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TAXONOMY AND BIOSTRATIGRAPHIC SIGNIFICANCE OF SOME MIDDLE CAMBRIAN TRILOBITES FROM THE CONASAUGA FORMATION IN WESTERN GEORGIA

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ABSTRACT—Biostratigraphic correlations of the Conasauga Formation in the southern Appalachians have been hindered by unreliable trilobite taxonomy. New fossil collections and re-examination of type specimens allow revision or confirmation of assignments for several Middle Cambrian trilobite taxa. These revisions reveal sufficient relationships with trilobites outside the region to place fossiliferous strata in Floyd County, Georgia, into the *Oryctocephalus* and *Bolaspidella* assemblage zones of the Middle Cambrian section defined for the Great Basin.

Trilobite taxa considered are: (Agnostida) *Baltagnostus centerensis* (Resser, 1938) and *Peronopsis* cf. *P. cuneifera* (Barrande, 1846); (Ptychopariida) *Alokistocare americanum* (Walcott, 1916), *Elrathia antiquata* (Salter, 1859), *Asaphiscus gregarius* Walcott, 1916, and *Glyphaspis* cf. *G. capella* (Walcott, 1916).

INTRODUCTION AND GEOLOGIC SETTING

THE CONASAUGA Formation or Group comprises the entire Middle to early Late Cambrian section in the southern terminus of the Appalachian Mountains (Palmer, 1971). Although the unit name derives from the Conasauga River in Georgia, subdivisions commonly recognized are based on sections in Tennessee where the Conasauga Group is divided into six predominantly shale or limestone formations (Hasson and Haase, 1988). In Georgia and Alabama, the formation is divided either by assumed correspondence with strata in Tennessee (Butts and Gildersleeve, 1948; McLemore and Hurst, 1970) or into unnamed lower, middle, and upper units (Cressler, 1970; Chowns, 1977).

The Conasauga Formation crops out extensively across northwestern Georgia, striking north-northeast with an especially broad outcrop area in Floyd County (Figure 1) and adjacent eastern Cherokee County in Alabama. However, deep weathering of poorly resistant beds, flooding of the Coosa River subsequent to construction of the Weiss Lake Dam, and extensive and imprecisely known faulting patterns (Cressler, 1970; Chowns, 1986, and personal commun.) have complicated interpretations of the Conasauga outcrop to a striking degree at both local and regional scales.

Numerous regions of "Conasauga" rocks may be distinguished in the wide area where the name is applied. Using the Georgia/Alabama border region in Floyd County (the prime study area here) as the reference, one may designate an eastern and western region in Georgia (after Cressler, 1970), divided by the Coosa Fault. It has been suggested that the eastern region contains strata corresponding lithologically with units in Tennessee (Spalvins, 1968); however, the strata are poorly fossiliferous and have not been examined for this report. The western belt, in Cressler's terminology, extends across the Coosa River Valley from western Floyd County into eastern Cherokee County. The Conasauga here is bracketed between the Rome and Coosa Faults, forming most of the low topography of the original river valley.

Generally, biostratigraphic relationships of the Conasauga Formation in the Georgia/Alabama border region are little known beyond recognition that the total temporal range includes beds of both Middle and Late Cambrian ages. Fossiliferous strata are common (Allen and Lester, 1954) but the trilobite biota in the regional Conasauga has not been systematically examined since 1938 (see "Previous Work," below). This study is primarily a taxonomic re-examination of some of the trilobites within the Georgia/Alabama border region outcrops of the Conasauga Formation. Taxonomy discussed here was based on examination of type specimens housed at the U.S. National Museum of Natural History (USNM), with the addition of new collections taken from sites proximal to the localities of described specimens. The results of this re-examination are insights into taxonomic and biostratigraphic relationships between the studied materials and Middle Cambrian faunas in the western United States.

PREVIOUS WORK

Trilobite taxonomy.—The literature dealing specifically with Conasauga trilobites is limited; however, one or more Conasauga taxa are described in papers by Walcott (1884, 1886, 1889, 1908, 1916a, 1916b, 1924–1925) and Resser (1935, 1936, 1937). Butts (1926) nonsystematically described and illustrated Conasauga species from Alabama, including several treated in this report. Resser (1938) wrote a comprehensive monograph on Cambrian trilobites of the southern Appalachians, which was the last work specifically on the subject and which remains the standard reference to which this report is addressed. Rasetti (1965b) discussed Upper Cambrian trilobites from the Conasauga Formation in Tennessee. Palmer (1962) discussed several Upper Cambrian trilobites from the southern Appalachians, including species from the Conasauga Formation in Alabama.

Biostratigraphy and biogeography.—Most trilobite systematic papers noted above include discussions of the biostratigraphic positions of the assemblages in their study; however, several additional papers dealing with larger scale Middle and early Late Cambrian biostratigraphic and biofacies patterns bear on the study at hand. Lochman and Wilson (1958) delimited biofacies realms, with the very important recognition of a strong zonation of the occurrences of American Cambrian trilobites into separate oceanic, intermediate, and cratonic biofacies. Palmer (1960) defined Cambrian stratigraphic patterns on the craton, which he correlated with the above-mentioned trilobite realms (e.g., "oceanic realm" trilobites of Lochman and Wilson are found in Palmer's "outer-detrital belt," composed of open marine shelf detrital sediment).

The essential framework of Middle Cambrian trilobite assemblage zone nomenclature evolved through a series of papers, notably by Howell et al. (1944), Rasetti (1951), and Lochman and Wilson (1958). No formal American "type" section is designated for the Middle Cambrian, but trilobite assemblages and strata in the Great Basin are a common reference. The trilobite zonation for the Great Basin developed by Robison (1976) will be used here, because environments of deposition and the taxonomic makeup of the Conasauga fauna compare favorably with certain units and taxa from the House Range, Utah.

COLLECTIONS AND LOCALITIES

Trilobites examined for this study are from localities in Floyd County, Georgia, and Cherokee County, Alabama, as listed below. Many of the C. D. Walcott, C. E. Resser, and older collections in the U.S. National Museum of Natural History (Smithsonian Institution) are from localities no longer accessible due to flooding of the Coosa River valley.

Twelve new fossiliferous Middle Cambrian localities in Floyd County (Figure 1) were discovered during this study (see appendix). The locations of new collections include coordinates measured in millimeters west and north from the southeastern corner of the U.S. Geological Survey 1:24,000 quadrangle map in which they occur: e.g., "33 × 78 Melson quad." translates as "33 mm west by 78 mm north from the southeastern corner of the Melson GA/AL 7½′ USGS 1:24,000 quadrangle map."

