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The Trilobite “*Dalmanites*” *maecurua* Clarke, 1890 (Middle Devonian, Amazon Basin, Brazil) and the New Genus *Amazonaspis* (Synphoriidae)

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ABSTRACT

The revision of “*Dalmanites*” *maecurua* Clarke, 1890, from the Upper Lontra Member, Eifelian, Maecuru Formation, Pará State, Amazon Basin, Brazil is presented. The new genus *Amazonaspis* is assigned within the family Synphoriidae. Comparisons are made with other Silurian and Devonian synphoriids, and some paleobiogeographic inferences are presented.

RESUMO

É apresentada a revisão de “*Dalmanites*” *maecurua* Clarke, 1890, procedente da parte superior do Membro Lontra, Eifeliano, da Formação Maecuru, no estado do Pará, da Bacia do Amazonas, Brasil. O novo gênero *Amazonaspis* é atribuído à família Synphoriidae. São feitas comparações com outros synforiídeos silurianos e devonianos, e apresentadas algumas inferências paleobiogeográficas.

INTRODUCTION

Clarke (1890) originally described *Dalmanites maecurua* among other trilobites from the Maecuru and Ererê formations of the Amazon Basin, with ages varying from late Eifelian to early Givetian. The material from the Maecuru Formation (late Eifelian) was

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collected in 1876 by the Imperial Geological Commission, from several localities along the Maecuru River, north of the Teaupixuna rapids, in the state of Pará. Additional material was collected in the same area, by the Orville Adalbert Derby Expedition, conducted by Petrobras in 1986.

Clarke (1900: 15) proposed *Synphoria* as a subgenus of *Dalmanites*, for his new species *Dalmanites (Synphoria) stemmatus* from the Oriskany fauna, Lower Devonian of New York State. He considered that the Brazilian species *Dalmanites maecurua* was closely related to that form as he included it in the same subgenus as *Dalmanites (Synphoria) maecurua* though he did not comment on the assignment (Clarke, 1900: 68). Delo (1935) reviewed the phacopid trilobites and divided the family Dalmanitidae into two subfamilies: Dalmanitinae Reed, 1905, and Synphoriinae Delo, 1935. He considered the Synphoriinae to be characterized by more or less complete distal fusion and elevation of L2 and L3 in the glabella, the reduction of S1 and S2 to submesial pits, and the presence in some forms of spines, denticles, or crenulations on the cephalon and pygidium. He also elevated *Synphoria* to generic status.

In the classification of Richter et al. (1959), the subfamily Synphoriinae was not recognized as valid and *Synphoria* was placed in the subfamily Dalmanitinae. However, Lespérance and Bourque (1971) resurrected the Synphoriinae and Lespérance (1975) subsequently elevated it to family status (Synphoriidae), characterized inter alia by the fusion of L2 and L3. Lespérance recognized two subfamilies within Synphoriidae: the Synphoriinae and the Trypaulitinae.

Campbell (1977) accepted Lespérance's (1975) subdivision of the Synphoriidae into the Synphoriinae and Trypaulitinae, but modified his concept of the family by rejecting the distal coalescence of L3 and L2 as diagnostic and arguing that this feature is widespread throughout the Dalmanitoidea. New criteria proposed by Campbell for recognizing the Dalmanitinae, Synphoriinae, and Trypaulitinae included the spacing of the cephalic apodemes (i.e., the gap between the occipital and S1 apodemes and between S1 and S2); the development of the cephalic borders and doublures; the presence or absence of a genal spine and an epiborder furrow; the thoracic and pygidial architecture, especially the morphology of the pleural furrows and the tips of the thoracic pleurae; and the position of the pygidial apodemes. Thus, according to Campbell (1977), diagnostic features of the Synphoriinae are: gap between S1 and S2 more than 1.5 times that between the occipital apodeme and S1; S1 slightly oblique to the sagittal line and S2 tends to be equidimensional in dorsal view (the shape of the apodeme in S2 produces the transversally short furrow); cephalic border narrow, convex, and poorly defined; lateral parts of the cephalic doublure correspondingly narrow and rather evenly rolled, or with a slight vincular furrow; genal spine (if present) short, lacking an epiborder furrow, tending to be oval in cross section; thoracic pleurae have a wide (exsag.) and well-rounded posterior pleural band, a thin anterior band, and pleural furrow not dominating; pygidial pleurae have well-developed anterior and posterior bands, and the posterior band does not fade toward the border; pygidial apodemes discrete and positioned away from the axial furrow.

