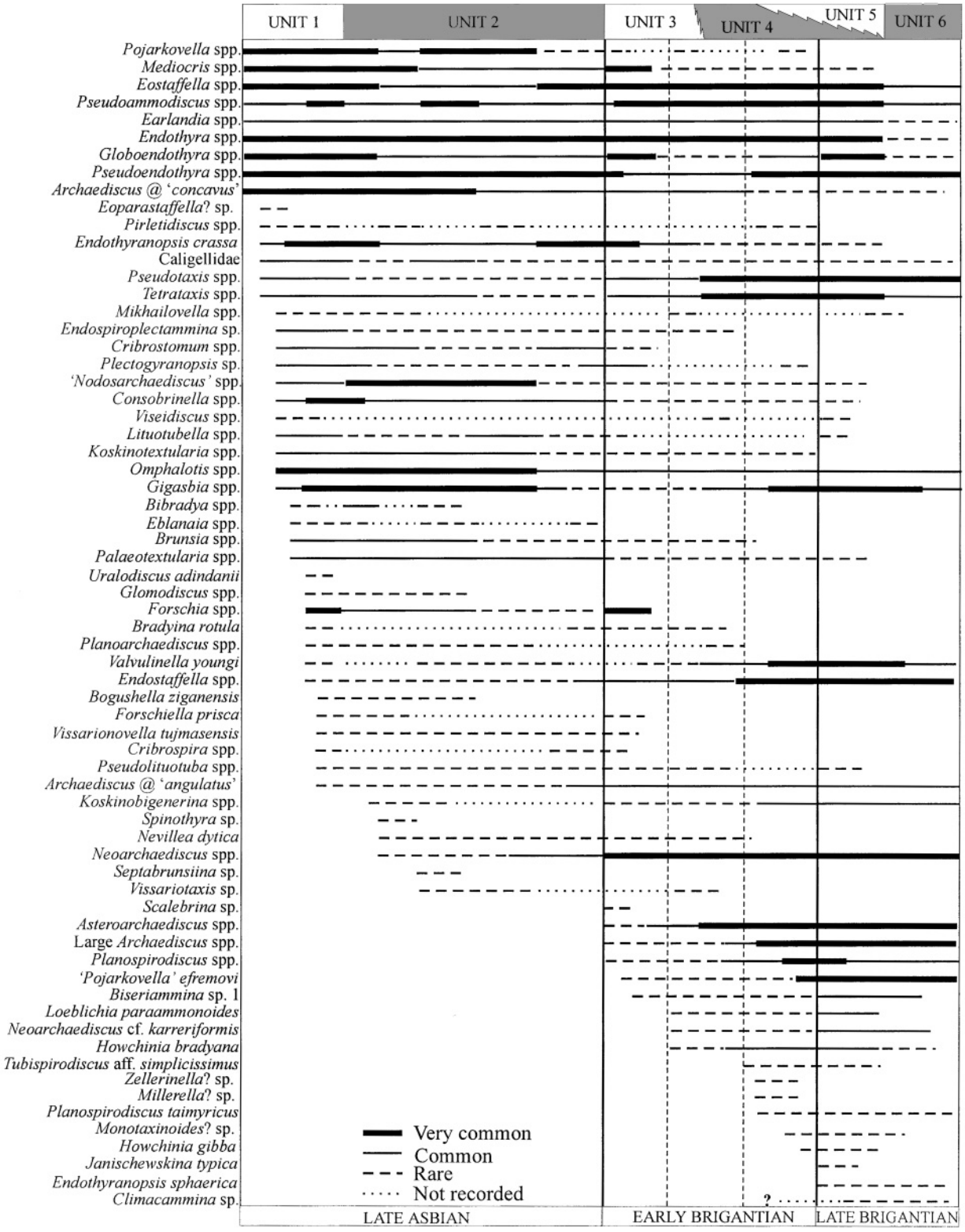
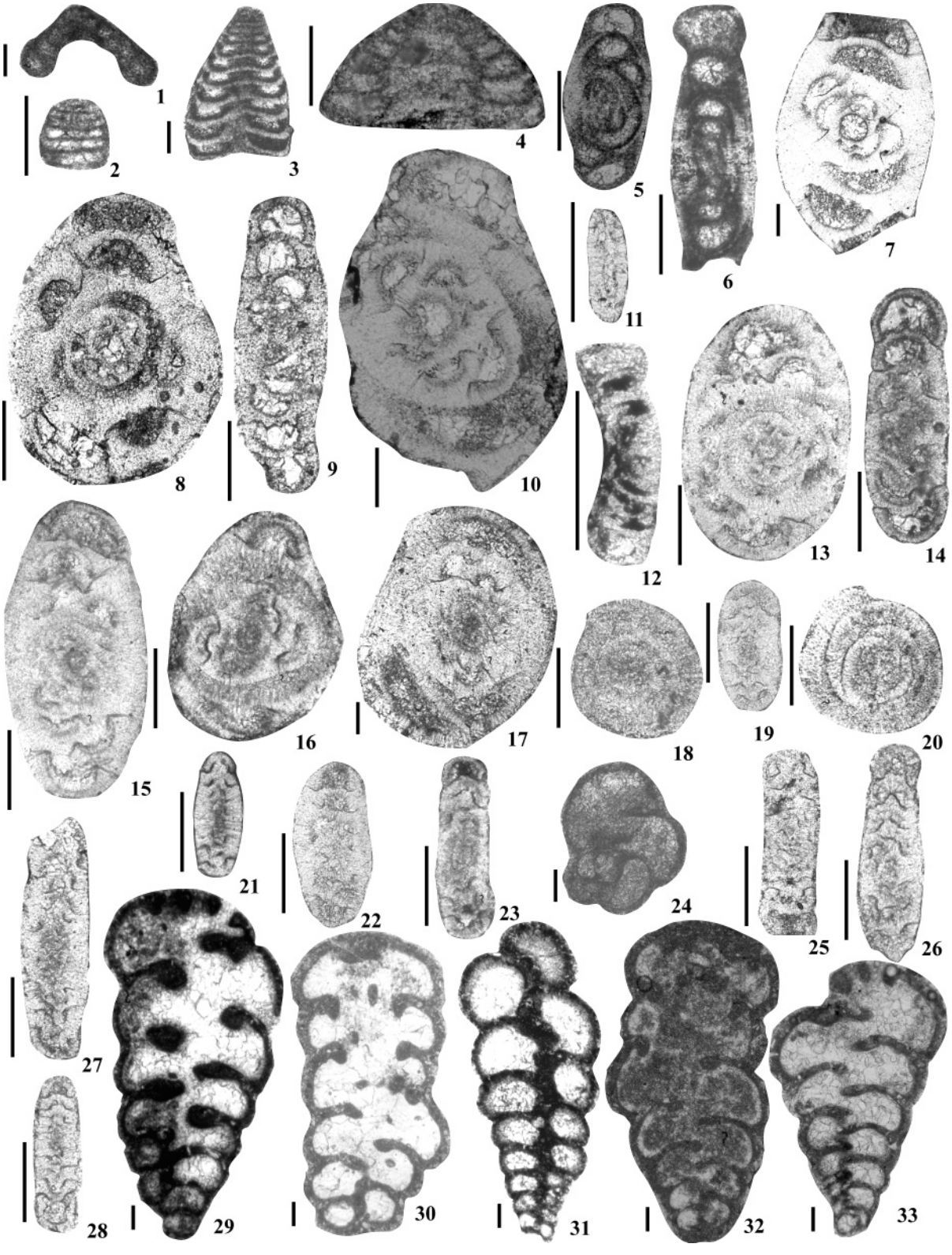


Fig. 3. Summary of the foraminiferal stratigraphic ranges in the Carlow district. Abbreviation: @, at stage. Rare, 1–2 specimens per thin section; common, 3–6 specimens per thin section; very common, >6 specimens per thin section.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Archaediscus is highly diversified and many 'morphotypes' are recognized. However, specific taxonomic criteria are not very reliable and, thus, the validity of many of the species formally described is questioned (Zaninetti & Altiner, 1979; Brenckle *et al*., 1987). Some authors have classified *Archaediscus* in species groups (e.g. Armstrong & Mamet, 1977; Pinard & Mamet, 1998), but even species groups do not seem to be representative of relative species and great differences are observed between specimens within the same group. As species and species groups of *Archaediscus* do not seem to be reliable enough for precision in the Carlow district, *Archaediscus* has been used exclusively as a function of its stage of evolution, based on Pirlet & Conil (1977) and Conil *et al*. (1980). A special group within the '*angulatus*' stage are the large *Archaediscus*, which include species such as *A. karreri* Brady and *A. chernoussovensis* Mamet. In the upper part of the Early Brigantian, and mostly in the Late Brigantian, some *Archaediscus* at '*angulatus*' stage exhibit 2–2.5 totally evolute final whorls, but tapering at the base of the lumina is not conspicuous. True *Archaediscus* at '*tenuis*' stage (=*Betpakodiscus* auct.) are not recorded in the Carlow district, but they are occasionally recorded in northeastern Ireland in the latest Brigantian (Poulmore Scarp, Kingscourt, Co. Meath; unpublished data).