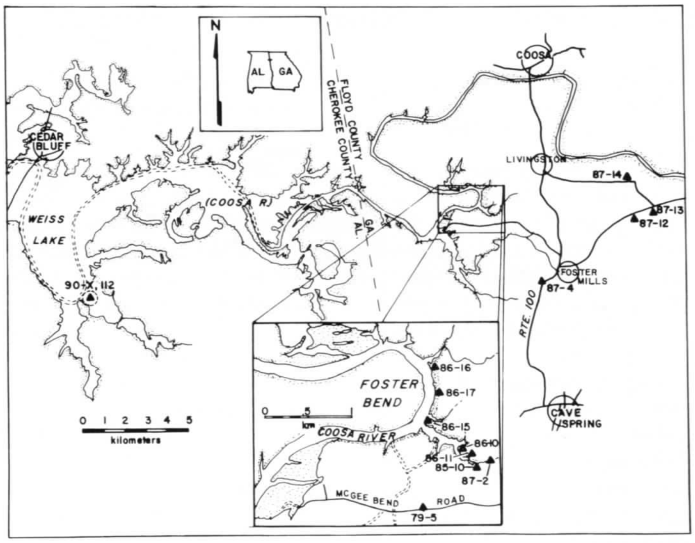

FIGURE *1*—Geography of the Coosa River Valley region, showing localities of most trilobite collections discussed in text. Lower inset shows collecting sites in the vicinity of Foster Bend of the Coosa River. Locality 90-x (=112) is inferred from notes in Walcott (1916a, 1916b) and Resser (1938). Upper inset shows position of the larger map area.

SYSTEMATIC PALEONTOLOGY

Terminology.—Trilobite descriptions here generally use terminology defined in Harrington et al. (1959). Agnostoid trilobite descriptions are based on morphologic terminology in Öpik (1967, 1979) and Robison (1964, 1982). Unless otherwise indicated, lengths are sagittal, widths are transverse, and heights are dorsoventral. References to Middle Cambrian polymeroid assemblage zones are given for each taxon, keyed to discussion which follows under "Biostratigraphy."

Repository.—All materials figured here, including previously described types, are cataloged and housed at the U. S. National Museum of Natural History and identified by USNM catalog numbers.

Class TRILOBITA Walch, 1771
Order AGNOSTIDA Kobayashi, 1935
Suborder AGNOSTINA Salter, 1864
Genus BALTAGNOSTUS Lochman, 1944

Type species.—*Proagnostus*? *centerensis* Resser, 1938, p. 48.

Diagnosis.—Refer to Robison *in* Jell and Robison (1978) and Öpik (1979) for current diagnosis of the genus, which is followed here.

BALTAGNOSTUS CENTERENSIS (Resser, 1938)
Figure 2.1–2.4

Proagnostus? *centerensis* RESSER, 1938, p. 48, Pl. 10, fig. 18.
Baltagnostus centerensis (Resser). LOCHMAN AND DUNCAN, 1944, p. 138; PALMER, 1954b, p. 718; HOWELL *in* Harrington et al., 1959, p. 184; ROBISON, 1964, p. 525–526.
Baltagnostus eurypyx ROBISON, 1964, p. 526–527, Pl. 80, figs. 1–16.

Diagnosis.—Small- to medium-sized agnostids with broad and generally shallow border furrows and narrow borders; cephalon relatively convex, overall width exceeds length; axial furrow nearly indistinct around anterior glabella, deepening to posterior sides.

Pygidial width exceeds length; axis prominent, convex, bearing a median node; posteroaxis widens slightly toward posterior and reaches border furrow, terminating abruptly; posterior lateral furrows shallow or absent; posterior margin with crescentic outline, posterolateral corners angular and bearing spines; border furrow widened adjacent to marginal spines.

Discussion.—The holotype of this species is a flattened individual, preserved in shale from the Conasauga Formation at Resser's locality 90a. New specimens from both bedded shales and chert nodules show that *B. centerensis,* in better preservation and in relief, is indistinguishable from *B. eurypyx,* well described by Robison (1964) and abundant in the *Bolaspidella* Zone of the Great Basin.

Several additional regional *Proagnostus* species reassigned to *Baltagnostus* by Lochman and Duncan (1944) (see also Palmer, 1954a, Howell *in* Harrington et al., 1959, and Robison, 1964) may indeed be *B. centerensis.* In all cases, the types are poorly preserved, and collecting for this study failed to produce Middle Cambrian specimens of this general morphology not readily assigned to *B. centerensis.* Thus, it is concluded that all regional *Baltagnostus* species are probably *B. centerensis.* However, since considerable fossiliferous outcrop has been lost to flooding of the Coosa River Valley, it is possible that different species are not represented in modern collections. Palmer (1954b) reported the presence of *Baltagnostus*? *centerensis* from the Riley Formation of Texas, also associated with a fauna of the *Bolaspidella* Zone.

Proagnostus bulbus Butts, 1926, also from the study area, is not congeneric with *Baltagnostus* (Lochman and Duncan, 1944; Palmer, 1954a; R. A. Robison, personal commun.), since it has a well-developed preglabellar median furrow. *Proagnostus bulbus* occurs in the *Cedaria* Zone and has not been re-collected by the author in the study area.

Holotype.—USNM 94868.

Collections.—Middle Cambrian, Conasauga Formation, *Bolaspidella* Zone, moderately common: CCЄ-79-5, CCЄ-86-11, CCЄ-86-10, CCЄ-86-17, CCЄ-87-2; 90a, 112 (Resser, 1938).

Genus PERONOPSIS Hawle and Corda, 1847

Type species.—*Battus integer* Beyrich, 1845.

Diagnosis.—See Robison, 1964, Pek and Vaněk, 1971, Robison *in* Jell and Robison, 1978, and Öpik, 1979, for current diagnosis of the genus, which is followed here.

PERONOPSIS cf. P. CUNEIFERA (Barrande, 1846)
Figure 2.5–2.10

Peronopsis cuneifera (Barrande, 1846). ŠNADJR, 1958, p. 63–68, Pl. 3, figs. 13–37, Pl. 4, figs. 1–11; PEK AND VANĚK, 1971, p. 271, Pl. 2, figs. 6–11. See ŠNADJR, 1958, for complete synonymy.

Diagnosis.—Cephalon subcircular; glabella tapers very slightly to anterior; border furrows on cephalon and pygidium moderately deep and wide, all borders moderately narrow; axial furrows well incised, shallowing slightly across anterior glabella; transverse glabellar furrow much more shallow; impressions of genal caeca appear as scrobicular ornamentation on some large, flattened cephala. (All other cephalic aspects and thorax typical for the genus.)

Pygidium subcircular; posterolateral corners bear short, slender spines; border widens only slightly adjacent to spines; pygidial axis has medial node and nearly indistinct transverse axial furrows; posteroaxis ogival in form, of average width for genus, terminating well before posterior border furrow. Postaxial median furrow indistinct or absent except when enhanced by compression.

Discussion.—The genus *Peronopsis* contains abundant species and needs taxonomic revision (Öpik, 1979), which is currently in progress (noted in Jell and Robison, 1978, and by R. A. Robison, personal commun.). The form discussed here is generally similar to several *Peronopsis* species with pygidial spines, especially *P. cuneifera* from the Middle Cambrian of Bohemia (Šnajdr, 1958, Pl. 3, figs. 13–37, Pl. 4, figs. 1–11; Pek and Vaněk, 1971, Pl. 2, figs. 6–11). The Conasauga specimens are largely flattened and exfoliated, making detailed comparisons tenuous; however, the scrobicular ornamentation observed here on the genal areas of crushed, large specimens has not been previously reported in *Peronopsis* from North America but it is shared with *P. cuneifera.* The Conasauga form differs slightly from *P. cuneifera* in its narrower pygidial border with a wider border furrow and longer posteroaxis; however, until the genus undergoes revision, the taxonomic significance of these subtle morphologic differences cannot be assessed.