Holloway (1981) revised some Silurian dalmanitaceans from North America and also supported this concept of the family Synphoriidae. His diagnosis of the subfamily Synphoriinae was adapted from Campbell's (1977) work with slight modifications to accommodate stratigraphically earlier (Silurian) taxa. The modifications included the shape of the cephalic border (flattened dorsally but rolled downward and inward along the outer margin) and the shape of the pleural tips on the thoracic segments (which can be rounded, pointed, or deflected backward into a spine).

MATERIAL AND METHODS

Specimens studied and figured herein are housed in the Museu Nacional/UFRJ (MN), Rio de Janeiro and Universidade Federal of Rio de Janeiro (UFRJ). For conservational reasons it was not possible to coat these specimens for photography.

Comparisons were made with another Malvinokaffric synphoriinid, *Dalmanitoides*

Delo, 1935, from the Devonian of Argentina; *Fenestraspis* Braniša and Vaněk, 1973, from the Devonian of Bolivia; the North American Devonian synphoriinids *Synphoria stemmata* (Clarke, 1900), *Odontocephalus selenourus* (Eaton, 1832), *Anchiops anchiopsis* (Green, 1832), and *Synphoroides biardi* (Clarke, 1907); and with two Silurian synphoriinids, *Lygdozoon collatum* Holloway (1981) from North America and *Delops obtusicaudatus* (Salter 1849) from Britain. Terminology used here for the descriptions follows Whittington and Kelly (1997).

GEOLOGICAL SETTING

The fossils described here were collected from fossiliferous sandstones that belong to the upper part of the Maecuru Formation (Lontra Member). These sandstones crop out along the Maecuru and Curuá rivers, in the northern border region of the Amazon Basin in Pará State, Brazil (fig. 1), and are overlain by the Ererê Formation (Melo, 1988). The Lontra Member consists mainly of fluvial sandstones and conglomerates, but its uppermost part includes shallow marine tempestites with hummocky cross-stratified sandstones that contain an important Devonian invertebrate fauna recorded by pioneer workers, among whom were Rathbun (1879), Clarke (1890, 1899), and Katzer (1903). The underlying Jatapu Member of the Maecuru Formation consists of bioturbated silty/shaly layers and argillaceous sandstones with chitinozoans and acritarchs, but does not contain marine macrofossils.

There is some palynological evidence that the underlying fluvio-deltaic and neritic parts of the Lontra Member are of Emsian to Eifelian age, while the overlying Ererê Formation is of Eifelian-Givetian ages (Melo and Loboziak, 2003). Thus, the age of the fossiliferous marine sandstones forming the uppermost part of the Lontra Member is constrained to the Eifelian (fig. 2).

The marine invertebrate fauna of the Maecuru Formation is considerably more diverse than other Devonian faunas from Brazil; besides trilobites, it includes brachiopods, bivalves, gastropods, bryozoans, corals, crinoids, and tentaculitids.

SYSTEMATIC PALEONTOLOGY

ORDER PHACOPIDA SALTER, 1864

SUBORDER PHACOPINA STRUVE, 1959

SUPERFAMILY DALMANITOIDEA VOGDES, 1890

FAMILY SYNPHORIIDAE LESPÉRANCE, 1975

SUBFAMILY SYNPHORIINAE DELO, 1935

Amazonaspis, new genus

Type and Only Species: *Dalmanites maecurua* Clarke, 1890, from the Upper Lontra Member, Eifelian, Maecuru Formation, Pará State, Brazil.

Diagnosis: Glabella wide, with sculpture of coarse tubercles. Frontal lobe rhombic in outline, moderately inflated, glabellar furrows reaching axial furrows; S1 very close to occipital ring and oblique, S2 subparallel to S1, inner ends of S3 and S1 joined by shallow longitudinal depression separating inflated L2 and L3 from depressed medial part of glabella. Anterior branch of facial suture running outside frontal glabellar lobe, parallel to preglabellar furrows. Anterior cephalic border increasing slightly in length (sag., exsag.) medially, margin without spines or crenulations. Pygidium with 16–17 axial rings, first three weakly convex (tr.); first four interpleural furrows weakly impressed, subsequent ones line-like; 11 wide and well-developed pleural furrows; narrow border; median keel or mucro absent.

Etymology: In reference to the Amazon Basin, where the type species occurs, together with the feminine Greek word *aspis,* "shield".

Stratigraphic Range: Eifelian, Middle Devonian.

