Ostracods as palaeoenvironmental indicators in the Lower Carboniferous Yoredale Series of northern England

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ABSTRACT — The ostracod fauna and vertical changes in its composition were examined in a shale sequence of the 5-Yard Limestone cyclothem (Yoredale Series) at a locality in Bishopdale, N. Yorkshire. The ostracod taxa are mainly confined to three superfamilies: Kirkbyacea, Healdiacea and Bairdiacea. The co-occurrence of several relatively short-ranging species such as *Kirkbya quadrata*, *Cribroconcha insculpta* and *Bairdiolites elevatus* suggests a Late Brigantian age. Four new species are described: *Cornigella posteroextensa*, *? Eriella minima*, *Rectobairdia bavarica* and *Roundysella binoda*.

Fluctuations in influx of terrigenous mud and water turbulence, related to delta growth, appear to have been the main environmental parameters that controlled the ostracod distribution and abundance along a nearshore-offshore gradient. Three different ostracod assemblages are recognized. A *Roundysella-Cribroconcha* assemblage, dominated by kirkbyacean and healdiacean ostracods, represents a quiet, nearshore environment with a fairly high depositional rate of terrigenous mud. A *Bairdia* assemblage, higher in the section, is dominated by bairdiacean ostracods that lived in a more turbulent, relatively offshore environment with less input of terrigenous sediment. A third, intermediate assemblage consists of almost equal amounts of bairdiacean and kirkbyacean ostracods, and reflects a transition from the *Bairdia* to the *Roundysella-Cribroconcha* assemblage.

INTRODUCTION: PALAEOGEOGRAPHY AND SEDIMENTATION

The 5-Yard Limestone cyclothem is one of the cyclothems of the Yoredale Series of Great Britain that was deposited during the Brigantian stage in late Lower Carboniferous times (Moore, 1958), not far south of the Carboniferous equator (fig. 1). As described in an earlier paper (Masurel, 1987), Great Britain then was an area of high relief with uplifted mountain chains in Scotland adjacent to major interior basins, and block and basement tectonics in northern England, subsequently inundated by marine sedimentation spreading across the British continental shelf from south to north. The basal bioclastic limestones and overlying shales and sandstones of the Yoredale succession reflect the passage from clear, limestone-forming seas to terrigenous delta progradation from the north.

METHODS OF STUDY

One of the sections of the 5-Yard Limestone cyclothem described by the author in 1987 (section 5; p. 231-236, figs. 1, 5c, 7, 8, table 1D), was selected for the purpose of this study. It is located in Bishopdale, N. Yorkshire (fig. 1, 2).

Samples were collected from horizons throughout the section. The purpose was to investigate the palaeo-environmental conditions that have been involved with vertical changes of lithology and fossil content in the stratigraphical column. Therefore, sampling horizons were widely spaced in relatively monotonous parts of the column, but closer where changes in lithology are distinct, e.g. the shale hori-
disarticulated, are autochthonous. Ostracods and other bioclasts often show some degree of pyritisation, which indicates that deposition of mud took place under quiet, reducing conditions. Poor oxygenation of the water and a fairly high influx and depositional rate of clay may have been important limiting factors preventing most organisms from colonising the sea floor. Shales that exhibit a relatively high abundance and diversity of ostracods and other bioclasts are largely confined to horizons below the 75 cm sample, in and around the three main nodule beds, and above the third nodule bed (fig. 3, 4). These probably reflect periods of decreased sedimentation rate linked with a temporarily increased water turbulence. Most of the ostracods that occur here do not show signs of post-mortem transport, and probably formed part of autochthonous populations. Their shells are usually articulated and various growth stages are found. Several specimens of spinose forms such as *Corrzigella tuherculospinosa* and *Cribroconcha insculpta* have been found with their spines still intact. The associated, stenohaline macrofauna which occurs at most of these fossiliferous shale horizons is dominated by benthic suspension feeders, most of which are probably indigenous. This, together with local concentrations of fossil debris, implies deposition in shallow, well-oxygenated water of normal marine salinity (Masurel, 1987).

The nodules that occur at 3 distinct, relatively fossiliferous shale horizons have been described by the present author (Masurel, 1987) and are interpreted as being algal in origin, since laminated structures were occasionally found in their Fe-rich matrix (dolomicrosparite). Furthermore, the matrix shows minor bioturbation phenomena and vague relics of brachiopods, bryozoa, foraminifera and ostracods in cracks subsequently filled by calcite. The formation and diagenetic history of these nodules is probably analogous to that of septarian concretions, which are not uncommon in clayey sediments (Vandenberghe & Laga, 1986; Astin & Scotman, 1988). The nodule beds represent carbonate-rich sedimentation horizons, resulting from periods of reduced clay sedimentation. During these periods conditions apparently were suitable for growth of algae, which may have formed algal mats that were suitable for attachment by suspension feeders such as brachiopods and bryozoa. Nodules were formed as result of remobilisation and redistribution of carbonate at an early diagenetic stage, the final shape being determined by the original thickness of the carbonate-rich sedimentation horizon and the amount of carbonate available in the horizon (Vandenberghe & Laga, 1986).

**ASSEMBLAGES**

1. *Roundylla binoda* n. sp. - *Cribroconcha caneyensis* Assemblage

This assemblage occurs in dark grey, finely laminated, organic-rich mud-shales at 25 cm, 190-200 cm, 500-560 cm and 1075 cm and less distinctly at other horizons. The assemblage can be divided into 3 sub-assemblages, based upon the relative occurrence of its two end members (see figs. 3, 4):

- **A. Roundylla binoda** dominates the ostracod fauna (400, 1075 cm), and is associated with only a scarcity of other taxa including *Cribroconcha caneyensis*.
- **B. Roundylla binoda** and *Cribroconcha caneyensis* together dominate the ostracod fauna, which exhibits a variable diversity of other species (500-550 cm).
- **C. Cribroconcha caneyensis** dominates, and is associated with a relatively high abundance and diversity of other species (560 cm).

Sub-assemblages B and C sometimes include significant numbers of the following ostracod taxa: *Scrobicula scrobiculata*, *Amphissites uei*, *Kirkbya quadrate*, *Healdianella* cf. *darwinoides* and *Cribroconcha insculpta*. Accessory components in these sub-assemblages are *Bairdiolites elevatus*, *Corrzigella tuberculospinosa*, *Hollinella radiata*, *Tetrasaccus mirabilis*, *Moorites elongatus*, and several others (fig. 4). It is noted that a relatively low diversity characterises sub-assemblage B in a sample from 500 cm, *Scrobicula scrobiculata* being the only important component that co-occurs with the two end members. The occurrence of the two kirkbyaceans *Amphissites uei* and *Kirkbya quadrate* is largely confined to fossiliferous shales between 540 and 560 cm (fig. 3). The diversity of microfauna as well...
as macrofauna (Masurel, 1987): table 1D) shows a relatively high peak at these horizons. *Amphissites* and *Kirkbya* probably needed well oxygenated water for growth of their fairly large and elaborate carapaces.