Collections.—Middle Cambrian, Conasauga Formation, *Bolaspidella* Zone, very common: CC€-79-5, CC€-85-10, CC€-86-10, CC€-86-11, CC€-87-2, CC€-87-3, CC€-86-15, CC€-86-16, CC€-86-17.

Order PTYCHOPARIIDA Swinnerton, 1915
Family ALOKISTOCARIDAE Resser, 1935
Genus ALOKISTOCARE Lorenz, 1906

Type species.—*Conocephalites subcoronatus* Hall and Whitfield, 1877, p. 277, Pl. 2, fig. 1.

Diagnosis.—Refer to Robison, 1971, for a current overall diagnosis of the genus; and to Palmer and Halley, 1979, for additional comments. Robison's diagnosis is followed here except for modifications dictated by redescription of *Alokistocare americanum*: anterior cephalic margin may range from evenly curved to centrally spade-shaped, or may be extended into a short, anteriorly projecting spine; cephalic border may range from horizontal to angled sharply upward from preglabellar field; palpebral lobes may range from gently uptilted to nearly vertical and elevated well above fixed cheeks.

ALOKISTOCARE AMERICANUM (Walcott, 1916a)
Figure 2.11–2.16, 2.18–2.20

Acrocephalites americanus WALCOTT, 1916a, p. 177, Pl. 24, figs. 2, 2a, 2b, 3, 3a, 3b.
Alokistocare americanum RESSER, 1935, p. 6; RESSER, 1938, p. 55, Pl. 8, figs. 17, 18.
Alokistocare georgiense RESSER, 1938, p. 55, Pl. 8, fig. 47.
Alokistocare blainense RESSER, 1938, p. 55, Pl. 8, figs. 30, 31.
Alokistocare centerense RESSER, p. 55, Pl. 8, fig. 50.
Acrocephalops insignis RESSER, 1938, p. 53, Pl. 8, figs. 28, 29.
Acrocephalops nitida RESSER, 1938, p. 54, Pl. 8, figs. 21, 22.
Acrocephalops granulosa RESSER, 1938, p. 54, fig. 57.
Acrocephalops gracilis RESSER, 1938, p. 54, figs. 26, 27.

Diagnosis.—Anterior cephalic margin subcircular, border relatively wide and of uniform dimensions around perimeter; librigenae relatively wide with genal angles forming moderately long spines; cranidium with palpebral lobes set well to posterior; fixigenae wide and inflated, angling strongly upward from deeply incised axial furrows; palpebral lobes sharply uptilted (in some specimens axial surfaces nearly vertical); glabella short, bearing three deep furrows; preglabellar median swelling prominent, reaching from anterior glabellar furrow to border furrow; border furrow indistinct, border moderately long, strongly uptilted, variable in shape from rounded to distinctly projecting and spade-shaped; cephalic surfaces show coarse tubercules in variable patterns, typically more dense on brim and border, and an underlying fine granulation on most elevated surfaces; some specimens show anastomosing veins on preglabellar fields, anterior limbs of fixigenae, and parts of anterior border furrows.

Thoracic segments with broad pleural and relatively narrow axial regions; pleurae with deep and wide pleural furrows, distal terminations in short, falcate spines; coarse tubercular ornamentation present on all surfaces in random patterns.

Pygidium poorly known, apparently composed of three segments with pleural furrows extending to margin.

Discussion.—*Alokistocare americanum* may be distinguished from other species by the combination of coarse and underlying fine tubercular/granular ornamentation, strongly upturned palpebral lobes, wide fixigenae, and the presence of a spade-shaped anterior border in many specimens (note discussion below of this feature). Many authors (e.g., Rasetti, 1951; Palmer, 1954a; Robison, 1971) have examined and lamented the confusing number and vague distinctions among *Alokistocare* species, which are distributed widely in late Early through Middle Cambrian North American strata, as well as contemporary strata in parts

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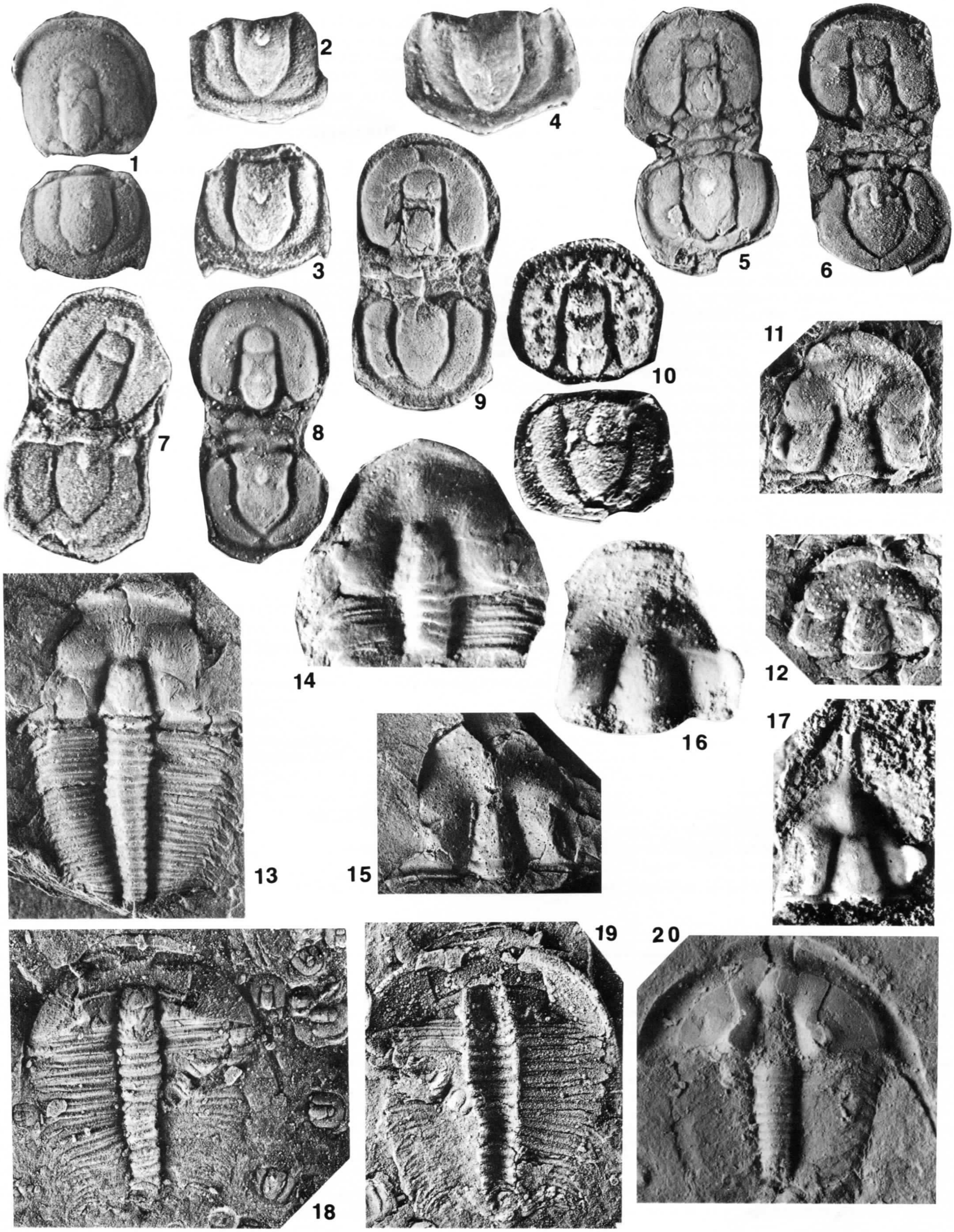
FIGURE 2—*1–4, Baltagnostus centerensis* (Resser). *1,* associated cephalon and pygidium in shale, USNM 436138, ×12; *2, 3,* isolated pygidia in shale, USNM 436139, ×10, USNM 436140, ×12; *4,* isolated pygidium in siliceous concretion, USNM 436141, ×10. *5–10, Peronopsis* cf. *P. cuneifera* (Barrande), all specimens preserved in shale. *5,6, 7, 9,* nearly complete individuals, USNM 436142, USNM 436143, both ×8, USNM 436144, USNM 436146, ×9; *8,* exfoliated individual showing postaxial median furrow, USNM 436145, ×9; *10,* cephalon showing scrobiculations, with associated pygidium, USNM 436147, ×8. *11–16, 18–20, Alokistocare americanum* (Walcott). *11, 12, 15,* isolated cranidia in shale, showing variations in ornamentation and border configuration, USNM 436148, USNM 436149, both ×5, USNM 436152, ×3; *13, 14,* cranidia with part of thorax, in shale, USNM 436150, ×3, USNM 436151, ×6; *16,* isolated cranidium in siliceous concretion, preserving full relief, USNM 436153, ×5; *18, 19,* interior of exoskeleton and exfoliated counterpart of partial individual in shale, lacking pygidium and several posterior thoracic segments, USNM 436154 ×2.5; *20,* cephalon and partial thorax in shale, compressed but preserving genal spine and retaining cephalic marginal outline, USNM 436155, ×2. *17,* holotype of *Alokistocare projectum* (Resser), in siliceous concretion, USNM 94819, ×3.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of Sweden, Greenland, China, Russia, and Argentina (Walcott, 1916a; Robison, 1971). Based on examination of many co-occurring specimens of *A. americanum,* it is concluded here that this species, and perhaps *Alokistocare* in general, is subject to unusually large amounts of intraspecific variation.