Remarks: Clarke (1890) did not provide a diagnosis for *maecurua* and his description was based upon a syntype series that consists only of a few disarticulated specimens. Although the available material is fragmentary and many morphological details are not very clear, some statements about the affinities of the species can be made. *Amazonaspis* displays at least some of the cranidial characters of synphoriinids, which include: distance between the cephalic apodemes S1 and S2 more than 1.5 times the gap between the

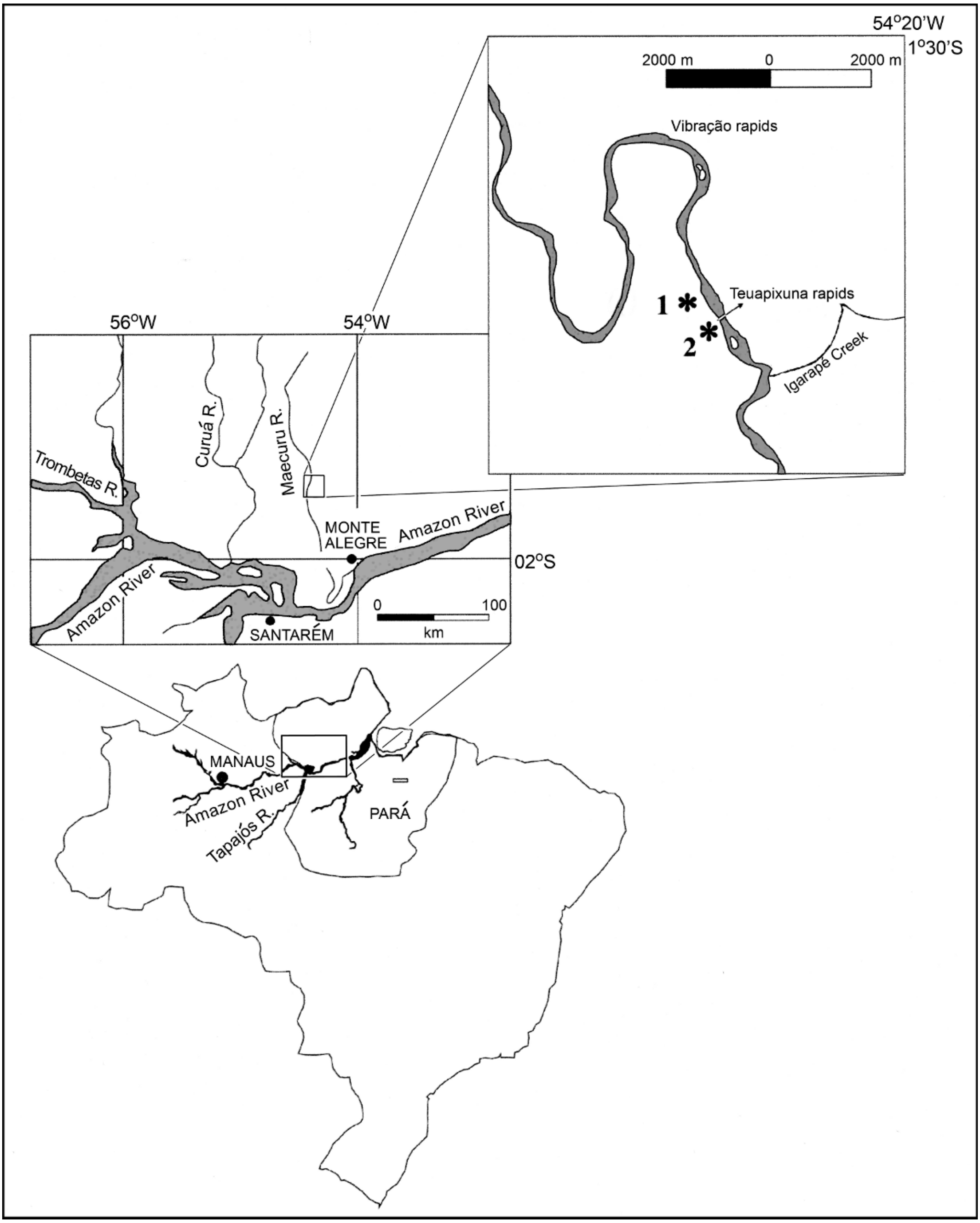


Fig. 1. Location map of the studied fossiliferous outcrops. **1**. Probable collecting site of the Imperial Geological Commission. **2**. Collecting site of the Orville A. Derby Expedition.