The stellate archaediscids (Asteroarchaediscinae in Appendix A) are also common and, in fact, they are more common in the Brigantian than the *Archaediscus* that are without occlusion of the lumina. The Upper Asbian rocks contain numerous '*Nodosarchaediscus*' spp., but they occur up to the Late Brigantian (Fig. 3). The validity of this genus is controversial (see Vachard, 1988; Pinard & Mamet, 1998) and some authors do not recognize the presence of 'nodes' as having morphological distinction (Brenckle *et al*., 1987; Brenckle & Grelecki, 1993). As none of the classification schemes for Archaediscidae are universally accepted, for the time being, all the specimens possessing nodes are referred to as '*Nodosarchaediscus*', some of them at '*concavus*' stage and others at '*angulatus*' stage. The most evolved *Neoarchaediscus* is *N*. cf. *karreriformis* (Reitlinger). The validity of the species is also controversial, because the holotype is not well orientated (see Brenckle & Grelecki, 1993). This taxon exhibits large tests, more than 400–500 μm, a sigmoidal coiling and more than 2.5 occluded whorls. *N*. cf. *karreriformis* occurs always in the middle part of the Early Brigantian and, locally, it can be very common in the Late Brigantian (Fig. 3).

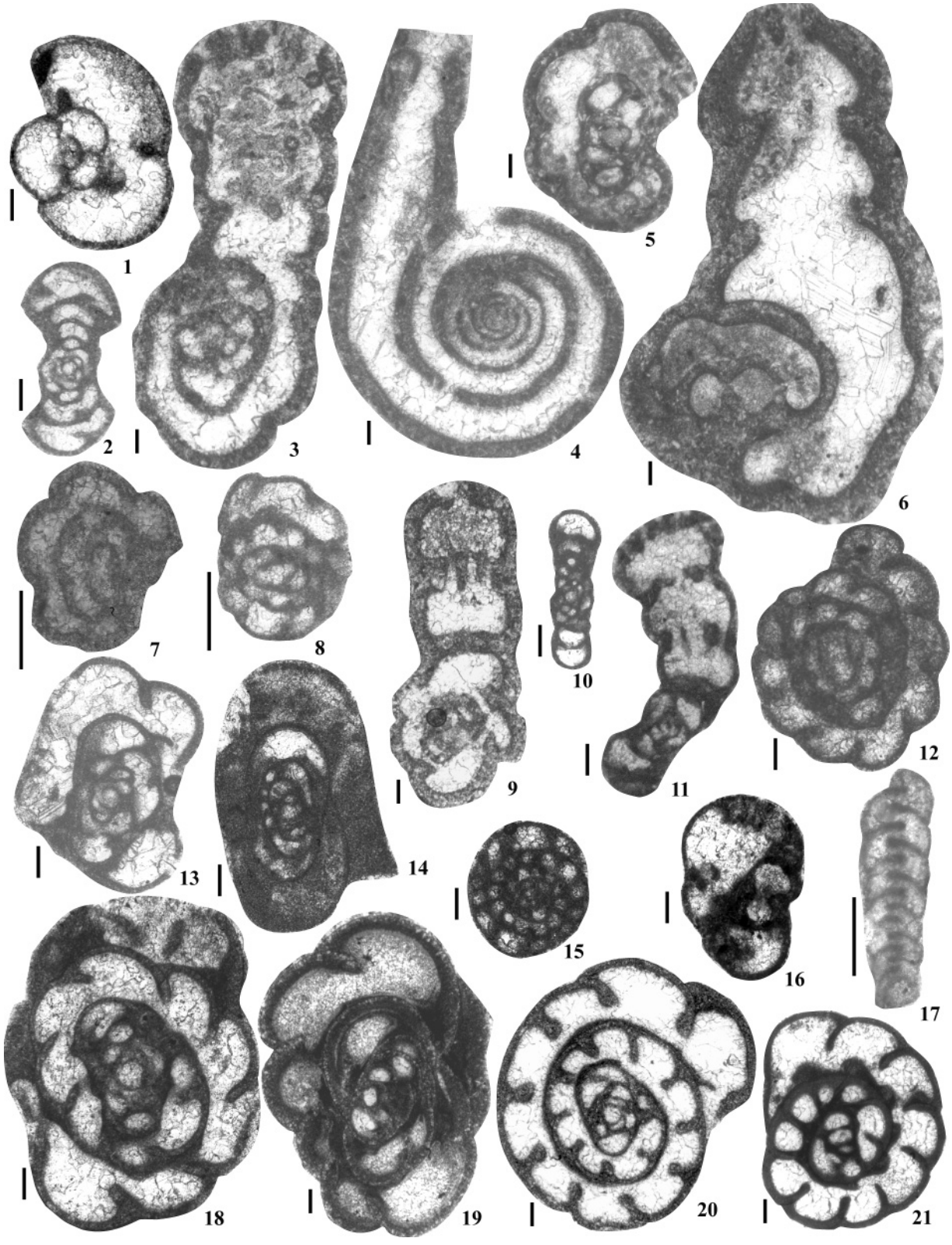
The Palaeotextulariidae are represented widely and many genera and species occur (see Appendix A). However, despite the presence of numerous specimens of palaeotextulariids in thin sections, well-orientated adult specimens are scarce. As a consequence, the database of palaeotextulariid assemblages is impoverished, as specific determinations are often impossible. Some genera of single-layered wall palaeotextulariids documented in the British literature, such as *Palaeobigenerina* and *Deckerella* (e.g. Hallett, 1971; White, in Johnson & Nudds, 1996), have not been recognized, but their presence in Upper Viséan rocks seems to be unlikely and they are probably guides for the Bashkirian (Pinard & Mamet, 1998).

In the Tetrataxidae, the validity of *Pseudotaxis eominima* (type species of the genus) and, therefore, of the genus *Pseudotaxis* Mamet 1974a, is still in a state of flux. Some authors considered the genus *Endotaxis* Bogush & Brazhnikova in Aizenverg *et al*. (1983) to be valid (and, hence, *Pseudotaxis* invalid), with the type species *E. brazhnikovae* (e.g. Groves, 1988), whereas other authors consider *E. brazhnikovae* synonymous with *P. eominima* (Vachard & Beckary, 1991; Pinard & Mamet, 1998; Cózar, 2003). In addition, some workers considered both taxa valid (e.g. White in Johnson & Nudds, 1996). Here, *E. brazhnikovae* is regarded as synonymous with *P. eominima*.

The Loeblichiidae are represented mostly by *Pojarkovella* spp., including *P. nibelis* (Durkina). The genus is very common in the Asbian (Fig. 3) and, usually, thin sections contain

Explanation of Plate 1.