Alokistocare americanum specimens collected from the strata in this study are quite variable in several aspects: ornamentation, overall holaspid sizes, and, most notably, shape and proportions of the anterior margin. The systematist may use two coequal approaches for taxonomy of this complex of trilobites. One approach is to recognize one or more species containing cranidial morphologies with subrounded profiles and borders of approximately uniform dimensions, and a second species or group of species with spade-shaped, projecting borders which thicken toward the midline. The second approach is to note that these forms invariably co-occur in collections from the study area, and that virtually all morphologies between the extremes of rounded and spade-shaped morphologies are observed. The consequence of this second line of reasoning is the recognition of a single, variably ornamented, dimorphic species.

The latter course is chosen here and finds supporting evidence in the following observations. Rasetti (1965a) erected "*Alokistocare nasutum*" as a new species from *Bolaspidella* Zone collections in the Pleasant Hill Formation of Pennsylvania: *A. nasutum,* described only from cranidia, features morphology similar to the spade-bordered variants of *A. americanum* observed in the study area. Rasetti (1965a) also reported the presence of *A. aoris* (Walcott, 1916a) from correlative strata in Pennsylvania (but not reportedly from the same sites); this latter taxon was based on a single, incomplete cranidium which does not appear to differ from round-bordered *A. americanum.* Thus, contemporary units in the northern Appalachians may feature an analogous pair of *Alokistocare* dimorphs. Only the type specimens were examined of *A. nasutum* and *A. aoris,* which consist of isolated cranidia, and therefore these are not proposed here as synonyms of *A. americanum.*

A related problem concerns *Alokistocare projectum* Resser, 1938. The hypodigm for the species comprises several cranidia on two chert concretions from Livingston, Georgia. Examination of the types confirms that the medial anterior cephalic spine (Figure 2.17) is real and present on several individuals; however, also present on each of these two concretions are cranidia which lack the spines and are identical to specimens referable to *A. americanum.* Additional specimens with anterior spines have not been found among several dozen congeneric cranidia collected in the Livingston area, and judgement about the relationship between *A. projectum* and *A. americanum* is withheld. However, as shown in Figure 2.16 and 2.17, there are no apparent differences between the species other than in the anterior border morphology.

Holotype.—USNM 61557; paratype, USNM 61559.

Collections.—Middle Cambrian, Conasauga Formation, *Bolaspidella* Zone, moderately common: CCЄ-79-5, CCЄ-86-11, CCЄ-86-10, CCЄ-87-3, CCЄ-86-15, CCЄ-86-17; 89x, 90x, 112 (Walcott, 1916a, 1916b; Resser, 1938).

Genus ELRATHIA Walcott, 1924

Type species.—*Conocoryphe* (*Conocephalites*) *kingii* Meek, 1870, p. 63.

Diagnosis.—Palmer, 1954a, and Robison, 1964, provide modern diagnoses of the genus, which are accepted here with the following modifications to accommodate *E. antiquata*: carapace subovate to elongate suboval; glabella may have three pairs of shallow to moderately incised furrows; anterior border approximates one-half to seven-eighths length of preglabellar field; interpleural furrows on pygidium shallow to moderately deep, in some specimens coequally incised with pleural furrows.

ELRATHIA ANTIQUATA (Salter, 1859)
Figure 3.1–3.5, 3.8, 3.9

Conocephalus antiquatus SALTER, 1859, p. 554, fig. 2.
Conocephalites antiquatus (Salter). BILLINGS, 1860, p. 242.
Ehmaniella antiquata (Salter). RESSER, 1938, p. 76, Pl. 9, fig. 34.
Elrathia georgiensis RESSER, 1938, p. 77, Pl. 8, fig. 35.
Elrathia alabamiensis RESSER, 1938, p. 77, Pl. 8, fig. 38.
?*Anomocarella smithi* WALCOTT, 1911, p. 92, Pl. 17, fig. 3, 3a.
?*Ehmania smithi* (Walcott). RESSER, 1935, p. 26; RESSER, 1938, p. 75, Pl. 8, figs. 61, 62.
Ehmaniella antiquata (Salter). MORRIS AND FORTEY, 1985, Pl. 1, fig. 8a, b.

Diagnosis.—Relatively large and elongate representatives of genus: largest specimens exceed 70 mm length. Cephalic outline and librigenae typical; cranidium with posterior course of sutures less acute than in other species, forming a wider (sag.) posterior limb; glabella shows three shallow but clearly demarcated furrows in well-preserved individuals; preglabellar field relatively short but still slightly greater than length of border, slight medial thickening may be present on border. All additional morphologies of cephalon as for generic diagnosis.

Thorax with 13 or 14 segments, pleural furrows relatively wide and laterally persistent; terminations of pleurae may be slightly recurved or nearly straight, dependent on convexity after preservation.