Where the assemblage reappears at 1075 cm, just above the thin limestone, it is characterised by a low density and diversity (figs. 3, 4). A new, relatively common component is *Cribratulina perplexa*, which was already fairly common in a transitional assemblage detected somewhat lower in the section (920 cm, see below).

### 2. *Bairdia* assemblage

This assemblage occurs in coarsely laminated, calcareous shales in and above the highest nodule bed, between 845 and 920 cm (fig. 2).

*Bairdia* is the most characteristic genus of the assemblage, associated with other bairdiaceans including *Rectobairdia* spp., *Bairdiocypris* spp., and, less commonly, *Bairdiolites elevatus*. Poor preservation of most of the ostracods in the calcareous shales made identification of species very difficult, but it is eliminated that there are probably more than 10.

Bairdiaceans are by far the most abundant ostracods in samples derived from 845 cm. The only accessory component of the assemblage is *Cribratulina perplexa*, which is not found at lower horizons. The abundance of *Gigantoproductus* shows a peak slightly higher in the sequence, between 870 and 898 cm. *Gigantoproductus* was probably an opportunist that took advantage of a reduced mud sedimentation rate, an increased water turbulence supplying sufficient food and oxygen, and a lack of competition by other large benthic suspension feeders (Masurel, 1987, p. 232-233, fig. 8).

It appears that the bairdiacean ostracods had already become established before the explosive colonisation by this large brachiopod.

*Bairdiocypris* joins the assemblage at 870 cm, and remains a fairly common component.

Assemblages dominated by bairdiacean ostracods are indicative of offshore marine environments. Late Palaeo-
zoic faunas in which bairdiacean ostracods predominate have been described by many authors, e.g. Brondos & Kaesler (1976), Haack & Kaesler (1980), Bless (1983), and Devery (1987). Kornicker (1961) described ostracod associations from recent stable offshore sediments which were also dominated by bairdiaceans. This author concluded that an abundance of *Bairdia* specimens in ancient sediments may indicate deposition in shallow, warm (above 10°C) water of normal marine salinity (30-40 parts per thousand).

The fact that bairdiaceans do not reach significant numbers in the lower part of the sequence would suggest that conditions remained hostile to them. Only *Bairdiolites elevatus* appears to have been a fairly adaptable species, an inference drawn from its fairly common occurrence (in different growth stages) in a sample from 25 cm (fig. 3).

Accessory ostracods that were found in samples from 870 cm and 895 cm are *Corvella reticosa* and the paraparchitaeceans *Shishuellia, williamsaee* and *Shivaella armstrongiana*. The last two were typical inhabitants of shallow offshore environments (Bless, 1983).

3. Transitional assemblage

This assemblage occurs in coarsely laminated, calcareous shales above the *Gigantoproductus* zone (920 cm). It represents a transition from the *Bairdia* assemblage into the *Roundyella-Cribroconcha* assemblage, indicating a gradual change of palaeo-environmental conditions.

Assemblage 3 consists of almost equal numbers of bairdiaceans (*Bairdia, Bairdiacypris*) and healdiaceans (*Cribroconcha caneyensis, C. perplexa*), associated with only a few specimens of the kirkbyacean *Roundyella binoda*.

A common occurrence of healdiid ostracods is often assumed to be indicative of relatively nearshore, muddy conditions (e.g. Bless, 1983 and Melnyk, 1985). It is therefore suggested that the main reason for the change in the ostracod fauna and for the extinction of *Gigantoproductus* may have been a slight increase of mud influx and sedimentation rate, related to a slowly retreating shoreline. *Gigantoproductus*, which probably had taken advantage of a temporarily reduced sedimentation rate, appears to have become locally extinct very quickly (Masurel, 1987, fig. 8), even before the appearance of significant amounts of healdiaceans in the ostracod fauna. Opportunists are characterised by relatively unstable populations, and often become extinct quickly at the onset of unfavourable conditions (Levinton, 1970).

**CONCLUSIONS AND DISCUSSION**

**Depositional environment**

The main part of the shale sequence, characterised by a scarcity of ostracods, was deposited in quiet shallow water of the prodelta area. Poor oxygenation of the water and a high influx of terrigenous mud probably inhibited colonisation by ostracods and other benthic organisms. Nevertheless, fairly diverse ostracod assemblages, sometimes containing more than 15 species, have been recognised at several different shale horizons. These are usually associated with a diversity of other microfossils (fig. 3), and an autochthonous macrofauna consisting mainly of suspension feeders, including stenohaline rugose corals (Masurel, 1987). The fossiliferous shale horizons thus reflect episodes of temporarily increased water circulation and reduced influx and deposition of mud under normal marine salinity conditions.

Assemblage 1 consists mainly of kirkbyacean and healdiacean ostracods (Fig. 3: 190, 550 cm). These must have had some tolerance to the influx of clay under very quiet conditions. The assemblage is dominated by either one or both of its end members, the ratio between which forms a basis for further division into 3 sub-assemblages (1A, 1B, 1C). *Roundyella binoda* was probably the most adaptable species, dominating a very impoverished ostracod fauna (sub-assemblage 1A at 400 cm, where other, often pyritised bioclasts only sporadically occur (Fig. 3, 4). At other shale horizons, where both end members or only *Cribroconcha caneyensis* dominate (sub-assemblages 1B and 1C), a fairly high diversity of ostracod species is usually found.

The most important and consistent components of assemblage 1, besides its end members, are *Scrobicula scrobiculata, Amphiissites urei, Kirkbya quadrata, Headlanellia cf. darwinifolida* and *Cribroconcha insculpta*.

Assemblage 2 is dominated by bairdiacean ostracods (Fig. 3: 845 cm), occurring in calcareous shales. It probably occupied a more offshore, open marine environment that was less influenced by the delta. Micro- and macrofauna contain evidence of a considerably reduced sedimentation rate of mud in well oxygenated, nutrient-rich, shallow water.

Assemblage 3 is transitional between assemblages 1 and 2, consisting of almost equal numbers of bairdiacean and healdiacean ostracods, associated with considerably fewer kirkbyaceans (Fig. 3: 920 cm). This assemblage reflects depositional conditions which are intermediate between that of the relatively nearshore, clastic-dominated environment of the kirkbyaceans and healdiaceans (assemblage 1), and the more offshore, carbonate-dominated environment of the bairdiaceans (assemblage 2).