Selected Lasiodiscidae, Archaediscidae, Biseriamminidae and Palaeotextulariidae from the Carlow district. In all plates the species name is followed by the thin-section sample number, stratigraphic section (quarry, unless a named borehole), horizon (these were documented in Cózar & Somerville, 2005b) and limestone unit (see Fig. 2) (scale bar 100 μm, except for figs 29–33, where scale bar 150 μm; all the thin sections are housed in the Department of Palaeontology Madrid, UCM): **1**, cf. '*Monotaxinoides*' sp., DPM-PC-1269, Dunamase, horizon 25 (unit 5); **2**, *Vissariotaxis* sp., DPM-PC-27/8/93, Ballyadams 2, horizon 61 (unit 2); **3**, *Howchinia bradyana* (Howchin) emend. Davis, DPM-PC-944, Clogrenan, horizon 55 (unit 3); **4**, *Howchinia gibba* (von Moeller), DPM-PC-20/8/24, Paulstown, horizon 20 (unit 4); **5**, *Glomodiscus rigens* (Conil & Lys), DPM-PC-27/8/85, Ballyadams 2, horizon 53 (unit 2); **6**, *Uralodiscus adindanii* Brenckle & Marchant, DPM-PC-27/8/25, Ballyadams 1, horizon 30 (unit 1); **7**, *Archaediscus chernoussovensis* Mamet, DPM-PC-1430, Dunamase, horizon −5 (unit 3); **8**, *Archaediscus karreri grandis* Conil & Lys, DPM-PC-8/8/71, Clogrenan, horizon 58 (unit 4); **9**, *Archaediscus* at '*angulatus*' stage (*Archaediscus krestovnikovi* Rauzer-Chernousova), DPM-PC-8/8/72, Clogrenan, horizon 59 (unit 3); **10**, '*Nodosarchaediscus*' *convexus* (Grozdilova & Lebedeva), DPM-PC-9/8/7, Bannagogle, horizon 2 (unit 3); **11**, *Tubispirodiscus* aff. *simplicissimus* Browne & Pohl, DPM-PC-24/9-2/25, Dunamase, horizon 16 (unit 4); **12**, *Tubispirodiscus* aff. *simplicissimus* Browne & Pohl, DPM-PC-24/9-2/25, Dunamase, horizon 16 (unit 4); **13**, *Neoarchaediscus occlusus* (Hallett), DPM-PC-8/8/45, Clogrenan, horizon 40 (unit 4); **14**, *Neoarchaediscus parvus* (Rauzer-Chernousova), DPM-PC-8/8/66, Clogrenan, horizon 54 (unit 4); **15**, *Neoarchaediscus regularis* (Suleimanov), DPM-PC-8/8/36, Clogrenan, horizon 33 (unit 3); **16**, *Neoarchaediscus ovoides* (Rauzer-Chernousova), DPM-PC-8/8/44, Clogrenan, horizon 39 (unit 4); **17**, *Neoarchaediscus* cf. *karreriformis* (Reitlinger), DPM-PC-1286, Dunamase, horizon 43 (unit 5); **18**, *Neoarchaediscus subbaschkiricus* (Reitlinger), DPM-PC-1335, Clogrenan B Borehole, horizon 5 (unit 2); **19**, *Asteroarchaediscus rugosus* (Rauzer-Chernousova), DPM-PC-20/8/12, Paulstown, horizon 8 (unit 3); **20**, *Asteroarchaediscus baschkiricus* (Krestovnikov & Theodorovich), DPM-PC-9/8/15, Bannagogle, horizon 7 (unit 3); **21**, *Planospirodiscus* aff. *taimyricus* Sossipatrova, DPM-PC-8/8/52, Clogrenan, horizon 45 (unit 4); **22**, *Neoarchaediscus incertus* (Grozdilova & Lebedeva), DPM-PC-20/8/1, Paulstown, horizon 1 (unit 3); **23**, *Neoarchaediscus* aff. *borealis* (Reitlinger), DPM-PC-8/8/59, Clogrenan, horizon 50 (unit 4); **24**, *Biseriammina* sp. 1, DPM-PC-24/9-2/65, Dunamase, horizon 54 (unit 6); **25**, *Planospirodiscus minimus* (Grozdilova & Lebedeva), DPM-PC-1386, Guileen-1 Borehole, horizon 8 (unit 4); **26**, *Planospirodiscus gregorii* (Dain), DPM-PC-1373, Clogrenan, horizon 9 (unit 3); **27**, *Planospirodiscus* cf. *gregorii* (Dain), DPM-PC-1273, Dunamase, horizon 28 (unit 5); **28**, *Planospirodiscus taimyricus* Sossipatrova, DPM-PC-24/9-2/74, Dunamase, horizon 62 (unit 6); **29**, *Cribrostomum lecomptei* Conil & Lys, DPM-PC-27/8/36, Ballyadams 2, horizon 10 (unit 1); **30**, *Koskinobigenerina prisca* (Lipina), DPM-PC-8/8/36, Clogrenan, horizon 33 (unit 3); **31**, *Palaeotextularia longiseptata* Vissarionova, DPM-PC-27/8/31, Ballyadams 2, horizon 5 (unit 1); **32**, *Climacammina* sp., DPM-PC-1448, Aghamaddock, horizon 17 (unit 6); **33**, *Koskinotextularia cribriformis* Eickhoff, DPM-PC-27/8/43, Ballyadams 2, horizon 18 (unit 1).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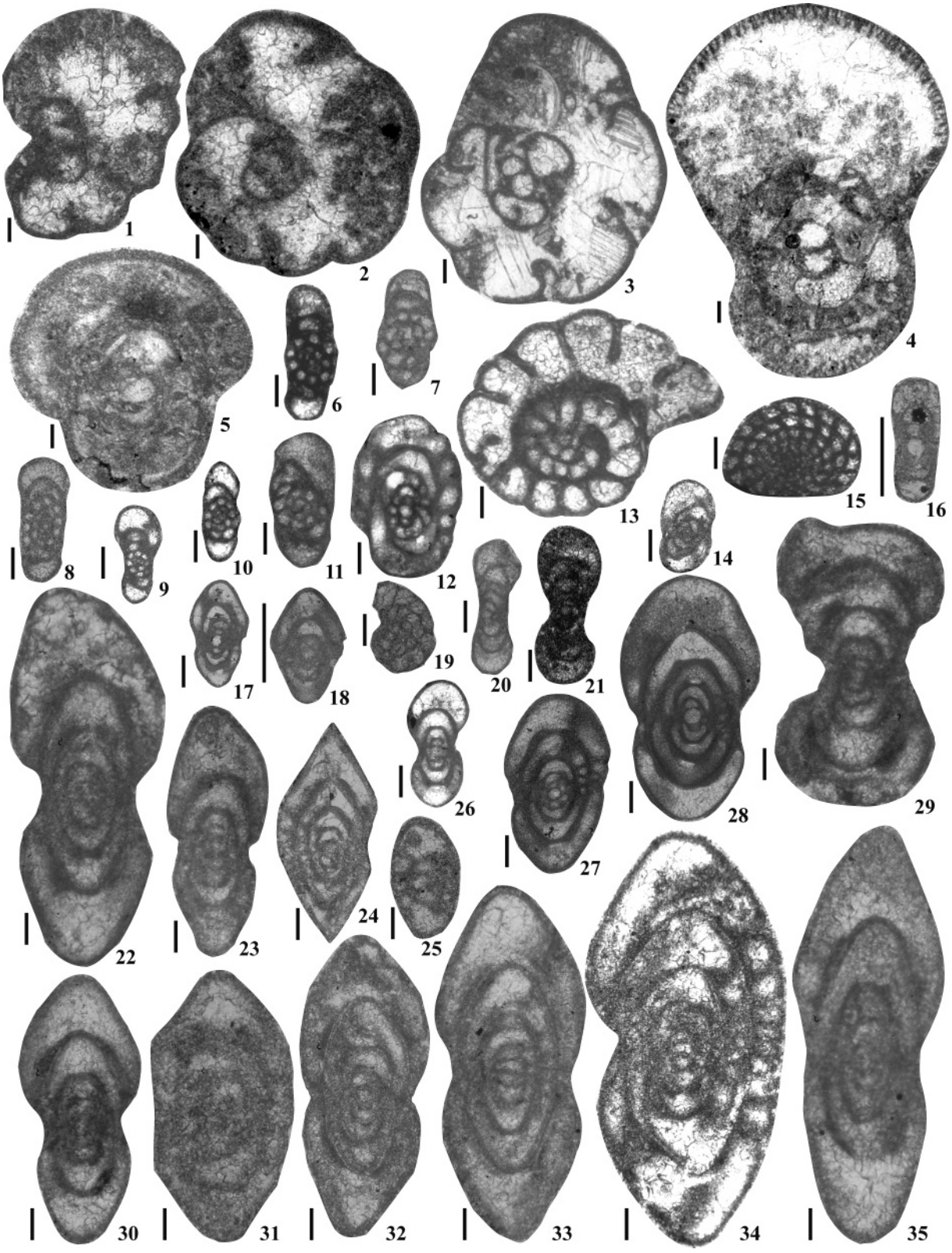
numerous specimens, up to 60 per thin section. This genus is actually poorly known, despite numerous documentations in the literature, and the presence of the luminotheca in the wall is a variable character (Cózar, 2002). There are several species included within the genus, mostly from Russian localities (see revision in Cózar, 2002) but, as shown by Strank (1981), the genus shows many morphological variations in Great Britain. Strank (1981) distinguished *P. nibelis* (Durkina) and five species in open nomenclature. A revision of the species included in the genus in Great Britain and Ireland is necessary. '*Pojarkovella*' *efremovi* (Vdovenko & Rostovceva) is a very common Brigantian taxon, mostly in the Late Brigantian, with tens of specimens per thin section. Its presence in the Late Asbian in western Palaeotethyan basins is occasional (Laloux, 1988; Cózar & Somerville, 2004). This taxon shows development of chomata, a partial development of an outer darker microgranular layer in the wall, a progressive deflection in the coiling axis, rounded external periphery of the whorls and rarely, a granular wall. Similar specimens were illustrated by Conil *et al*. (1980) as *Endostaffella parva* (pl. 22, figs 20–22), in the Brigantian of the Archerbeck Borehole, Scotland. *Endostaffella* exhibits a rapid change in the final two whorls, which are almost planispiral, and is clearly evolute. Moreover, the size of '*Pojarkovella*' is larger than in the *Endostaffella*. On the other hand, these specimens could be determined as being included in the genus *Plectostaffella*, commonly documented in Britain and Ireland (Conil *et al*., 1980; Strank, 1981; Gallagher, 1992). However, these *Plectostaffella* are problematical; some of the illustrated specimens are interpreted here as pathologies in *Eostaffella* (e.g. in Gallagher & Somerville, 1997), a second group of *Plectostaffella* show only slight deflections in the initial coiling axis of *Eostaffella* (e.g. in Conil *et al*., 1980; Strank, 1981) and a third group are interpreted here as oblique sections of the second group (e.g. in Conil *et al.*, 1980). Additionally, it can be stated that true *Plectostaffella* first occur in the Late Serpukhovian and Bashkirian (Mamet, 1974b; Groves, 1983; Vachard & Maslov, 1996), together with true *Eostaffellina*. In a separate study, Reitlinger (1981) placed *Euxinita* in synonymy with *Pojarkovella*, but Pinard & Mamet (1998) did not accept this synonymy, because they considered *Euxinita* as a smaller genus characterized by a well-differentiated wall. However, as demonstrated by Cózar (2002), there are species of *Pojarkovella* with and without well-developed luminotheca, as well as species with poorly- and well-developed outer tectoria. Thus, Cózar (2002) concluded that the presence of this differentiation in the wall is not a very reliable character for generic or specific taxonomy in this group. Here, in the Carlow district, similar features are observed: there are rare specimens with an 'undifferentiated' wall and a 'luminotheca', and many specimens with an outer tectoria.