Pygidium proportionately large, length equals one-half that of cranidium in adult specimens; width may exceed that of anterior cranidial margin by one-fourth; five or six axial rings

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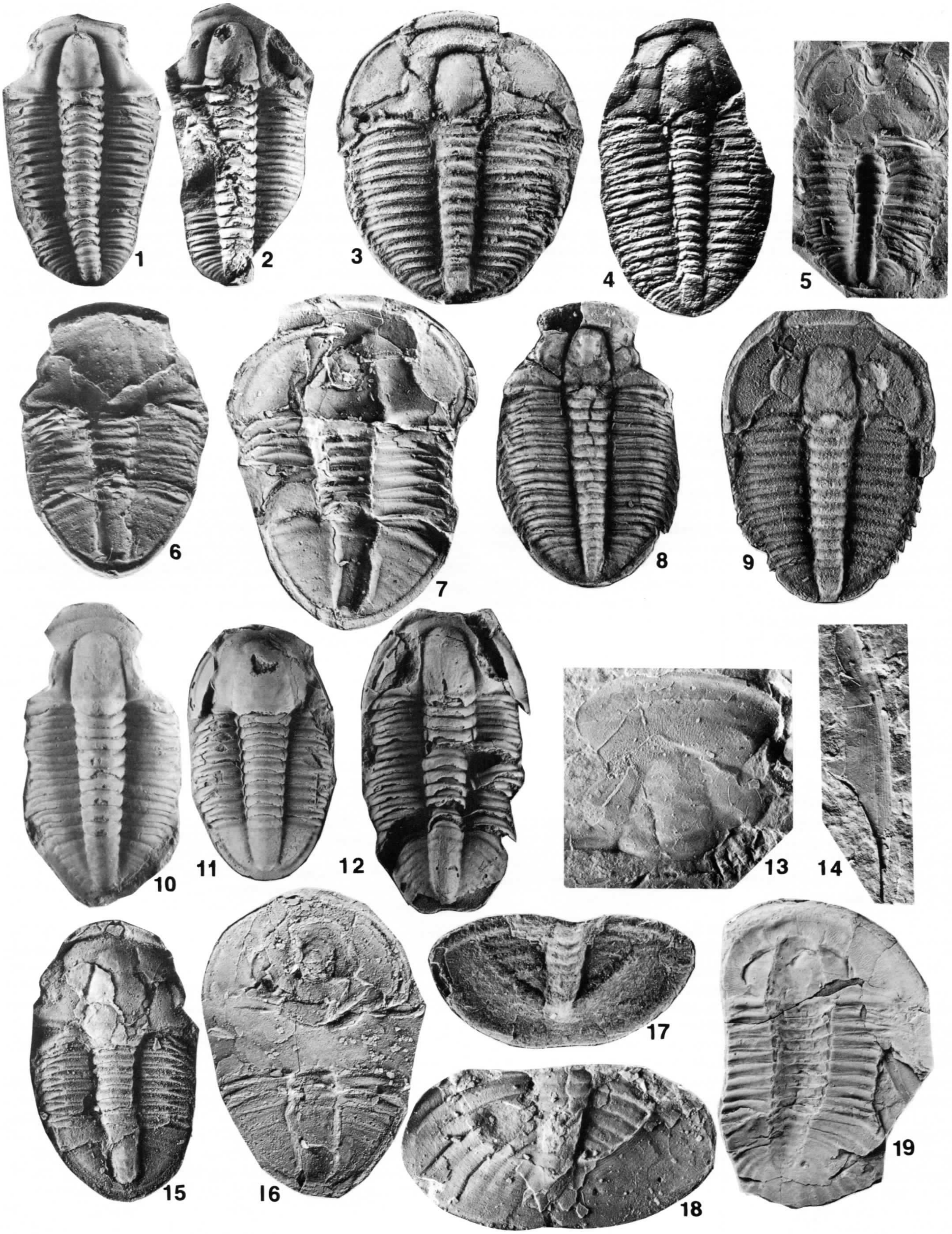
FIGURE 3—*1–5, 8, 9, Elrathia antiquata* (Salter). *1,* plesiotype figured by Resser, 1938 (Pl. 9, fig. 34), preserved in siliceous concretion, lacking librigenae, USNM 94852, ×1.2; *2,* topotype individual preserved in siliceous concretion, USNM 436156, ×1.5; *3, Elrathia alabamiensis* Resser, holotype preserved in shale, USNM 94822, ×2; *4,* individual in shale, lacking librigenae, showing slight medial thickening of anterior border, USNM 436157, ×2.2; *5,* ventral aspect of partial exoskeleton, showing hypostomata and rostral plate, USNM 436158, ×2; *8, Elrathia georgiensis* Resser, holotype preserved in shale, USNM 94820, ×1.7; *9,* complete individual in shale, USNM 436161, ×3.5. *6, 7, 10–12, 15, 16, Asaphiscus gregarius* Walcott. *6,* ventral view of exoskeleton in shale, nearly complete individual lacking librigenae, USNM 436159, ×2.5; *7,* ventral view of exoskeleton of nearly complete individual with librigenae attached, USNM 436160, ×2.5; *10, 12, Blainia gregaria* (Walcott); *10,* plesiotype figured by Resser, 1938 (Pl. 9, fig. 7), lacking librigenae, in siliceous concretion, USNM 62791, ×2.4; *12,* paratype figured by Walcott, 1916b (Pl. 62, fig. 1b), nearly complete individual in siliceous concretion, USNM 62793, ×1.8; *11, Blainia? paula* (Walcott), lectotype figured by Resser, 1938 (Pl. 9, fig. 3), nearly complete individual in siliceous concretion, USNM 62802, ×1.2; *15,* nearly complete individual, lacking librigenae and partly exfoliated, USNM 436162, ×3.0; *16,* ventral view of partial individual in shale, showing hypostomata and with librigenae preserved, USNM 436163. *13, 14, 17, 18, Glyphaspis* cf. *G. capella* (Walcott), all specimens isolated parts preserved in shale. *13,* cranidium, USNM 436164, ×2; *14,* librigena, USNM 436165, ×1.5; *17, 18,* pygidia, USNM 436166, ×2.6, USNM 436167, ×1.5. *19, Glyphaspis capella* (Walcott), paratype figured by Walcott, 1916b (Pl. 59, fig. 2b), ventral view of partial exoskeleton in shale, USNM 62763, ×1.1.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plus terminus present; posterior margin unnotched, outline wide oval to semicircular; interpleural furrows relatively deep and laterally persistent, coequal with pleural furrows in some individuals.

Discussion.—Robison (1964) discussed the genus at length and observed that *Elrathia* was a virtual wastebasket taxon into which were placed a large number of simple ptychoparine forms. Robison also acknowledged in the same discussion that *E. alabamiensis* Resser and *E. georgiensis* Resser were among the few "unquestionably" correctly assigned *Elrathia* species (that is, with the type species *E. kingii* and two additional Great Basin species, *E. alapyge* and *E. marjumi*).

Based on examination of holotypes and several dozen specimens from topotype and new collecting sites, it is evident that many regional ptychoparine taxa are indeed all referable to *Elrathia* and comprise one species. *Elrathia antiquata* is a very common species, showing considerable allometric growth variation; Bright (1959) demonstrated allometric variation in many of the same features in *E. kingii* from the Wheeler Shale. Great apparent morphological variation is also an artifact of different preservation formats; it is notable that the paratypes of *E. georgiensis* and *E. alabamiensis* are compressed shale specimens whereas the USNM plesiotype of *Conocephalus antiquatus* is preserved with full dimensions in chert. The holotype of *C. antiquatus,* described by Salter (1859) in a monograph on British trilobites and deposited in the British Museum, as well as the plesiotype at the USNM, came from the Conasauga Formation in Georgia.