The ostracod assemblages and related palaeo-environmental conditions described above are comparable with those recognised by Devery (1987), in the Bangor Limestone Formation (Chesterian, Mississippian) of Alabama. He described ostracods from intercalations of argillaceous limestones and calcareous shales, which were probably deposited in a middle shelf-carbonate environment where delta progradation played an important role. Salinity percentages probably remained within normal marine levels. Devery related his assemblages to a nearshore-offshore gradient, and concluded that fluctuations in the influx of terrigenous sediment and small variations in salinity were probably the main environmental parameters that controlled the ostracod distribution along the nearshore-offshore ecocline.

The *Roundyella-Cribroconcha* assemblage (1) is comparable with the *Kirkbya gutkei* subassemblage recognised.
in the Sansabella assemblage of Devery, which is characterised by a large number of healdiaceans and kirkbyaceans, and thought to have occupied a nearshore environment.

The Bairdia assemblage (2) can be compared with Devery's subgroup 1 of the Bairdia golcondensis assemblage, characterised by an abundance of bairdiaceans and common occurrence of kirkbyaceans, associated with endothyracean foraminifera, indicative of the offshore environment.

The Transitional assemblage (3) is comparable with subgroup 2 of the Bairdia golcondensis assemblage of Devery, which contains a glyptopleurid-bairdiacean fauna and represents a transitional phase between a nearshore and an offshore assemblage.

**Biostratigraphy and palaeogeography**

The ostracod fauna of the 5-Yard Limestone cyclothem contains several short range species that have been recorded from the Cawdor Limestones of the Derbyshire massif, England (Robinson, 1959), and are diagnostic for the upper Brigantian stage, e.g. Cribroconcha insculpta, C. perplexa, Kirkbya quadruta and Bairdiolites elevatus. The stratigraphic range of two species that were known from the Pendleian to Arnsbergian of Great Britain (Robinson, 1978), Coryellina reticosa and Bairdia beedei, is here extended.

The fauna shows affinity to Lower Carboniferous ostracod faunas from Belgium, Germany, France, Russia and North Africa, described by several authors, e.g. Bushmina (1968, 1970, 1975), Becker & Bless (1974), Becker et al. (1974), Bless & Massa (1982) and Crasquin (1984). Several forms that are conspecific or closely related to Russian species, e.g. Shivaella armstrongiana, Bairdiacypris fimikhaensis and Bairdiacypris sp. aff. robusta, appear to occur later in western Europe than in Russia. This phenomenon was already noted by Bless (1983), and can be explained by considering palaeogeographic and palaeo-oceanic reconstructions of the Hercynian Ocean and adjacent areas during Visean times (Ziegler et al., 1979 and Dewey, 1985). A westward equatorial ocean current fed by the Uralian Ocean would have flowed along the northern margin of the Hercynian Ocean, whereas a weaker counter equatorial current would have flowed along the southern edge. Extensive development of epicontinental shelves in the northern Hercynian Ocean further would have facilitated migration of ostracod larvae (Dewey, 1985). Evidence for westward migration can also be derived from the distribution of other faunal groups, such as conodonts. Higgins (1981) noted that the range of the cosmopolitan conodont species Paragnathodus commutatus is not identical in Eurasia and the Midcontinent of North America. In Europe it appears at the base of the Visean, but in the Midcontinent its first appearance is in
The ostracod assemblages described in this paper are equivalent in age and partly conspecific to faunas from the Chesterian Kinkaid and Bangor Limestone formations of the Midcontinental United States (Cooper, 1942, 1947; Devery, 1987), and the upper units of the Codroy and Windsor Groups of Maritime Canada (Dewey, 1983, 1985 and Dewey & Flihreaus, 1987), all representing series of transgressive and regressive episodes. The chronostratigraphical relationship is based on several sources, e.g. Mamet (1970), Conil et al. (1976) and George et al. (1976). The Midcontinental faunas contain several forms that are conspecific to those described herein, such as Cribroconcha caneyensis, Cornigella tuberculospinosa and Tetrasaccus mirabilis. The assemblages from Maritime Canada are often dominated by paraparchitacean ostracods, and show considerably less similarities to both the Midcontinental and the faunas described herein. This can be explained by a restricted circulation of sea water and prevailing hypersaline conditions in the Maritime Basin, which was a shallow embayment of the Hercynian Ocean. Dewey (1985) considered the low affinity between the Midcontinental and eastern Canadian ostracod faunas to be a function of the Appalachian barrier and circulation of ocean currents away from the Midcontinent in northward direction. Data obtained in this study on the other hand provide evidence of a faunal connection between northern England and the Midcontinent during the late Visean, thus implying a less isolated position of the latter.

SYSTEMATIC PALAEONTOLOGY

The material described in this paper is housed in the collections of the Rijksmuseum van Geologie en Mineralogie, Leiden, The Netherlands, under reference numbers RGM 350, 501-350.638.

Synonymy lists are selective and refer only to important revisions and citations. Dimensions are in millimetres and the following abbreviations are employed: RV right valve and LV left valve; DM dorsal margin and VM ventral margin; L maximum length, H maximum height and W maximum width.

Class Ostracoda Latreille, 1806
Order Palaeocopida Henningsmoen, 1953
Suborder Beyrichicopina Scott, 1961
Superfamily Drepanellacea Ulrich & Bassler, 1923
Family Aechminellidae Sohn, 1961
Genus Cornigella Warthin, 1930

Cornigella tuberculospinosa (Jones & Kirkby, 1886)
(Pl. 6, figs. 2a, b)

Diagnosis. Carapace subovate-cuneiform in lateral view. DM straight, VM convex, ends rounded, anterior broader. Maximum height anterior of mid-length. Surface of each valve marked by a strong, slightly backward pointing dorsal spine (just posterior of mid-length) and six nodes.

1886 Beyrichia tuberculospinosa Jones & Kirkby, p. 258, Pl. 8, Figs. 7-8.
1947 Cornigella tuberculospinosa - Cooper, p. 89, Pl. 21, figs. 4-6
1951 Cornigella tuberculospinosa - Posner, p.43, Pl. 15, fig. 5.
1987 Cornigella tuberculospinosa var. A - Devery, p. 82, Pl. 3, figs. 1-2.

Material. 4 carapaces, two of which are completely pyritised.

Description. The most prominent node is located in front of the dorsal spine, five others border the free margin at some distance, including a weakly developed node behind the dorsal spine. Surface regularly reticulated, spines and nodes almost smooth with scattered pits.

Remarks. Cornigella tuberculospinosa may show some variation in the number of nodes. The specimens described herein closely resemble those figured by Jones & Kirkby (1886) and Devery (1987).

Occurrence: Upper Visean of Great Britain, Upper Mississippian to Pennsylvanian of U.S.A., Lower Carboniferous of U.S.S.R.