BIOZONATION OF THE CARLOW DISTRICT

The Late Asbian in Ireland was divided into two subzones: Cf6γ1 and Cf6γ2 (Gallagher, 1996; Jones & Somerville, 1996; Gallagher & Somerville, 1997). The guides for the lower subdivision (Cf6γ1) were the first appearance of *Cribrostomum lecomptei*, *Bibradya grandis* and *Cribrospira* spp.; guides for the upper subdivision (Cf6γ2) were the first appearance of *Howchinia bradyana* (rare, and only at the top), *Bradyina rotula*, *Neoarchaediscus stellatus*, *Neoarchaediscus incertus*, *Saccamminopsis* sp., along with the algae *Fasciella kizilia* (rare) and *Koninckopora* sp. B. The first occurrence of *Cribrostomum lecomptei*, *Bibradya grandis* and *Cribrospira* spp. is in unit 1 (Ballyadams Quarry). *Bradyina rotula* is also recorded in Ballyadams 1 (unit 1), near the base of the succession in the Carlow district (Figs 2, 3). However, in much of the Ballyadams Quarry section *Bradyina rotula, Bibradya* and *Cribrospira* are rare or unrecorded (Fig. 3). *Howchinia bradyana* and the algal problematicum *Saccamminopsis*, on the other hand, first occur 15 m and 5 m (respectively) above the Asbian/Brigantian boundary (unit 3), and *Neoarchaediscus* occurs approximately in the middle part of Ballyadams 2 (unit 2, Fig. 3). The algal problematicum *Fasciella kizilia* is recorded in the middle part of unit 1, and the alga *Koninckopora* sp. B in the upper part of unit 2 (Cózar & Somerville, 2005a). Thus, the stratigraphic ranges of some of the taxa are not in full agreement with the proposed scheme. Nevertheless, the presence of common *Neoarchaediscus*, together with *Bradyina rotula* and *Cribrospira panderi*, suggest the top of the Ballyadams Quarry and the upper part of Clogrenan B Borehole are assignable to an uppermost Late Asbian, Cf6γ2 Subzone. This is further supported by the presence of *Koninckopora* sp. B, only known at this level (Somerville *et al*., 1992; Gallagher & Somerville, 1997), and the marked concentration of *Gigasbia gigas*, '*Nodosarchaediscus*', *Pojarkovella* and *Endothyranopsis crassa* (Fig. 3). However, an extension down of this subzone to the base of Ballyadams Quarry (where *Bradyina* and *Fasciella* occur) is uncertain.

Explanation of Plate 2.

Selected Tournayellidae, Forschiniidae, Dainellidae and Endothyridae (pars) from the Carlow district (scale bar 100 μm, except for figs 2–6 and 19–21 where scale bar 150 μm): **1**, *Spinothyra* sp., DPM-PC-27/8/44, Ballyadams 2, horizon 20 (unit 1); **2**, *Septabrunsiina* sp. 1, DPM-PC-1128, Ballyadams 2, horizon 1 (unit 1); **3**, *Lituotubella glomospiroides* Rauzer-Chernousova, DPM-PC-27/8/73, Ballyadams 2, horizon 48 (unit 1); **4**, *Forschiella prisca* (Mikhailov), DPM-PC-27/8/70, Ballyadams 2, horizon 47 (unit 2); **5**, *Bogushella ziganensis* (Grozdilova & Lebedeva), DPM-PC-27/8/40, Ballyadams 2, horizon 13 (unit 1); **6**, *Lituotubella magna* Rauzer-Chernousova, DPM-PC-1142, Ballyadams 2, horizon 15 (unit 1); **7**, *Septabrunsiina* sp. 2, DPM-PC-1321, Clogrenan B Borehole, horizon 3 (unit 2); **8**, *Septabrunsiina* sp. 1, DPM-PC-27/8/15, Ballyadams 1, horizon 18 (unit 1); **9**, *Nevillea dytica* (Conil & Lys), specimen number DPM-PC-27/8/104, Ballyadams 2, horizon 71 (unit 2); **10**, *Septabrunsiina* sp. 2, DPM-PC-27/8/80, Ballyadams 2, horizon 51 (unit 2); **11**, *Mikhailovella gracilis* (Rauzer-Chernousova), DPM-PC-27/8/15, Ballyadams 1, horizon 18 (unit 1); **12**, *Eblanaia michoti* (Conil & Lys), DPM-PC-1321, Clogrenan B Borehole, horizon 3 (unit 2); **13**, *Eblanaia* sp., DPM-PC-27/8/27, Ballyadams 2, horizon 1 (unit 1); **14**, *Vissarionovella tujmasensis* (Vissarionova), DPM-PC-1320, Clogrenan B Borehole, horizon 2 (unit 2); **15**, *Vissarionovella tujmasensis* (Vissarionova), DPM-PC-1326, Clogrenan B Borehole, horizon 5 (unit 2); **16**, *Bibradya* sp., DPM-PC-1181, Ballyadams 2, horizon 51 (unit 2); **17**, *Endospiroplectammina* sp. 1, DPM-PC-27/8/1, Ballyadams 1, horizon 1 (unit 1); **18**, *Globoendothyra* sp., DPM-PC-27/8/62, Ballyadams 2, horizon 36 (unit 1); **19**, *Globoendothyra* ex gr. *globulus* (d'Eichwald), DPM-PC-27/8/25, Ballyadams 1, horizon 30 (unit 1); **20**, *Globoendothyra globulus* (d'Eichwald), DPM-PC-27/8/58, Ballyadams 2, horizon 33 (unit 1); **21**, *Omphalotis omphalota* (Rauzer-Chernousova & Reitlinger), DPM-PC-27/8/43, Ballyadams 2, horizon 18 (unit 1).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The Early Brigantian (Cf6δ Subzone) foraminiferal distribution seems to be the result of two main factors: biostratigraphical changes and facies control. Facies control is a significant factor, because laterally equivalent units (upper part of unit 4 in SE Carlow and unit 5 in NW Carlow, Fig. 2) exhibit distinct assemblages, compositionally, as well as in the number of specimens. Moreover, a change between units 3 and 4 is lithologically conspicuous, but is also highlighted by distinct foraminiferal assemblages (both in composition, as well as in the number of specimens). Thus, three distinct assemblages are recognized in the Early Brigantian (Fig. 3).