Although analysis of all simple ptychoparine trilobites would be a Herculean task, *E. antiquata* may comprise a link between the genera *Elrathia* and *Ehmania* Resser, 1935. *Ehmania* species are common Rocky Mountains inner detrital belt trilobites (Deiss, 1939; Schwimmer, 1973, 1975), which are typically older than species of *Elrathia* and differ morphologically by very minor features: the glabella has well-developed furrows; the pygidium is semicircular, relatively large, and shows interpleural furrows equal in depth with the pleural furrows. From the above specific diagnosis of *E. antiquata,* it will be observed that these are among the features added to accommodate the species in *Elrathia.* I suggest that *E. antiquata* may be a less derived descendant from ancestral *Ehmania* stock than are the Great Basin congeneric species.

Holotype.—British Museum of Natural History I 4853; plesiotype, USNM 94852.

Collections.—Middle Cambrian, Conasauga Formation, *Bolaspidella* Zone, very common: CC€-79-5, CC€-85-10, CC€-87-2, CC€-86-15, CC€-86-16, CC€-86-17, CC€-87-14; 92c (Resser, 1938), 112 (Walcott, 1916a; Resser, 1938), 90x (Walcott, 1916a; Resser, 1938).

Family ASAPHISCIDAE Raymond, 1924
Genus ASAPHISCUS Meek, 1873

Type species.—*Asaphiscus wheeleri* Meek, 1873, p. 485.

Diagnosis.—Palmer (1954a) provided a generic diagnosis which is adopted here with the following modifications to accommodate inclusion of *A. gregarius*: cranidium with long, tapering glabella, which may reach to border furrow in some species; border furrow moderately to deeply incised; facial sutures may extend straight to margin or may diverge anteriorly; pygidial outline semicircular to rounded-subtriangular.

Discussion.—Walcott (1916b) described a large number of *Asaphiscus* species from Cordilleran, Appalachian, and Chinese collections, and he simultaneously erected the subgenus *Blainia,* based on a type species from the Conasauga Formation (locality 90x), and included within it four species from the southern Appalachians. Resser (1935) reassigned all but two of Walcott's species to other genera, and designated *Blainia* as a separate genus with Walcott's species *Asaphiscus* (*Blainia*) *gregarius,* from the Conasauga Formation, as the type species. Palmer (1954a) reincorporated several of Resser's (1935) reassigned species back into *Asaphiscus,* but he did not analyze the validity of *Blainia* as a distinct genus.

New specimens from topotype and proximal collections show that the differences used by Resser (1935) to differentiate *Blainia* from *Asaphiscus* are at best trivial, and may be based largely on artifacts. For example, Walcott and Resser illustrated "*Blainia*" specimens from Cherokee County, Alabama, with a median notch in the pygidial border. Examination of the type series of *B. gregaria* and *B.* (=*Eteraspis*) *paula* shows that this feature may be preservational: in each specimen the "median notch" was either nonexistent or apparently formed by ablation of the exoskeleton. In Resser's (1938) figured "plesiotype" of *B. gregaria* (see Figure 3.10), the mid-posterior pygidial margin is entirely ablated. In the lectotype of *B. paula* (USNM 62802, see Figure 3.11), the posterior pygidial margin is complete and smooth, as originally illustrated by Walcott (1916b, Pl. 62, fig. 2); a median notch was obviously added to the figure in Resser (1938). Further, renewed collecting from nearby localities has yielded dozens of similar pygidia, all lacking the notch.

Specimens collected in this study also lack genal spines (e.g., Figure 3.7, 3.16) and sharp, reflexed pleural spines (e.g., Figure 3.6) illustrated (via retouched photographs) by Walcott (1916b); these too comprised generic differences for Resser. In the type series of *B. gregaria,* only USNM 62793 retains the librigenae (Figure 3.12). Careful examination shows that both librigenae, especially the more complete left librigena, have been displaced laterally and posteriorly, giving the impression that a genal spine was once present. Reconstruction of this individual leaves the presence of genal spines ambiguous. The lectotype of *B. paula* retains the left librigena and shows a rounded genal region, lacking a genal spine. In summary, the main features used by Resser (1935) to erect *Blainia* as a distinct genus are artifactual, erroneous, or inconclusive. It is suggested here that *Blainia* be suppressed as a junior subjective synonym of *Asaphiscus.*

ASAPHISCUS GREGARIUS Walcott, 1916b
Figure 3.6, 3.7, 3.10–3.12, 3.15, 3.16

Asaphiscus (*Blainia*) *gregarius* WALCOTT, 1916b, p. 394, Pl. 62, fig. 1, 1a–1i.
Blainia gregaria (Walcott). RESSER, 1938, p. 62, Pl. 9, fig. 7.
Asaphiscus (*Blainia*) *paula* WALCOTT, 1916b, p. 395, Pl. 62, fig. 2, 2a.
Blainia? *paula* (Walcott). RESSER, 1938, p. 62, Pl. 9, fig. 3.
Eteraspis paula (Walcott). RESSER, 1942, p. 22.
Asaphiscus (*Blainia*) *elongatus* WALCOTT, 1916b (part), p. 393, Pl. 63, fig. 5, 5a (not fig. 4, 4a =*Elrathia antiquata*).

Diagnosis.—Medium to large representatives of the genus, maximum lengths observed to 50 mm. Overall outline smoothly oval, cephalon slightly wider than pygidium; cranidium with generally shallow furrows, glabella reaching nearly to border furrow; border furrow moderately shallow to distinct; anterior course of facial sutures straight to border, convergent toward midline across border; librigenal border distinctly separated by border furrow. All other features as per generic diagnosis.

Thorax typical for genus. Pygidium rounded-subtriangular, width nearly equals that of posterior limbs of cranidium; axis shows seven or more poorly defined rings; anterior margin curves backward, anterior segment wide (sag.) with wide pleural furrow; border relatively narrow, unnotched, distinctly demarcated.

Discussion.—All *Asaphiscus* specimens collected and examined from the study area can easily be accommodated in the single species, *A. gregarius.* Walcott illustrated several additional Asaphiscidae from Conasauga strata in Tennessee which were not examined for this study; however, based on the plates in Walcott (1916b), they do appear to represent a different species assignable to *Asaphiscus.* Rasetti (1965a) reported two Asaphiscidae from contemporary strata in Pennsylvania: *Asaphiscus glaber* (Walcott, 1916b) and *Blainia buttsi* n. sp. Based on photographs and descriptions in his report, *A. glaber* closely resembles *A. gregarius,* whereas "*Blainia*" *buttsi* is quite different and may not be correctly assigned at the familial level.

Lectotype.—USNM 62797; paratypes, USNM 62791, 62793–62796, 62798–62801.

Collections.—Middle Cambrian, Conasauga Formation, *Bolaspidella* Zone, common: CCЄ-86-10, CCЄ-86-11, CCЄ-87-3, CCЄ-86-15, CCЄ-86-17; 90x (Walcott, 1916a, 1916b), 112 (Walcott, 1916a, 1916b).

Genus GLYPHASPIS Poulsen, 1927

Type species.—*Asaphiscus*? *capella* Walcott, 1916b (see synonymy with specific discussion).