Cornigella posteroextensa sp. nov.
(Pl. 6, figs. 1a,b)

? 1987 Cornigella tuberculospinosa var. B - Devery, p. 82, Pl. 3, fig. 10.

Derivation of name. Latin, referring to extended posterior extremity, compared with C. tuberculospinosa (Jones & Kirkby, 1886).

Diagnosis. Carapace subovate-cuneiform in lateral view. DM straight, VM convex, ends rounded, anterior broader. Maximum height anterior of mid-length. Surface of each valve marked by a slightly backward pointing dorsal spine (just posterior of mid-length) and 5 distinct nodes.

Holotype. RGM 350.505
Paratype. RGM 350.506

Explanation of Plate 1

Figs. 1-3 Amphissites uwi (Jones, 1859)
Fig. 1 RGM 350.516, 560 cm, LV, L 0.74 mm, H 0.44 mm (x 100).
Fig. 2 RGM 350.517, 550 cm, LV, L 0.54 mm, H 0.32 mm (x 120).
Fig. 3a-b RGM 350.518, 560 cm, L 0.44 mm, H 0.23 mm: fig. 3a, RV (x160); fig. 3b, detail of RV (x320).
Figs. 4-5 Kirkbya quadrata Robinson 1959.
Fig. 4 RGM 350.523, 560 cm RV, L 0.40 mm, H 0.21 mm (x160).
Fig. 5a-b. RGM 350.524, 540 cm, L 0.76 mm, H 0.38 mm: fig. 5a, RV (x80); fig. 5b, detail of RV (x400).

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Material. Two complete carapaces.

Type locality. See Fig. 2. It corresponds to locality 55 of Moore (1958) and section 5 of Masurel (1987: fig. 1) in Bishopdale, northern England.

Description. The two specimens of this new species distinguish themselves from C. tuberculospinosa (Jones & Kirkby, 1886) by a more elongated shape, due to a slightly extended posterior end. The dorsal spines are less pronounced and the reticulation pattern is variable, reticulum being relatively smaller in the posterior part, along the margins and on the nodes. The slightly swollen anterior is separated from the flattened posterior half of the carapace by a more or less distinct, narrow sulcus in front of the dorsal spine.

Remarks. The new species shows similarities in shape, presence of a median sulcus, and delicacy of the dorsal spines with C. tuberculospinosa var. B from the Upper Mississippian Bangor Limestone formation of U.S.A., described by Devery (1987). It is distinguished from the latter by the variation in reticulation on different parts of the carapace. Furthermore it lacks the posterodorsal tubercle that marks the surface of all specimens of C. tuberculospinosa var. B (Dewey, personal communication), which, however, may be due to abrasion.

Superfamily Hollinacea Swartz, 1936
Family Hollinidae Swartz, 1936
Genus Hollinella Coryell, 1928
Hollinella (Keslingella) radiata (Jones & Kirkby, 1886) (Pl. 7, fig. 5)

Synonymy list and diagnosis. See Bless & Jordan (1972, p. 54-56, PI. 19, figs. 1-5, Pl. 20, figs. 1-7).

Material. 6 recognisable fragments of single valves.

Occurrence. Lower Carboniferous of Great Britain, Germany, U.S.S.R. and U.S.A. (Bless & Jordan, 1972).

Genus Tetrasacculus Stewart, 1936
Tetrasacculus mirabilis (Croneis & Gale, 1938) (Pl. 6, figs. 3a-b, Pl. 7, fig. 1)
1938 Pterocodella mirabilis - Croneis & Gale, p. 264-265, fig. 5.
1941 Tetrasacculus mirabilis - Cooper, p. 16, Pl. 2, figs. 1-2.
1978 Tetrasacculus mirabilis - Robinson, p. 130, Pl. 1, fig. 4.
1987 Tetrasacculus mirabilis - Devery, p. 83-84, Pl. 1, figs. 1-3.

Diagnosis. Carapace subovate-cuneiform in lateral view. DM straight, VM convex, ends rounded, anterior broader. Greatest height anterior, LV larger, moderately overlapping RV along free margin. Valves bilobed, with a deep curved median sulcus extending anteroventrally. Surface regularly reticulated.

Material. 4 carapaces including 2 tecnomorphs and 2 heteromorphs.

Remarks. A distinct sexual dimorphism, characteristic of this species, is found here: tecnomorphs with a small projection at the ventral end of the front lobe (Pl. 6, figs 3a-b), heteromorphs with 4 anteroventral loculi (Pl. 7, fig. 1).

Occurrence. Asbian to Brigantian of Great Britain, Upper Mississippian of U.S.A.

Suborder Kirkbyacopina Grindel, 1969, sensu Pokorny, 1978
Superfamily Kirkbyacea Ulrich & Bassler, 1906
Family Amphissitidae Knight, 1928
Genus Amphissites Girty, 1910
Subgenus Amphissites (Amphissites) Girty, 1910
Amphissites (Amphissites) urei (Jones, 1859) (Fig. 5, Pl. 1, figs. 1-3)
1859 Kirkbya urei - Jones, p. 136 (not illustrated).
1870 Kirkbya urei - Jones, p. 185, Pl. 61, figs. 15a, b.
1885 Kirkbya urei - Jones & Kirkby, p. 189, Pl. 30, fig. 19.
1932 Amphissites urei - Latham, p. 369, fig. 16.
1978 Amphissites urei - Robinson, p. 144, Pl. 8, figs. 1a,b.
1982 Amphissites urei - Bless & Massa, p. 27, Pl. 1, fig. 5.

Fig. 5 Size distribution chart for 28 carapaces of Amphissites urei.
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**Diagnosis.** Carapace oblong, rounded in lateral view, elongate subrectangular in dorsal view. Greatest length just above midline, hinge line straight. Surface reticulate, with a subcentral oval pit only observable on well preserved specimens. Three strong concentric carinae enclose an inner, more delicate V-shaped ridge, all attached to the marginal dorsal carina.

**Material.** About 50 carapaces and 5 valves.

**Dimensions.** See Fig. 5.

**Remarks.** Robinson (1978) noted that a study of the variation in the pattern of the carinae, particularly the inner one (which may be U-, V- or J-shaped), might justify further subdivision.

**Occurrence.** Holkerian to Arnsbergian of Great Britain, Lower Carboniferous of U.S.S.R. and Upper Carboniferous of Libya.

Genus *Kegelites* Coryell & Booth, 1933

*Kegelites* sp.

**Material.** 1 pyritised carapace

**Description.** Carapace oblong, small (L 0.25 mm, H 0.15 mm), subquadrate in lateral view. Hinge line straight, ends rounded, anterior broader. VM slightly concave medially. Distinct marginal carina along free margin, posterior node projecting above hinge line. Surface finely reticulate.