The first assemblage (from the base of unit 3 and the base of the Early Brigantian) is characterized by the first occurrence of *Asteroarchaediscus*, *Planospirodiscus* and large *Archaediscus* at '*angulatus*' stage (e.g. *A. karreri*) from the base, and at higher levels in the assemblage, '*Pojarkovella*' *efremovi* and *Biseriammina* sp. 1, all of which are rare. Many typical Asbian taxa last occur, mostly Forschiidae (*Forschia* and *Forschiella*), Dainellidae (*Vissarionovella*) and '*Endothyra*' ex gr. *prisca*. Moreover, many other taxa are recorded very rarely, e.g. *Lituotubella*, *Endospiroplectammina*, *Cribrospira*, most species of *Pojarkovella* and *Brunsia*, or show a significant decrease in the number of specimens per thin section, e.g. '*Nodosarchaediscus*' spp. and most species of Palaeotextulariidae. The primitive *Neoarchaediscus* are common. A comparable suite of foraminifera characterize the Early Brigantian Liscarrol Limestone Formation in North Co. Cork in which stellate archaediscids and *Neoarchaediscus* are abundant, as well as large archaediscids of the *A. karreri* group (Gallagher, 1992; Gallagher & Somerville, 1997).

The second assemblage (uppermost part of unit 3 to the lower part of unit 4; Figs 2, 3) is characterized by the first occurrence of rare *Howchinia bradyana*, *Neoarchaediscus* cf. *karreriformis* and *Loeblichia paraammonoides*. *Neoarchaediscus* are common and the last occurrence of *Nevillea dytica*, *Bradyina rotula* and *Vissariotaxis* are recorded.

The third assemblage (the middle part of unit 4 and the lower part of unit 5 in the NW area; Figs 2, 3) is characterized by the first occurrence of rare *Tubispirodiscus* aff. *simplicissimus*, *Howchinia gibba* and *Planospirodiscus taimyricus*. '*Pojarkovella*' *efremovi* and *Biseriammina* sp. 1 are also rare, although the former taxon can be very common locally. Moreover, there are common to very common *Howchinia bradyana*, *Asteroarchaediscus* and *Neoarchaediscus*. Two striking taxa recorded in this interval are *Millerella*? sp. and *Zellerinella*? sp. Both taxa do not extend higher in the succession and, thus, their biostratigraphical significance for interbasinal correlations in Ireland and Britain remains rather limited. However, their occurrences are relevant, because true *Millerella* is only recorded from the upper part of the early Serpukhovian (Arnsbergian) (Groves, 1983; 1988; Vachard & Maslov, 1996; Armstrong & Mamet, 1977; Pinard & Mamet, 1998) and most species of *Millerella* recorded by authors (e.g. Conil *et al*., 1980; Strank, 1981), were transferred into the genera *Eostaffella*, *Zellerinella*, or *Pseudoendothyra* (e.g. Armstrong & Mamet, 1977). Similar specimens, questionably assigned to *Millerella* were recognized in northern England (Cózar & Somerville, 2004), but from the Pendleian Great Limestone. On the other hand, *Zellerinella* is a typical taxon of the North American Chesterian Stage (Upper Mississippian) and, thus, its occurrence in the Brigantian of the Carlow district agrees with its stratigraphic range in North American basins. However, *Zellerinella* is currently considered to be an endemic taxon of North America and South Asia (Pinard & Mamet, 1998) and possibly also in the Russian basins.

The guides for the Late Brigantian assemblages are the first occurrence of rare *Climacammina*, *Janischewskina typica*, *Endothyranopsis sphaerica*, as well as common large *Archaediscus* at '*angulatus*' stage, *Neoarchaediscus*, *Asteroarchaediscus*, *Neoarchaediscus* cf. *karreriformis*, *Biseriammina* sp. 1 and '*Pojarkovella*' *efremovi*. *Climacammina* occurs in the uppermost part of the succession in Dunamase and Aghamaddock quarries (Fig. 2). However, there is a specimen of questionable determination from unit 4 in Paulstown Quarry (Figs 2, 3). This

Explanation of Plate 3.

Selected Endothyridae (pars), Endostaffellidae, Loeblichiidae, Eostaffellidae and Pseudoendothyridae from the Carlow district (scale bar 100 μm, except for figs 1–5 where scale bar 150 μm): **1**, *Bibradya grandis* Strank, DPM-PC-1314, Clogrenan B Borehole, horizon 2 (unit 2); **2**, *Cribrospira panderi* (von Moeller), DPM-PC-1340, Clogrenan B Borehole, horizon 7 (unit 2); **3**, *Janischewskina typica* Mikhailov, DPM-PC-24/9-2/40, Dunamase, horizon 28 (unit 5); **4**, *Bradyina rotula* (d'Eichwald), DPM-PC-953, Bannagogle, horizon 2 (unit 3); **5**, *Endothyranopsis sphaerica* (Rauzer-Chernousova & Reitlinger), DPM-PC-1307, Dunamase, horizon 62 (unit 6); **6**, *Endostaffella shamordini* (Rauzer-Chernousova), DPM-PC-27/8/42, Ballyadams 2, horizon 17 (unit 1); **7**, *Endostaffella parva* (Moeller), DPM-PC-27/8/36, Ballyadams 2, horizon 10 (unit 1); **8**, *Endostaffella*? sp., DPM-PC-20/8/24, Paulstown, horizon 20 (unit 4); **9**, *Endostaffella* sp. 1, DPM-PC-881, Clogrenan, horizon 5 (unit 3); **10**, *Endostaffella shamordini* (Rauzer-Chernousova), DPM-PC-1379, Guileen-1 Borehole, horizon 4 (unit 3); **11**, *Endostaffella* aff. *parva* (Moeller), DPM-PC-27/8/36, Ballyadams 2, horizon 10 (unit 1); **12**, '*Pojarkovella*' *efremovi* (Vdovenko & Rostovceva), DPM-PC-8/8/11, Clogrenan, horizon 15 (unit 3); **13**, *Pojarkovella* sp. 2, DPM-PC-27/8/1, Ballyadams 1, horizon 1 (unit 1); **14**,.'*Pojarkovella*' *efremovi* (Vdovenko & Rostovceva), DPM-PC-20/8/31, Paulstown, horizon 25 (unit 4); **15**, *Loeblichia paraammonoides* Brazhnikova, DPM-PC-1397, Guileen-1 Borehole, horizon 18 (unit 5); **16**, *Mediocris* sp. 1,DPM-PC-8/8/32, Clogrenan, horizon 31 (unit 3); **17**, *Eostaffella radiata* (Brady), DPM-PC-9/8/15, Bannagogle, horizon 7 (unit 3); **18**, *Eostaffella* ex gr. *proikensis* Rauzer-Chernousova, DPM-PC-8/8/37, Clogrenan, horizon 34 (unit 4); **19**, *Zellerinella*? sp., DPM-PC-8/8/52, Clogrenan, horizon 45 (unit 4); **20**, *Zellerinella*? sp., DPM-PC-8/8/52, Clogrenan, horizon 45 (unit 4); **21**, *Millerella*? sp., DPM-PC-8/8/43, Clogrenan, horizon 39 (unit 4); **22**, *Eostaffella* sp. 2, DPM-PC-1335, Clogrenan B Borehole, horizon 5 (unit 2); **23**, *Eostaffella* sp. 1, DPM-PC-1347, Clogrenan B Borehole, horizon 12 (unit 2); **24**, *Eostaffella* ex gr. *ikensis* Vissarionova, DPM-PC-24/9-2/24, Dunamase, horizon 15 (unit 4); **25**, *Eostaffella* ex gr. *parastruvei* Rauzer-Chernousova, DPM-PC-8/8/9, Clogrenan, horizon 13 (unit 3); **26**, *Eoparastaffella*? sp., PC1617, Ballyadams 1, horizon −3 (unit 1); **27**, *Eostaffella mosquensis* Vissarionova, DPM-PC-1434, Dunamase, horizon −4 (unit 3); **28**, *Eostaffella parastruvei* Rauzer-Chernousova, DPM-PC-1432, Dunamase, horizon −3 (unit 3); **29**, *Eostaffella* sp. 3 (*E. parastruvei* group), DPM-PC-1337, Clogrenan B, horizon 7 (unit 2); **30**, *Pseudoendothyra ornata* (Brady), DPM-PC-1337, Clogrenan B Borehole, horizon 7 (unit 2); **31**, *Pseudoendothyra kremenskensis* Rozovskaya, DPM-PC-1316, Clogrenan B Borehole, horizon 2 (unit 2); **32**, *Pseudoendothyra sublimis* (Schlykova), DPM-PC-1369, Clogrenan B Borehole, horizon 2 (unit 3); **33**, *Pseudoendothyra sublimis* (Schlykova), DPM-PC-8/8/11, Clogrenan, horizon 15 (unit 3); **34**, *Pseudoendothyra bona* Rozovskaya, DPM-PC-9/8/39, Bannagogle, horizon 26 (unit 3); **35**, *Pseudoendothyra* aff. *nodus* (Durkina), DPM-PC-1333, Clogrenan B Borehole, horizon 5 (unit 2).