Diagnosis.—Macropygous, large ptychopariids, oval in outline. Cephalon with evenly rounded anterior margin, genal angles extended into stout, moderately long spines; cranidium subquadrate with preglabellar field and border long (sag.), in some species equal to glabellar length and commonly bearing anastomosing veins; border furrow variably indistinct to well demarcated, border angled upward from flat preglabellar field; palpebral lobes long, usually more than one-half glabellar length; anterior limbs wide (tr.), with divergent sutures extending forward from palpebral lobes at angles to 45°; posterior limbs very narrow (sag.).

Thorax with 9 or 10 segments, axis narrower than pleurae; pleurae terminate in short spines.

Pygidial outline smoothly rounded, in some species bearing a medial flattened section or subtle notch; pygidial axis bears from 5 to 10 segments; pygidial border broad and flat, with pleural furrows persisting almost to margin; pygidial border furrow often indistinct but showing strong demarcation in exfoliated specimens.

Discussion.—This genus can be readily distinguished among macropygous ptychopariids on the basis of cephalic features, including the divergent anterior sutures, presence of genal spines, relatively deeper axial furrows, much longer palpebral lobes, and long preglabellar field without any trace of medial swelling. The pygidium is distinguished by having a short, broad profile with a very broad border and poorly demarcated pygidial border furrow.

Glyphaspis species are reported in uppermost units of the open-shelf *Oryctocephalus* Zone (using terminology in Robison, 1976) in the Great Basin (Hintze and Robison, 1975; Rees, 1986), and in the *Bathyuriscus–Elrathina* Zone (in older usage) for inner-shelf facies in Montana (Walcott, 1916b; Deiss, 1939; Schwimmer, 1975), the Canadian Rocky Mountains (Rasetti, 1951), and Greenland (Poulsen, 1927). Resser (1938) named three species from the southern Appalachians, as discussed below.

GLYPHASPIS cf. G. CAPELLA (Walcott, 1916)
Figure 3.13, 3.14, 3.17, 3.18

Asaphiscus? *capella* WALCOTT, 1916b, p. 385, Pl. 59, fig. 2, 2a–c.
Glyphaspis capella (Walcott). POULSEN, 1927, p. 273.
?*Glyphaspis cowanensis* RESSER, 1938 (part), p. 80, Pl. 8, fig. 40.

Diagnosis.—A large species, with especially broad borders. Cranidium with long preglabellar field, approximately 0.4 times glabellar length; border upturned and set off by wide, shallow furrow; faint anastomosing veins present within and adjacent to the border furrow; palpebral lobes 0.8 times glabellar length; posterior limbs very narrow (sag.); anterior limbs very wide; librigenae relatively narrow, with stout, moderately long genal spines; thorax imperfectly known, segments typical for the genus.

Pygidium wide and short; anterior profile nearly straight with strongly rounded corners; posterior margin evenly rounded with slight medial notch; six or seven visible rings present on axis plus terminus with one or more indistinct rings.

Discussion.—The individuals collected from the study area are all compressed in soft, orange-colored shale and are incomplete. These isolated parts from the Conasauga Formation in Georgia are indistinguishable from the same trilobite parts in the type series of *Glyphaspis capella* (Walcott, 1916b) from Montana. However, both the type species and the study area specimens are too poorly known to claim specific identity.

Resser (1938) described three southern Appalachian *Glyphaspis* species, none of which are correctly assigned to the genus. The holotypes of *G. gracilis, G. nitida,* and *G. cowanensis* each feature 13 thoracic segments and pygidia considerably smaller than the cephala; they are very likely individuals of *Elrathia antiquata.* However, an isolated pygidium assigned by Resser (1938) to *G. cowanensis* may indeed belong to the *Glyphaspis* species discussed here.

Deiss (1939) described eight *Glyphaspis* species from Montana, including several from the locality of the type species. Schwimmer (1973) considered Deiss' species to be invalid, in part based on indeterminably poor material and in part comprising junior synonyms of *G. capella* or another, very similar Montana species, *G. camma* (Walcott, 1916b). *Glyphaspis parkensis* Rasetti (1951), from the Canadian Rocky Mountains, is also similar to the study area form of the genus (and the type species) in all observable respects. A Greenland species, *Glyphaspis perconcava* (Poulsen, 1927), has a relatively narrow preglabellar field and cranidial border, which distinguishes it from the species in study.

Syntypes.—USNM 62761–62764.

Collections.—Middle Cambrian, Conasauga Formation, *Oryctocephalus* Zone, common: CCЄ-87-4, CCЄ-87-12, CCЄ-87-13.

BIOSTRATIGRAPHY

The trilobite taxa collected and examined for this study may be placed in two North American polymeroid trilobite assemblage zones, which may be further correlated globally by means of agnostoid biostratigraphy. Figure 4 summarizes these relationships and includes a listing of new collecting sites assigned to biozones. In general, all trilobites examined from the vicinity of Livingston, Georgia, as well as the Resser and Walcott collections from Blaine and lower-elevation outcrops in Cedar Bluff, Alabama (the latter now under Weiss Lake), represent the *Bolaspidella* Assemblage Zone of the late Middle Cambrian. Regional assemblages contain a mix of trilobites which correlate on the generic level with the fauna of the Wheeler and Marjum Formations in Utah (Robison, 1976): i.e., containing *Asaphiscus, Elrathia, Peronopsis, Baltagnostus,* and *Alokistocare.* The abundance of agnostoids in the Conasauga shaly strata, as well as the generic mix of polymeroid trilobites, shows that the study area was probably situated on the outer marine shelf during *Bolaspidella* time, as were the correlatives in the Great Basin.

Collections containing *Glyphaspis* are found at localities CCЄ-87-4, CCЄ-87-12, and CCЄ-87-13, all located to the south and/or east of the *Bolaspidella* Zone localities. All species of *Gly-*