Superfamily Kirkbyacea Ulrich & Bassler, 1906

Family Kirkbyidae Ulrich & Bassler, 1906

Genus *Kirkbya* Jones, 1859

*Kirkbya quadrata* Robinson, 1959

(Fig. 6, Pl. 1, figs. 4-5)

1959 *Kirkbya quadrata* - Robinson, p. 437, Fig. 2: 4-5
1978 *Kirkbya quadrata* - Robinson, p. 142, Pl. 7, figs. 4a,b.

**Diagnosis.** Carapace quadrate in lateral outline, DM and VM almost straight. Elongate subrectangular in dorsal view, hinge line straight. Greatest length just above midline, valves subequal, slightly higher behind than in front. Surface regularly reticulated, reticulum being fairly large, with a subcentral kirkbyan pit and 2 marginal rims.

**Material.** About 40 carapaces and 8 valves.

**Dimensions.** See fig. 6.

**Remarks.** Many specimens are flattened and more or less distorted, due to compression in the sediment.

**Occurrence.** Upper Brigantian of Great Britain.

Genus *Coronakirkbya* Sohn, 1954

*Coronakirkbya cornuta* (Robinson, 1978)

(Pl. 2, figs. 1-2)

1978 *Coronakirkbya cornuta* - Robinson, p. 142, Pl. 7, figs. la-b.

**Diagnosis.** Carapace semicircular in lateral view, maximum height posterior of midline. DM straight, VM and ends rounded, cardinal angles obtuse. Two hollow spines rise from the cardinal angles, pointing slightly backwards. A central lobe is more or less strongly developed, carrying a kirkbyan pit. The inner of the two marginal carinae is somewhat irregular to the outline. Surface finely reticulate.

**Material.** 2 carapaces with damaged spines.

**Remarks.** The specimens described in this paper closely resemble *?Kirkbya cornuta* illustrated by Robinson (1978, Pl. 7, figs. la,b). Robinson assigned his specimens with some doubt to the genus *Kirkbya*, because of the absence of a distinct central lobe. Nevertheless, it is suggested here that the central lobe, which is a diagnostic feature of *Coronakirkbya*, may sometimes be obscured by abrasion or may be less well developed, as illustrated by the specimens described in this paper. Other species of *Coronakirkbya* also often show some variation in the prominence of the central lobe, e.g. *C. krejcigraphy* from the Upper Carboniferous of N. Spain (Becker, 1978: p. 57-58, Pl. 4, figs. 19-22).

Family Roundyellidae Gramm, 1976

Genus *Roundyella* Bradfield, 1935

*Roundyella hinoda* sp. nov.

(Fig. 7, Pl. 1, figs. 1-5)

1976 *Roundyella hinoda* - Gramm, p. 52, Pl. 1, figs. 1-5

**Explanation of Plate 3**

Figs. 1-5 *Roundyella hinoda* n. sp.

Fig. 1 RGM 350. 530, holotype, 500 cm, LV, L 0.45 mm, H 0.25 mm (x 140).

Fig. 2 RGM 350. 531, paratype, 500 cm, dorsal view, L 0.38 mm, H 0.22 mm (x 140).

Figs. 3a-b RGM 350. 532, paratype, 560 cm, L 0.41 mm, H 0.26 mm: fig. 3a, LV (x 140); fig. 3b, detail of LV (x 400).

Fig. 4 RGM 350. 533, 540 cm, RV, L 0.42 mm, H 0.25 mm (x 140).

Fig. 5 RGM 350. 534, 540 cm, RV, L 0.40 mm, H 0.25 mm (x 140).

Figs. 6a-b *Eriella minima* n. sp., RGM 350. 635, holotype, 200 cm, L 0.44 mm, H 0.25 mm: fig. 6a, LV (x 160); fig. 6b, detail of LV (x 320)

Fig. 6 Size distribution chart for 18 carapaces of *Kirkby quadrata*.
Derivation of name. Latin, referring to the presence of 2 node-like posterodorsal spines.

Diagnosis. Carapace oblong, subquadrate in lateral outline. DM straight, VM straight or slightly concave, ends almost equally rounded. Inequivalved, RV overlapping LV. Hinge line straight, hinge slightly impressed. Surface ornamented with a regular reticulation and scattered spines/papillae, and a small but distinct node-like spine in the posterodorsal area of each valve, a subcentral smooth muscle spot.

Holotype. RGM 350.530 (Pl. 1, fig. 1)
Paratypes. RGM 350.531, 350.532 (Pl. 1, figs. 2, 3).

Material. More than 150 carapaces.

Type locality. See fig. 2. It corresponds to locality 55 of Moore (1958) and section 5 of Masurel (1987: fig. 1) in Bishopdale, northern England.

Dimensions. See fig. 7.

Remarks. This new species has similarities in shape and surface ornament to R. reticulosa (Jones & Kirkby, 1886) and R. simplicissima (Knight, 1928). It is distinguished by the presence of two relatively larger posterodorsal spines observable in dorsal view (Pl. 1, fig. 2), and which are already prominent in early instars. R. dorsopapillosa Sohn (1954, p. 19, Pl. 1, figs. 20-26) is another species with posterodorsal spines. The latter is considerably larger and has a greater number of spines scattered on the surface.

Fig. 7 Size distribution chart for 40 carapaces of Roundyella binoda n. sp.

Fig. 8 Size distribution chart for 26 carapaces of Scrobicula scrobiculata.

Dimensions. See fig. 8

Remarks. A study of variations in the reticulate pattern of this species might lead to further subdivision.

Occurrence: Brigantian of Great Britain, Lower Carboniferous of U.S.S.R.

Superfamily Primitiopsacea Swartz, 1939
Family Graviidae Polenova, 1952
Genus Coryellina Bradfield, 1935
Coryellina cf. reticosa (Jones & Kirkby, 1886) (Pl. 7, fig. 2)
Ostracods as palaeoenvironmental indicators
**Diagnosis.** Carapace obliquely subovate in lateral outline. DM straight, VM arched, ends rounded, posterior broader. Valves almost equal, RV larger. Surface regularly reticulate, median sulcus anterior of mid-length.

**Material.** 1 carapace.

**Description.** A deep median sulcus marks the finely reticulate surface, with an obscure node behind and a more clearly developed lobe in front of the sulcus. Small spines are scattered in the posteroventral area, and there is a larger posteroventral spine (broken off in the material examined).

**Remarks.** Robinson (1978) described this species from the Pendleian of Great Britain, and illustrated it with a specimen with a slightly weaker median sulcus.