specimen appears to be a transitional form between *Cribrostomum* and *Climacammina,* because the uniserial arrangement of the chambers is not well developed or, alternatively, it could be a juvenile of *Climacammina*. *Janischewskina typica* (=*J. operculata* auct.) is only recorded in Upper Brigantian rocks in England and Ireland. However, Strank (1981) recorded *Janischewskina delicata* from the basal Brigantian Peghorn Limestone in northern England. As documented by Conil *et al.* (1980, p. 83, pl. 19, fig. 11; pl. 26, figs 13–14), the latter species and other specimens recorded in the Late Brigantian part of the Archerbeck Borehole and the Petershill Limestone, Scotland, exhibit a distinct 'alveolar'-like septum wall in the final chambers and, thus, their inclusion in the genus *Janischewskina* is debatable. Cózar & Somerville (2004) referred to these specimens as *Janischewskina*? spp. No other specimens belonging to *Janischewskina*? spp. are recorded anywhere else in Ireland.

COMPARISON WITH NORTHERN ENGLAND FORAMINIFERAL ASSEMBLAGES

Similar genera and species of Pseudolituotubidae are recorded in both the SE Ireland and northern England successions (Cózar & Somerville, 2004), but they are more common in the latter. However, these genera are also common in SW Ireland (Gallagher, 1996). Thus, the poor assemblages in Pseudolituotubidae in the Carlow district are interpreted as a local phenomenon. In addition, Conil *et al*. (1980) recorded a greater assemblage of Pseudolituotubidae in a more extensive geographical area in Britain, although its Brigantian marker, *Warnantella*, has not been recorded by the authors in Ireland, nor in northern England.

Vissariotaxis, one of the typical basal Asbian markers (e.g. Conil *et al.*, 1991), is very rare in the Carlow district (only four specimens have been recorded) and, in the sections from northern England revised by Cózar & Somerville (2004), only one specimen was recorded – from the Gordale Limestone in the Back Scar Borehole. In Little Asby Scar (Basal Asbian Stratotype), the first occurrence of *Vissariotaxis* is 13.3 m above the base (only in one thin section; Ramsbottom, 1981; Strank, 1981). Despite this though, there is still a general consensus about the validity of *Vissariotaxis* as a basal Asbian marker. In marked contrast is the occurrence of *Vissariotaxis* in other basins, such as the Guadiato Area, SW Spain (Cózar, 2003), in which many thin sections of Late Asbian rocks (*c*. 50%) contain one or two specimens and often up to five specimens.

As was mentioned previously, the first occurrence of *Howchinia bradyana* was used by Jones & Somerville (1996) and Gallagher (1996) to define the uppermost Late Asbian or Cf6γ2 division, although in North Co. Cork it does not first appear until Cf6δ Subzone, 30 m above the base of the Brigantian (Gallagher & Somerville, 1997). In the Carlow district, *H. bradyana* is first recorded in the upper part of unit 3 (only one specimen) and more commonly from the base of unit 4 (Fig. 3). Thus, its first occurrence is about 25 m above the base of the Brigantian. In the shallow-water platform facies in the Alston and Askrigg blocks (northern England), *Howchinia bradyana* is occasionally recorded in the lower part of the Brigantian and it is common above the Smiddy Limestone (Cózar & Somerville, 2004). However, in the slightly deeper-water platform facies in the Stainmore Trough, *H. bradyana* first occurs from the Late Asbian Knipe Scar Limestone and it is common from the Peghorn Limestone (Basal Brigantian limestone, according to George *et al*., 1976) (Fig. 4). However, as Cózar & Somerville (2004) demonstrated, algae and foraminifera in the Janny Wood section (Basal Brigantian Stratotype in the Stainmore Trough), do not correlate precisely with the fauna and flora recorded in shallower-water facies of the adjacent Alston and Askrigg blocks. Algal and foraminiferal taxa, together with brachiopod and coral data, suggest that the Robinson or Birkdale limestones could be considered as Brigantian in age and, thus, before a detailed revision of the Brigantian Stratotype is undertaken, comparison of the fauna in the Janny Wood section with other outcrops in England or Ireland is inappropriate for the moment. On the other hand, in the middle part of the Early Brigantian in northern England, *Howchinia gibba* (Moeller) first occurs and becomes common at the top of the Early Brigantian. This species is recorded very rarely in the Carlow district in the upper part of the Early Brigantian and base of the Late Brigantian (Fig. 4), but it is unrecorded in SW Ireland. However, it is common in the Brigantian in NE Ireland (Carganamuck Quarry, Co. Armagh and Poulmore Scarp, Kingscourt, Co. Meath; unpublished data).

Most Archaediscidae exhibit similar stratigraphic ranges in England and Ireland, except for *Asteroarchaediscus* and *Planospirodiscus* (Fig. 4). These genera are excellent basal Brigantian markers in Ireland but, in northern England, they first occur at the top of the Early Brigantian (Strank, 1981; Cózar & Somerville, 2004). In addition, *Planospirodiscus taimyricus* is known only from the 'Namurian' in northern England, much later than in Ireland. Also notable, is the absence of *Tubispirodiscus* aff. *simplicissimus* in the Brigantian from northern England; it is known only from the Yeadonian (Upper 'Namurian' =Pennsylvanian) (Fewtrell *et al*. 1981, pl. 3.12, fig. 20, as *Neoarchaediscus incertus*).

The Palaeotextulariidae also exhibit similar stratigraphic ranges in England and Ireland, with *Climacammina*, recorded only in the Late Brigantian, for which it can be considered as a useful marker.

Among the Tournayellidae, the absence of '*Tournayellina*' can be highlighted in the Carlow district. This is a genus known in other districts in Ireland (Somerville *et al*., 1992; Gallagher, 1996; Somerville, 1999) and also recorded commonly in northern England from the Robinson Limestone and higher levels (Cózar & Somerville, 2004).

Biseriammina sp. 1 has been recorded in the Carlow district, as well as in the Kingscourt district, Co. Meath and Cookstown, Northern Ireland (unpublished data), but does not occur in northern England (Cózar & Somerville, 2004). However, the distribution of *Biseriammina* is not restricted to Ireland because this taxon occurs also in Belgium (Laloux 1988, as *Globispiroplectammina*). This distribution suggests an incomplete knowledge of its occurrences and possibly a misidentification with *Biseriella* in other basins. However, *Biseriella parva* (Chernysheva) has not been recorded in the Carlow district, yet the genus is known from the Late Brigantian in England (Fig. 4).