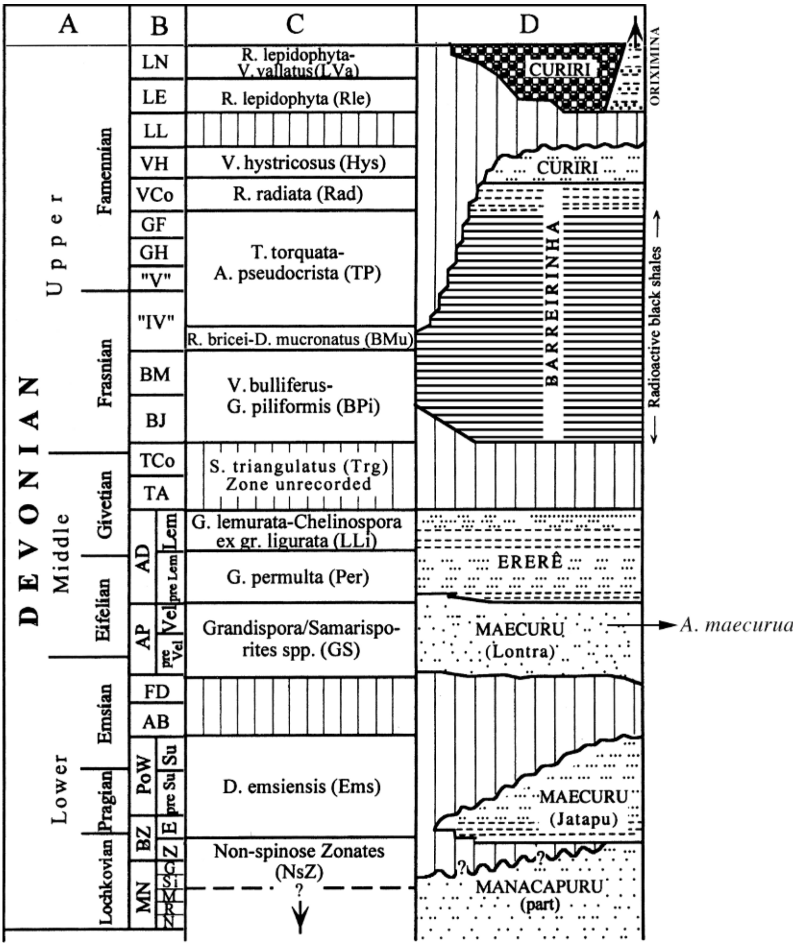


Fig. 2. The Devonian miospore zonation schemes of the Amazon Basin and its relationships with regional rock units, the standard zonal schemes in Western Europe and Petrobras operational palynozonation. **A**. Chronostratigraphy. **B**. Palynozonal scheme in Western Europe. **C**. Palynozonal scheme in Amazon Basin. **D**. Lithostratigraphy.

occipital and S1 apodemes (these apodemes are more nearly equidistant in dalmanitinids); S1 directed obliquely forward adaxially; S2 also oblique; L2 and L3 inflated above the median part of the glabella adjacent to them; genal spine lacks a longitudinal furrow. In addition, the pygidium of *Amazonaspis* lacks a well-defined border; the apodemes are discrete and isolated from the axial furrow; and the pleural furrows are deep and wide (although it is not clear whether these are symmetrical in cross section). It is concluded that the Amazonian material can be placed within the family Synphoriidae rather than the Dalmanitidae.

Comparison of *Amazonaspis* with *Synphoria*: As Clarke (1900) recognized, *Amazonaspis maecurua* and *Synphoria stemmata* are very similar, particularly in the general shape of the frontal glabellar lobe (with a large and rounded anterior margin); the smooth curvature of the posterior cephalic border toward the blunt and rounded genal spines; the smooth occipital ring, without a central spine or tubercles; and the third and second glabellar lobes, which have similar ornamentation. The pygidial margins are also similar, with a slight outward curvature terminating posteriorly at a rounded angle, which does not form a mucro or spine; furthermore, the axis does not reach the posterior margin of the pygidium.

Despite these similarities, these two species differ in a number of characters: the axial furrows are shallower in *A. maecurua*; glabellar lobes L3 and L2 are not fused abaxially in *A. maecurua*; S2 and S3 are wider (tr.) and touch the axial furrows in *A. maecurua*; the occipital furrow is distinct in both species, deep and almost transverse in *Synphoria stemmata*, but slightly convex forward medially in *A. maecurua*; the central area of the glabella in *A. maecurua* bears tubercles but is smooth in *S. stemmata*; the anterior cephalic margin of *A. maecurua* lacks crenulations like those of *S. stemmata*, and the pygidium includes 10–11 axial rings and 10–11 pleural furrows in *S. stemmata* against 16–17 axial rings and 13 pleural furrows in *A. maecurua*.