**Occurrence.** C. reticosa is recorded from the Pendleian to lower-most Arnsbergian of Great Britain (Robinson, 1978).

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**Diagnosis.** Carapace subcircumferential in lateral view, greatest width above mid-height. Hinge short, straight and depressed below DM. Surface ornamented by very faint concentric striae, more or less parallel to the free margin.

**Material.** About 100 carapaces and 15 valves.

**Dimensions.** See Fig. 9.

**Fig. 9** Size distribution chart for 35 carapaces of *Cribroconcha caneyensis*.

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**Explanation of Plate 5**

Figs 1-2 *Cribroconcha perplexa* Robinson 1959.

Fig. 1 RGM 350.576, 920 cm, RV, L 0.65 mm, H 0.33 mm (120).

Fig. 2 RGM 350.577, 920 cm, RV, L 0.68 mm, H 0.35 mm (x 100).

Figs 3-7 *Headliellina cf. darwinuloides* Posner, 1951.

Fig. 3 RGM 350.593, 25 cm RV, L 0.42 mm, H 0.22 mm, tecnomorph (x 200).

Fig. 4 RGM 350.594, 200 cm, RV, L 0.43 mm, H 0.25 mm, tecnomorph (x 160).

Figs. 5a-b. RGM 350.595, 190 cm, L 0.46 mm, H 0.23 mm, tecnomorph: fig. 5a, RV (x 160); fig. 5b, detail of RV (x 400).

Fig. 6 RGM 350.596, 560 cm, heteromorph, LV, L 0.61 mm, H 0.33 mm (x 120).

Fig. 7 RGM 350.597, 550 cm heteromorph. RV, L 0.62 mm, H 0.36 mm (x 120).
Ostracods as palaeoenvironmental indicators
Remarks. The assignment of this species to the genus *Cribroconcha* is based on the presence of a pit-field anterior of the posterior ridge (Sylvester-Bradley in Moore, 1961, p. 361). It is probably conspecific with *Healdia* sp. ex gr. *H. caneyensis* recorded from the Upper Mississippian of northern Arkansas (Sohn, 1977). The latter only differs in that the posterior ridge is straight which may be a geographic variation.

Occurrence. So far only recorded from the Upper Mississippian of U.S.A., this is the first record from Great Britain.

*Cribroconcha insculpta* Robinson, 1959

(Fig. 10, Pl. 4, figs. 5-8)

1959 *Cribroconcha? insculpta* - Robinson, p. 443, Fig. 1: 4a-c.

1978 *Cribroconcha insculpta* - Robinson, p. 144, Pl. 8, figs. 3a,b.

Diagnosis. Carapace elongate in lateral and dorsal view. DM convex, VM slightly concave. Ends rounded, anterior narrower, maximum height and width central. Surface smooth, marked by an anterior marginal flange and a vertical ridge near the posterior margin of each valve. The ridge is concave anteriorly, with two backward pointing spines at the dorsal and ventral ends. The ventral spine points slightly downwards, the dorsal slightly upwards. A pit-field with small, irregularly spaced pits borders the anterior side of the ridge.

Material. 5 carapaces and 6 partly damaged valves.

Occurrence. Brigantian of Great Britain.

*Genus Healdianella* Posner, 1951

*Healdianella cf. darwinuloides* Posner, 1951

(Fig. 11, Pl. 5, figs. 3-7)

Diagnosis. Carapace elongate-ovate to subtriangular in lateral view. Maximum height and width at, or just posterior of mid-length. DM convex, VM straight or slightly convex. LV larger, overlapping RV. Surface generally smooth, occasional faint reticulation at posterior.

Material. 45 carapaces and 2 valves.

Dimensions. See fig. 11.

Fig. 11 Size distribution chart for 27 carapaces of *Healdianella cf. darwinuloides*.

Explanation of Plate 6

Figs 1a-b *Cornigella posteroextensa* n. sp., RGM 350. 505, holotype, 540 cm, L 0.59 mm, H 0.30 mm: fig. 1a, LV (x 160); fig. 1b, detail of LV (x 400).

Figs 2a-b *Cornigella tuberculospinosa* (Jones & Kirkby, 1886), RGM 350. 501, 500 cm, L 0.49 mm, H 0.32 mm: fig. 2a, RV (x 120); fig. 2b, detail of RV (x 240).

Figs 3a-b *Tetracoccus mirabilis* (Cronies & Galke, 1938), RGM 350.512, 540 cm, L 0.65 mm, H 0.32 mm tecnomorph: fig. 3a. LV (x 100); fig. 3b, detail of LV (x 200).
Remarks. The lenticular and transversely stretched meshes of the reticulation pattern, which is sometimes visible in the posterior area, are similar to those illustrated by Gramm (1982, Pl. 2, fig. 7, Pl. 3, fig. 4). This author suggested that in a related species (“Healdia cornuta” Posner, 1951) the posteroventral spine, which is usually found on right valves only, may be a larval adaption that is sometimes retained into the adult stage. In this study, the presence of a posteroventral spine is confined to early instars and males (tecnomorphs), which are distinguished from females (heteromorphs) by a less symmetrically rounded, generally more elongated shape (fig. 11). The tecnomorphs illustrated in Plate 5, figs. 3-5, resemble Healdianella darwinuloides Posner (Gramm, personal communication).

The subcircular adductor muscle scar is sometimes faintly visible just to the postero-ventral of centre.

Occurrence. Healdianella darwinuloides has been recorded from Visean strata of U.S.S.R. (Posner, 1951; Gramm, 1982). Species with affinities have been described from the Visean of France (Crasquin, 1987, PI. 1), Mississipian of U.S.A. (Dewey, 1987, PI. 6, figs. 9-11). Species with affinities have been described from Lower Tournaisian strata of Belgium (Becker & Bless, 1974) and late Dinantian Carbonates of N. Belgium (Bless et al., 1981, and B. quasie elongata Bushmina, 1968 from the Tournaisian of U.S.S.R. (Bless et al., 1981, p. 150, Pl. 3, figs. 55-57).

Bairdiacypris cf. curvis (Cooper, 1941)

Diagnostic. Carapace small, elongate, Concavity of VM distinct, slightly anterior to mid-length. DM gently convex, ends rounded. Surface smooth.

Material. 1 carapace.

Occurrence. Bairdiacypris curvis has been recorded from the Upper Mississippian of U.S.A. (Cooper, 1941, p. 25, Pl. 1, figs. 43-44; Sohn, 1960, p. 58, Pl. 2, figs. 11-13).

Genus Bairdia McCoy, 1844

Bairdia beedei Ulrich & Bassler, 1906 (Pl. 9, fig. 5)

1906 Bairdia beedei - Ulrich & Bassler, p. 161, Pl. 11, figs. 19-20.

Diagnostic. Carapace subellongate, dorsum convex, venter almost straight. Posterior end acuminate, anterior end broadly rounded above mid-length. LV larger, moderately overlapping RV along the entire margin. Anterolateral margin gently convex, anterodorsal margin straight. Posteroventral margin slightly convex, posterodorsal margin more strongly convex. Dorsal outline ovate, sides evenly rounded, sloping towards anterior and posterior ends. Surface pitted.