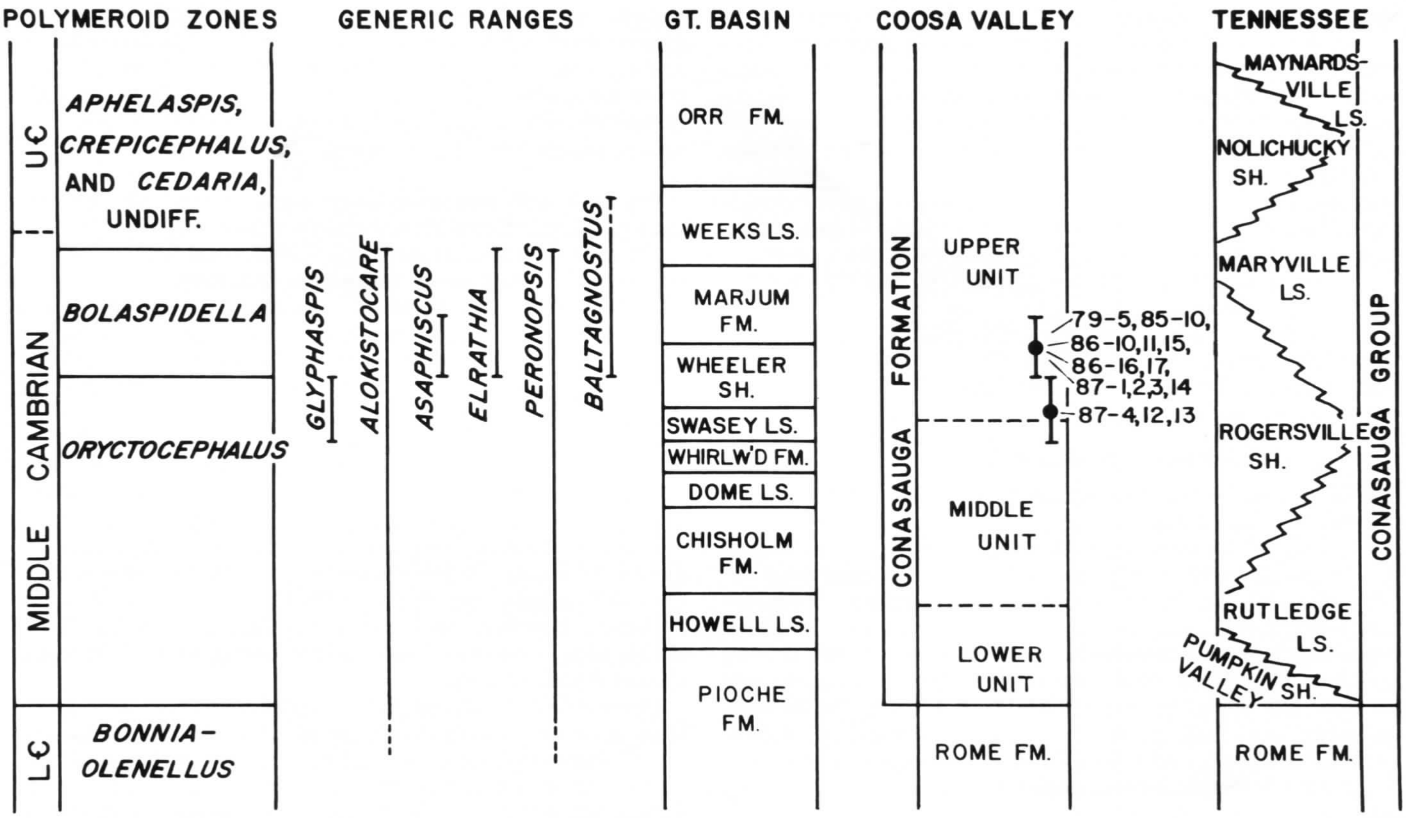

FIGURE 4—Biostratigraphic correlations of the Conasauga Formation in the Coosa Valley and contemporary strata in Tennessee and the Great Basin (House Range). Bars within the Coosa Valley column indicate the ranges of possible positions for collections in this study. Polymeroid trilobite assemblage zones based on Robison (1976). Great Basin column based on Robison and Hintze (1975); Tennessee column based on Rasetti (1965b), Palmer (1971), and Hasson and Haase (1988).

phaspis in the Rocky Mountains and Great Basin come from strata slightly older than *Bolaspidella* time, which is a biozone traditionally termed the *Bathyuriscus–Elrathina* Zone, following Lochman and Wilson (1958) and based on inner-shelf trilobite faunas. For open-shelf polymeroid trilobite occurrences, this interval was renamed by Robison (1976) as the upper part of the *Oryctocephalus* Zone (see Figure 4). Based on occurrences of the genus *Glyphaspis,* the localities in question are tentatively assigned to that biozone. *Glyphaspis* species in western America occur in strata representing inner-shelf environments (Deiss, 1939; Schwimmer, 1973), as well as in carbonate shoal and outer-shelf environments (Rasetti, 1951; Hintze and Robison, 1975; Rees, 1986). In the study area, *Glyphaspis* beds seem to represent the inner-shelf environment; in support of this argument, it is noted that sediments containing *Glyphaspis* are orange-tan, soft, poorly fissile, noncalcareous shales, in contrast with the olive-brown, fissile, calcareous shales enclosing the *Bolaspidella* Zone fossils. The *Glyphaspis* beds also contain far fewer of the characteristic siliceous concretions which are interbedded with most local *Bolaspidella* Zone strata. It is therefore hypothesized that regional marine transgression may have occurred during the transition from *Oryctocephalus* to *Bolaspidella* time on the southeasternmost continental shelf.

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APPENDIX

NEW COLLECTIONS

CCЄ-79-5	Siliceous nodules along roadside and adjacent fields, McGee Bend Road, vicinity of Livingston, Floyd County, Georgia. Coordinates 34 × 273, Melson, Georgia/Alabama quad. (This is probably locality 89x in Walcott, 1916a, 1916b.)
CCЄ-85-10	South bank, valley of unnamed drainage, 800 m upstream from debouchment to east side of Coosa River, vicinity of Livingston, Floyd County, Georgia. Coord. 11 × 294, Melson quad.
CCЄ-86-11	South blank of same drainage, 150 m downstream from 85-10. Coord. 14 × 297, Melson quad.
CCЄ-86-10	North bank of same drainage, 80 m downstream from 86-11. Coord. 16 × 298, Melson quad.
CCЄ-87-2	In stream bed of same drainage, 75 m upstream from 85-10. Coord. 4 × 295, Melson quad.
CCЄ-86-15	East bank of Coosa River, north bank of drainage noted above. Coord. 32 × 316, Melson quad.
CCЄ-86-17	Outcrops exposed along east bank of Coosa River approximately 1,000 m north from 86-15. Coord. 27 × 328, Melson quad.
CCЄ-86-16	"Copra's Bluff" on east side of Coosa River at Foster Bend, approximately 700 m north of 86-17. Coord. 28 × 340. (Site also mentioned in Cressler, 1970.)
CCЄ-87-4	Roadside outcrops on both sides of Highway 100, 900 m south of the crossing of Big Cedar Creek, vicinity of Foster Mills, Floyd County, Georgia. Coord. 385 × 164, Livinston, Georgia quad. (This is also locality 142a in Resser, 1938.)
CCЄ-87-12	Roadside outcrops on south side of Black's Bluff Road, 4.6 km east of Route 100, Floyd County, Georgia. Coord. 206 × 294, Livingston quad.
CCЄ-87-13	Roadside outcrop in ditch on north side of Black's Bluff Road, 2 km east of 87-12. Coord. 170 × 306, Livingston quad.
CCЄ-87-14	Roadside outcrops on both sides of Livingston Road, 2.4 km northwest of intersection with Black's Bluff Road, Floyd County, Georgia. Coord. 238 × 358, Livingston quad.

WALCOTT AND RESSER LOCALITIES

89x	Fields around Livingston, Floyd County, Georgia (Walcott, 1916a, 1916b, and see locality CCЄ-79-5).
90x	Chert nodules in fields 5 miles (8 km) east of Centre, vicinity of Blaine, Alabama; no detailed data given (Walcott, 1916b). Same locality indicated as 3 miles (5 km) east of Centre in Resser, 1938.
112	Bedded shales in same area as 90x; no detailed data (Walcott, 1916a, 1916b; Resser, 1938).
92c	Cave Spring, Floyd County, Georgia; no detailed data (Resser, 1938).
141	Roadside near cemetery 1.6 km northeast of Cave Spring, Georgia (Walcott, 1916a, 1916b).
142a	One kilometer south of Big Cedar Creek, north of Cave Spring (Resser, 1938, and see CCЄ-87-4).