Janischewskina typica is recorded only in Upper Brigantian rocks in England and Ireland. However, no other specimen of *Janischewskina*? spp. (recorded in the Early Brigantian Peghorn Limestone in Janny Wood section and the Archerbeck

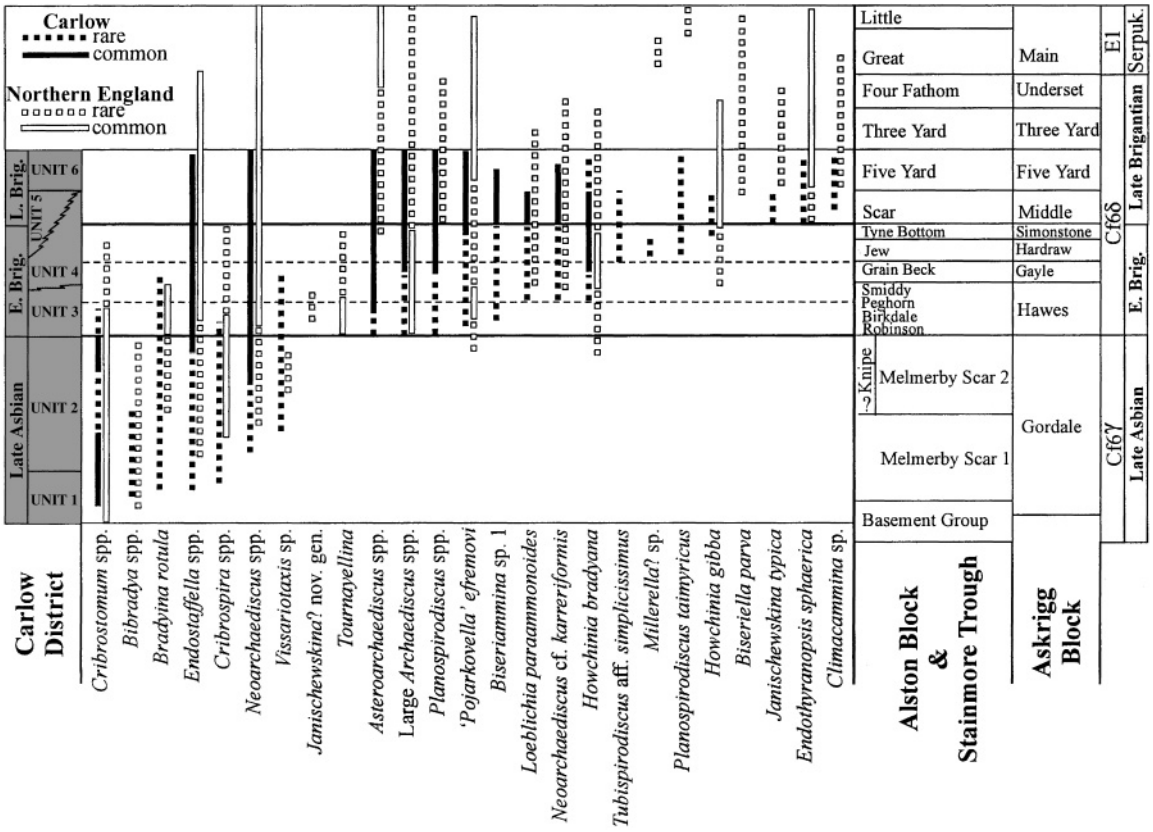

Fig. 4. A comparison of the stratigraphical ranges of the key foraminiferal taxa in the Carlow district and northern England (modified from Cózar & Somerville, 2004). Abbreviations: E. Brig., Early Brigantian; L. Brig., Late Brigantian; Serpuk., Serpukhovian.

Borehole and Petershill Limestone, Scotland) is known by the authors.

The Loeblichiidae, Eostaffellidae and Pseudoendothyridae also exhibit similar stratigraphic ranges in England and Ireland.

A summary of the stratigraphically significant genera and species is shown in Figure 4. Most of the taxa have the same distribution in Ireland and northern England (Fig. 4). The exceptions are the absent species in the Carlow district, such as *Janischewskina*? nov. gen., *Biseriella parva* and '*Tournayellina*'. In addition, *Asteroarchaediscus*, *Planospirodiscus taimyricus* and *Tubispirodiscus* have first occurrences earlier in Ireland. The diversity and abundance of the assemblages of northern England and the Carlow district are also different, e.g. in the Pseudolituotubidae.

Other data described by Cózar & Somerville (2004) from northern England, regarding the stratigraphical range of typical basal Brigantian markers (*Loeblichia*, *Janischewskina* and *Warnantella* according to Conil *et al*., 1991), suggest that they do not occur at the base of this stage (e.g. *Loeblichia*), or occur only in the Late Brigantian (e.g. *Janischewskina*), or are absent (e.g. *Warnantella*) in Ireland. Alternative basal Brigantian markers for Ireland are considered here to include: *Asteroarchaediscus*, large *Archaediscus*, *Planospirodiscus*, '*Pojarkovella*' *efremovi* and *Biseriammina* sp. 1. Basal Late Brigantian guides include: *Endothyranopsis sphaerica*, *Climacammina* and *Janischewskina typica*. Nevertheless, the acmes of '*Pojarkovella*' *efremovi*, *Biseriammina* sp. 1, *Neoarchaediscus* cf. *karreriformis* and *Planospirodiscus taimyricus* are considered here to be restricted primarily to the Late Brigantian.

CONCLUSIONS

The foraminifera of shallow-water platform carbonates from the Asbian to Brigantian strata of the Carlow district have been examined. The typical Late Asbian assemblages are dominated by *Pojarkovella nibelis*, *Mediocris*, *Eostaffella* ex gr. *radiata*, *E.* ex gr. *proikensis*, *Pseudoendothyra* ex gr. *ornata*, *P.* ex gr. *bona*, *Endothyra*, *Globoendothyra*, *Archaediscus* at '*concavus*' stage, *Pseudotaxis micra*, *Omphalotis* and *Gigasbia*, associated with the other typical markers such as *Bibradya*, *Cribrospira panderi*, *Bradyina rotula*, *Endothyranopsis crassa* and *Cribrostomum lecomptei* (Fig. 3).

The Early Brigantian assemblages are dominated by *Eostaffella* ex gr. *parastruvei*, *E.* ex gr. *mosquensis*, *Pseudoammodiscus*, *Endothyra* (with common *E.* ex gr. *phrissa* and *E.* ex gr. *spira*), *Globoendothyra* (*G. globulus*), *Pseudotaxis eominima*, *Tetrataxis*, *Omphalotis omphalota*, *Valvulinella youngi*, *Endostaffella*, *Archaediscus* at '*angulatus*' stage, *Neoarchaediscus* and *Howchinia bradyana*, with the other important markers: *Asteroarchaediscus*, large *Archaediscus*, *Planospirodiscus*, '*Pojarkovella*' *efremovi* and *Biseriammina* sp. 1 (Fig. 3).

The Late Brigantian assemblages are dominated by *Eostaffella* ex gr. *parastruvei*, *E.* ex gr. *mosquensis*, *Pseudoendothyra sublimis*, *Pseudotaxis eominima*, *Tetrataxis*, *Omphalotis omphalota*, *Gigasbia gigas*, *Endostaffella*, *Valvulinella*,

Neoarchaediscus, *Asteroarchaediscus*, large *Archaediscus*, *Planospirodiscus*, '*Pojarkovella*' *efremovi*, *Biseriammina* sp. 1 and *Neoarchaediscus* cf. *karreriformis*, associated with the markers *Endothyranopsis sphaerica*, *Climacammina* and *Janischewskina typica* (Fig. 3).

The recognition of these three distinct foraminiferal assemblages in the Late Asbian, Early Brigantian and Late Brigantian from shallow-water platform limestones in SE Ireland has been made in other parts of Ireland and also, especially, within the well-documented sections in northern England, including the stratotype sections for the Asbian and Brigantian stages in the British Isles. Although the Asbian type section at Little Asby Scar is in a carbonate-dominant sequence, comparable to the Ballyadams Formation in SE Ireland, the Brigantian stratotype section at Janny Wood is in a mixed siliciclastic–carbonate sequence, unlike the mainly limestone-rich Clogrenan Formation in SE Ireland. The cyclothemic sequences (Yoredale facies) in northern England contain thick shallow-marine limestone beds developed throughout the Alston and Askrigg blocks, representing widespread transgressive events (see Burgess & Mitchell, 1976; George *et al*., 1976; Johnson & Nudds, 1996). Many of the diagnostic Brigantian foraminiferal taxa in this region are also recorded in SE Ireland (except for those in the upper Late Brigantian interval, which is absent) and they also have comparable stratigraphic ranges (see Cózar & Somerville, 2004). However, because of the difficulties in identifying the previously distinguished foraminiferal taxa for the basal Brigantian (see Fewtrell *et al*., 1981; Strank, 1981; Strank *in* Ramsbottom, 1981), several different taxa which characterize the Early Brigantian substage have been proposed. They include: large *Archaediscus, Asteroarchaediscus, Planospirodiscus,*'*Pojarkovella*' *efremovi* and *Biseriammina* sp. 1.