Material. 2 carapaces and 1 valve.

Occurrence. Lower Pennsylvanian to Permian of U.S.A. (Sohn, 1960); Pendleian to Arnsbergian of Great Britain (Robinson, 1978). This is the first record from strata older than Pendleian. See Sohn (1960, p. 23) for full synonymy.

Bairdia harltoni Cooper, 1946

(Pl. 9, figs. 7-8.)

1946 Bairdia harltoni - Cooper, p. 45, Pl. 2, figs. 30-31. (For synonymy list see Sohn, 1960, p. 27).

Diagnostic. Carapace subdeltoid in lateral view, dorsum boldly convex, venter straight or slightly convex. Sinuous antero- and posterodorsal margins, anterior margin with
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broadly rounded extremity above mid-height, and a poste-
rrior, bluntly pointed extremity below mid-height. Antero-
and posterovenstral margins convex. Surface smooth.

**Material.** 2 carapaces.

**Occurrence.** Carboniferous of Great Britain and U.S.A.
(Stohn, 1960)

Genus *Rectohuirdia* (Sohn, 1960)

**Remarks.** Some authors consider *Rectohuirdia* as a
genus (e.g. Sohn, 1960 and Bless et al., 1981) or a subgenus
of *Buirdiu* (e.g. Crasquin, 1984)

*Rectohuirdiu havarici* sp. nov. (Fig. 12)

1865 *Bairdia hisingeri* - Jones & Kirkby, p. 408, Pl. 20, figs.
12a-c.
21960 *Rectohuirdiu* sp. E - Sohn, p. 56.

**Derivation of name.** After Bavaria. Specimens of this
species that were obtained from the Carboniferous Lime-
stone at Regitzlosan, near Hof in Bavaria, Germany, were
described by Jones & Kirkby (1865), and, together with
several different species, assigned to *Bairdia hisingeri*
(Münster, 1830).

Fig. 12 *Rectohuirdiu bavarica* n. sp. (outside right valve; 25x).

**Diagnosis.** Carapace subelongate, DM highly arched, VM
slightly concave medially, ends acuminate. Posterdorsal
slope steep and flatly concave, anterdorsal margin longer
and slightly concave. Posterior end bluntly pointed below
mid-height, anterior end broader. Antero- and posteroven-
tral margins convex. Maximum height posterior to mid-
length, maximum width central. Surface smooth.

**Holotype.** RGM 350.611
**Paratype.** RGM 350.612
**Material.** 1 carapace and 1 valve.

**Type locality.** See Fig. 2. It corresponds to locality 55 of
Moore (1958) and section 5 of Masurel (1987: fig. 1) in
Bishopdale, northern England.

**Remarks.** The various species that have been assigned to
*Buirdiu hisingeri* (Münster, 1830), including this one, were
later separated by Sohn (1960).

**Occurrence.** Carboniferous of Germany and Great Britain.

Genus *Bairdiolites* Croneis & Gale, 1939

*Bairdiolites elevatus* Robinson, 1959

(Pl. 9, figs. 1-4.)

1959 *Bairdiolites elevatus* - Robinson, p. 44

1978 *Bairdiolites elevatus* - Robinson, p. 154, Pl. 13, figs. 4a-
b.

**Material.** 9 carapaces.

**Occurrence.** Upper Brigantian of Great Britain.

Family *Bairdiocypridae* Shaver, 1961

Genus *Bairdiocypris* Kegel, 1932

*Bairdiocypris fomikhaensis* Bushmina, 1968

(Pl. 8, figs. 3-4.)

1968 *Bairdiocypris fomikhaensis* - Bushmina, p. 95, Pl. 6, fig. 5, Pl. 17, figs. 1-3, Pl. 18, fig. 1.

1970 *Bairdiocypris fomikhaensis* - Bushmina, p. 29, Pl. 8, figs. 1-3.

1975 *Bairdiocypris fomikhaensis* - Bushmina, p. 53, Pl. 8, fig. 3.

1981 *Bairdiocypris* cf. *rudolphi* - Bless et al., p. 150-151, Pl. 4, figs. 58-61.

1984 *Bairdiocypris fomikhaensis* - Crasquin, p. 62, Pl. 8, fig. 10.

1987 *Bairdiocypris fomikhaensis* - Crasquin, p. 56, Pl. 10, figs. 8-11.

**Diagnosis.** Carapace subtriangular in lateral view, DM of
right valve gently angular, LV overlapping. Maximum
height just anterior to mid-length. VM gently concave, ends
rounded, anterior slightly narrower and pointed in dorsal
view. Surface smooth.

**Material.** 9 carapaces and 11 single valves or fragments.

**Remarks.** *B. fomikhaensis* has not been recorded from
British strata before. The specimens that are illustrated in
this paper closely resemble those described from Lower
Tournaisian to Upper Visean strata of France (Crasquin,
1984, 1987), and from the Tournaisian of Russia (Bushmina,
1968, 1970, 1975). Bless et al. (1981) suggested a close relationship with Bairdiocypsis cf. rudolphi (Kummerow, 1939) from the uppermost Famennian to Upper Viséan of Belgium (Becker & Bless, 1974) and late Dinantian Carbonates of N. Belgium (Bless et al., 1981), also with B. bilobatus (Münster, 1830) sensu Kummerow, 1939 from the Lower Viséan of Belgium and Germany (Becker & Bless, 1974).

Suborder Cytherocopia Gründel, 1967
Superfamily Cytheracea Baird, 1850
Family Bythocytheridae Sars, 1926
Genus Monoceratina Roth, 1928
Monoceratina antiqua (Jones & Kirkby, 1886)
1886 Bythocythere antiqua - Jones & Kirkby, p. 263, Pl. 9, figs. 5a,b.
1956 Monoceratina antiqua - Posner in Zanina, p. 194-195, Pl. 1, fig. 3.
1978 Monoceratina antiqua - Robinson, p. 140, Pl. 6, figs. 4a,b.
1983 Monoceratina antiqua - Dewey, p. 113, fig. 6J.
? 1977 Monoceratina ? sp. - Sohn, p. 150, Pl. 2, fig. 17.
1987 Monoceratina antiqua - Dewey & Fähraeus, p. 105, Pl. 4, figs. 17-20.

Diagnosis. Carapace subrhomboidal in lateral view, tumid. DM long and straight, VM convex, anterior end broadly convex. Posterior end flathy convex, projecting above. Cardinal angles obtuse, marginal rim distinct along anterior and posterior margins, narrow along VM. Wing-like expansions or alae, most developed posteriorly, with a dorsoventral, backwards pointing thorn-like spine on each valve. Median sulcus faint, extending to centre of valve. Surface pitted.

Material. 1 carapace.

Occurrence. Summarised by Dewey (1987): Newfoundland, Great Britain, U.S.S.R., U.S.A. The range of this species, known from Chadian to Asbian strata of Great Britain (Robinson, 1978), is now extended to the Upper Brigantian stage. Dewey (1987) also suggested a possible extension of the species range to the Upper Chesterian of the Midcontinent of U.S.A.

Order indet.
Suborder Paraparchitopina Gramm, 1975
Superfamily Paraparchitacea Scott, 1959

Family Paraparchitidae Scott, 1959
Genus Shishuella Sohn, 1971
Shishuella cf. williamsae Sohn, 1971
(PI. 7, fig. 3.)

Diagram. Carapace subcircular in lateral view. DM gently convex, VM broadly convex, ends almost equally rounded. Maximum height just anterior to mid-length. Dorsoposterior spine very close to the dorsal margin of the right valve. Surface smooth.

Material. 3 valves.

Occurrence. S. williamsae has been recorded from the Upper Mississippian (Lower Meramecian) of Alaska (Sohn, 1971).

Genus Shivaella Sohn, 1971
Shivaella armstrongiana (Jones & Kirkby, 1886)
(Pl. 7, fig. 4.)
1886 Leperditia armstrongiana - Jones & Kirkby, p. 253, Pl. 7, fig. 1.
1932 Paraparchites armstrongianus - Latham, p. 356, fig. 4.
1971 Shivaella armstrongiana - Sohn, p. 8-9.

Diagram. Carapace subovate in lateral view, DM straight, VM convex, ends broadly rounded. Posterodorsal spine, surface smooth.

Material. 1 left valve.

Remarks. The lateral outline of the only specimen is slightly obscured by compaction in the sediment, a circular stump indicates the position of the posterodorsal spine.

Occurrence. Courceyan to Arnsbergian of Great Britain. It may be conspecific with Shivaella cf. armstrongiana from the late Dinantian of Belgium (Bless et al., 1981, p. 146, PI. 1, figs. 5-8), S. quasiporrecta (Bushmna, 1968) from the Tournaissian of U.S.S.R., and S. bucera (Kummerow, 1953) from the Dinantian of Poland.

Order indet.
Superfamily Quassilitacea Coryell & Malkin, 1936
Family Quassilitidae Coryell & Malkin, 1936
Genus ? Eriella Stewart & Hendrix, 1945
?Eriella minima sp. nov.
(Pl. 3, figs. 6a,b)

Derivation of name. Latin, referring to the relatively small size (compared to that of other species of Eriella).

Explanation of Plate 9

Figs. 1-4 Bairdiolites elevatus Robinson 1959.
Fig. 1 RGM 350. 615, 25 cm, RV, L 0.90 mm, H 0.45 mm (x 70)
Fig. 2 RGM 350. 616, 25 cm, RV, L 1.05 mm, H 0.53 mm (x 70)
Fig. 3 RGM 350. 617, 25 cm, dorsal view, L 0.95 mm, H 0.50 mm (x 70)
Fig. 4 RGM 350. 618, 25 cm, RV, L 0.95 mm, H 0.51 mm (x 70)
Fig. 5 Bairdia beedei Ulrich & Bassler, 1906, RGM 350. 608, 870 cm, L 1.01 mm, H 0.52 mm, LV (x 60).
Fig. 6 Bairdiolites elevatus Robinson 1959 RGM 350. 619, 25 cm, RV, L 0.82 mm, H 0.39 mm (x 80).
Figs. 7-8 Bairdia Harttoni Cooper, 1941.
Fig. 7 RGM 350. 611, 895 cm, LV, L 1.41 mm, H 0.76 mm (x 55)
Fig. 8 RGM 350. 612, 920 cm, RV, L 1.25 mm, H 0.51 mm (x 60)

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**Diagnosis.** Carapace oblong, DM straight, hinge line straight and channelled. DM and VM subparallel, ends rounded. LV larger, overlapping RV along the entire margin. Surface regularly reticulated with a central smooth muscle spot.

**Holotype.** RGM 350. 635

**Paratype.** RGM 350. 636

**Material.** 2 carapaces.

**Remarks.** The species shows similarities in surface ornament to E. ? cribaria Green, 1963 from the Lower Carboniferous Banff Formation, Alberta (Green, 1963, Pl. 14, figs. 9-20). It differs from the type species of *Eriella (E. robusta Stewart & Hendrix, 1945)* in the absence of a distinct antero-marginal flange. The generic assignment on this criterion is therefore doubtful (Bless & Massa, 1982). However, the occurrence of another species with strong affinities to *Eriella* and lacking distinct marginal flanges, *E. ? courseyana* (Robinson, 1978, Pl. 10, figs. 6a,b), implies that the development of the antero-marginal flange may be of minor diagnostic importance, as already assumed by Robinson (1978).

Order Platycopida Sars, 1866

Suborder Platycopina Sars, 1866

Superfamily Cytherellacea Sars, 1866

Family Cavellinidae Egorov, 1950

Genus Cavellina Coryell, 1928

*Cavellina cf. benniei* (Jones, Kirkby & Brady, 1884) (Pl. 8, fig. 1)

**Diagnosis.** Carapace elongate-quadrate in lateral view. DM and VM almost straight and subparallel, dorsal incurved. Valves compressed anteriorly and swollen posteriorly. Anterior end rounded, posterior end almost straight. Central muscle spot just above mid-length. RV larger, overlap most prominent along the anterior margin. Surface smooth.

**Material.** 1 carapace.

**Remarks.** *C. benniei* shows a considerable variation in size and shape (Jones, Kirkby & Brady, 1884), a study of which might lead to subdivision.

**Occurrence.** Robinson (1978, p. 132, Pl. 2, fig. 1) described *C. benniei*, ranging from the uppermost Brigantian to Arnsbergian of Great Britain.

?Class Ostracoda Latreille, 1806

Genus Cryptophyllum Levinson, 1951

*Cryptophyllum* sp. (Pl. 8, fig. 2.)

**Diagnosis.** Carapace umbonate, greatest width at about mid-height, greatest length ventral. Hinge line short, depressed below the dorsal order. Ventral, anterior and posterior borders rounded, ventral broader. Antero- and posterodorsal borders straight or slightly concave.

**Material.** 9 carapaces, generally poorly preserved.

**Remarks.** A variable number of delicate concentric ridges (7 or more) is detected on the surface of some of the specimens examined.

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