In the type Viséan section in Belgium, the Upper Viséan (Warnantian) is incomplete, with most of the upper Warnantian (=Brigantian) strata very thin (Laloux, 1988). As such, it is impossible to make detailed comparisons of the foraminiferal assemblages from the Belgian sections with those in SE Ireland and northern England.

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List of identified species within families (subfamilies)

1. Earlandiidae: *Earlandia clavatula* (Howchin), *E. elegans* (Rauzer-Chernousova & Reitlinger), *E. moderata* Malakhova, *E. minima* Birina, *Earlandia* spp., *Gigasbia gigas* Strank, and *Gigasbia* spp.
2. Pseudoammodiscidae: *Brunsia pseudopulchra* (Lipina) and *B. spirillinoides* (Grozdilova & Glebovskaya), *Pseudoammodiscus priscus* (Rauzer-Chernousova), *P. volgensis* (Rauzer-Chernousova), and *Pseudoammodiscus* spp.
3. Caligellidae: *Ademasa inucta* Vachard, *Baituganella chernyshinensis* Lipina, *Protoinsolentitheca fundamenta* Vachard & Cózar and *Protoinsolentitheca serpuchoviensis* (Brazhnikova).
4. Pseudolituotubidae: *Pseudolituotuba* sp. 1, *Pseudolituotuba gravata* (Conil & Lys), and *Scalebrina* sp. 1.
5. Lasiodiscidae: *Howchinia bradyana* (Howchin) emend. Davis, *Howchinia gibba* (von Moeller), *Monotaxinoides*? sp. and *Vissariotaxis* sp. (poorly orientated specimens, probably *V. compressa* Brazhnikova).
6. Archaediscidae
   (a) (Archaediscinae): *Archaediscus* at '*concavus*' stage, *Archaediscus* at '*angulatus*' stage, large *Archaediscus* at '*angulatus*' stage (*A. karreri* Brady, *A. chernoussovensis* Mamet, *A. gigas*, *A. krestovnikovi* Rauzer-Chernousova groups), *Glomodiscus rigens* (Conil & Lys), *Planoarchaediscus spirillinoides* (Rauzer-Chernousova), *Planoarchaediscus* spp., *Pirletidiscus*? sp. 1, *Tubispirodiscus* aff. *simplicissimus* Browne & Pohl emend. Vachard, *Uralodiscus adindanii* Brenckle & Marchant, *Viseidiscus monstratus* (Rauzer-Chernousova).
   (b) (Asteroarchaediscinae): *Asteroarchaediscus baschkiricus* (Krestovnikov & Theodorovich), *A. rugosus* (Rauzer-Chernousova), *Neoarchaediscus incertus* (Grozdilova & Lebedeva), *N. ovoides* (Rauzer-Chernousova), *N. occlusus* (Hallett), *N. stellatus* (Bozorgnia), *N. parvus* (Rauzer-Chernousova), *N. regularis* (Suleimanov), *N. probatus* (Reitlinger), *N. timanicus* (Reitlinger), *Neoarchaediscus* spp., *N. subbaschkiricus* (Reitlinger), *N.* aff. *borealis* (Reitlinger), *N.* cf. *karreriformis* (Rauzer-Chernousova), '*Nodosarchaediscus*' *demaneti* (Conil & Lys), '*N.*' *convexus* (Grozdilova & Lebedeva), '*Nodosarchaediscus*' spp., *Planospirodiscus minimus* (Grozdilova & Lebedeva), *P. gregorii* (Dain), *P.* aff. *gregorii* (Dain), and *P.* aff. *taimyricus* Sossipatrova, *Planospirodiscus taimyricus* Sossipatrova.
7. Palaeotextulariidae: *Climacammina* sp., *Consobrinella minima* (Lipina), *C. consobrina* (Lipina), *Consobrinella* spp., *Cribrostomum lecomptei* Conil & Lys, *Koskinotextularia cribriformis* Eickhoff, *Koskinobigenerina prisca* (Lipina), *Palaeotextularia longiseptata* Vissarionova and *Palaeotextularia* spp.
8. Tetrataxidae: *Pseudotaxis micra* Conil & Longerstaey, *P. eominima* (Rauzer-Chernousova), *Tetrataxis conica* Ehrenberg, *Tetrataxis* spp., *Valvulinella youngi* (Brady).
9. Tournayellidae: *Bogushella ziganensis* (Grozdilova & Lebedeva), *Eblanaia michoti* (Conil & Lys), *Septabrunsiina* sp. 1, *S.* sp. 2, *Spinothyra* sp.
10. Forschiidae: *Forschia mikhailovi* Dain, *F. parvula* (Rauzer-Chernousova), *Forschiella prisca* (Mikhailov), *Lituotubella glomospiroides* Rauzer-Chernousova, *L. magna* Rauzer-Chernousova, and *Nevillea dytica* Conil & Lys.
11. Biseriamminidae: *Biseriammina* sp. 1.
12. Dainellidae: *Vissarionovella tujmasensis* (Vissarionova).
13. Endothyridae: *Bibradya grandis* Strank, *Bibradya inflata* Strank, *Bradyina rotula* (Eichwald), *Cribrospira panderi* von Moeller, *Cribrospira* spp., '*Endothyra*' ex gr. *prisca* Rauzer-Chernousova & Reitlinger (=*Priscella* auct.), *Endothyra* ex gr. *similis* Rauzer-Chernousova & Reitlinger, *Endothyra* ex gr. *bowmani* Phillips emend. China, *Endothyra* ex gr. *spira* Conil & Lys, *Endothyra* ex gr. *phrissa* Rauzer-Chernousova, *Endothyranopsis compressa* (Rauzer-Chernousova), *E. crassa* (Brady), *E. sphaerica* (Rauzer-Chernousova & Reitlinger), *Endospiroplectammina* sp. 1, *Globoendothyra globulus* (Eichwald), *Globoendothyra* sp. 1,

Mikhailovella gracilis caledonae Conil & Longerstaey, *Janischewskina typica* Mikhailov [=*J. operculata* (Rauzer-Chernousova & Reitlinger)], *Mikhailovella gracilis* Rauzer-Chernousova, *Omphalotis minima* (Rauzer-Chernousova & Reitlinger), *O. omphalota* (Rauzer-Chernousova & Reitlinger), *Plectogyranopsis convexa* (Rauzer-Chernousova), *P. ampla* (Conil & Lys), *P. settlensis* Conil & Longerstaey, and *P. hirosei* (Okimura) *sensu* Mamet *et al.* (1993).

14. Endostaffellidae: *Endostaffella parva* (Moeller), *E. shamordini* (Rauzer-Chernousova), *Mediocris mediocris* (Vissarionova), *M. breviscula* (Ganelina), *Mediocris* sp. 1.
15. Loeblichiidae: *Loeblichia paraammonoides* Brazhnikova, '*Pojarkovella*' *efremovi* (Vdovenko & Rostovceva), *Pojarkovella nibelis* (Durkina), *Pojarkovella* spp.
16. Pseudoendothyridae: *Eoparastaffella*? sp., *Pseudoendothyra sublimis* (Rauzer-Chernousova), *P. bona* Rozovskaya, *P. kremenskensis* Rozovskaya, *P. ornata* Brady, and *P. nodus* (Durkina).
17. Eostaffellidae: *Eostaffella* ex gr. *radiata* (Brady), *Eostaffella* ex gr. *proikensis* Rauzer-Chernousova, *Eostaffella* ex gr. *ikensis* Vissarionova, *Eostaffella* ex gr. *mosquensis* Vissarionova, *Eostaffella* ex gr. *parastruvei* Rauzer-Chernousova, *Millerella*? sp., *Zellerinella*? sp.

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