Amazonaspis maecurua (Clarke, 1890)

figure 3A–H

Dalmanites maecurua Clarke; Clarke, 1890: 23–29, pl. II, figs. 1–3; 6–7; 10; 15.

Dalmanites (*Synphoria*) *maecurua* Clarke; Clarke, 1900: 68.

Dalmanites maecurua Clarke; Katzer, 1903: 212, pl. 15, fig.12.

Dalmanites maecurua Clarke; Lima, 1989: 12.

Dalmanites maecurua Clarke; Silva and Fonseca, 2005: 76, fig. 3C–D.

TYPE MATERIAL: From Clarke's syntypes, MN 3383-I, internal mold of glabella plus small part of left fixigena (figured by Clarke, 1890: pl. II, fig. 2; refigured here as fig. 3C–E) is here designated as lectotype; this designation is made in order to establish a single name-bearing type for the species. Paralectotypes are: MN 3382-I, internal mold of part of the left librigena including genal spine; MN 3384-I, incomplete internal mold of hypostome; MN 3385-I, internal mold of an incomplete thoracic segment; MN 3386-I and MN 3387-I, external and internal molds respectively of an almost complete pygidium.

OTHER MATERIAL: UFRJ-DG 115-Tr, internal and external molds of a cranidium with cheeks missing.

DESCRIPTION: The cephalon is represented only by two very incomplete specimens (MN 3383-I, UFRJ 115-Tr). It is moderately convex (sag., tr.) with the highest point on the posterior part of the frontal glabellar lobe. The anterior cephalic border has a rounded and smooth margin. The axial furrow is broad and shallow. It diverges gently forward to about the middle (exsag.) of L3, thereafter converges to the outer end of S3, from where it becomes deeper and diverges again anteriorly. The lateral glabellar furrows are well developed. S3 is broad, shallow, slightly narrower and deeper proximally, lengthening (exsag.), and diverging forward abaxially. S2 is deeper than S3, directed slightly obliquely backward abaxially, shallowing as it reaches the axial furrow. S1 is situated very close to the occipital ring, curved in a gentle forwardly concave arc parallel to the occipital furrow and becomes shallower distally where it meets the axial furrow. The occipital furrow (S0) is bowed slightly forward medially, becoming narrower and deeper as it approaches the axial furrows. L3 and L2 are inflated above the median part of the glabella adjacent to them. L3 is subtriangular with rounded edges; L2 is roughly rectangular with the edges similarly rounded. L1 is shorter (sag., exsag.) than the occipital ring and extends across the entire width of the glabella, slightly curved forward medially. The occipital ring is longer than L1 (sag.) with a weakly concave anterior margin and convex posterior margin. The median area of the glabella is ornamented with tubercles. The frontal glabellar lobe is relatively large, rhombic in outline, with its anterior margin broad and rounded, and its posteromedian extremity forms a subacute and prominent angle. There is a very faint elongate posteromedian depression on the sagittal line and a circular pit near each of the lateral angles. The frontal glabellar lobe, L3, and L2 are all covered with low tubercles. Those on the frontal glabellar lobe are approx. 1–1.5 mm across and scattered unevenly (2–3 mm apart) over its surface. Tubercles on L3 and L2 are slightly smaller and closer together. A small portion of the left fixigena is preserved, with a small and elevated palpebral lobe situated opposite the anterior half of L2 and the posterior half of L3. The anterior branch of the facial suture delimits a very narrow strip of the gena between the facial suture and the axial furrow, along of the frontal lobe, running close to the glabella. The lateral border is beveled; the lateral and posterior furrows are broad and quite deep. The posterior furrow curves backwards and tapers distally toward the genal spine but does not meet the lateral cephalic furrow (which is wide and also tapers posteriorly). The furrows are separated by a small, narrow convex portion of the free gena. The genal spine is small, diverging laterally, its internal margin forms a smooth concave curve. The hypostome is elongate-linguiforme in outline, with a convex anterior margin. The lateral margins converge in a gently concave curve from the anterior wings to the shoulder, situated opposite the posterior lobe of the middle body; behind the shoulder the posterior margin is parabolic in outline. The anterior lobe is convex, separated from the posterior lobe by a well-developed furrow that is deep and narrower abaxially and very shallow medially. The macula is located approximately midway between the lateral margin and the midline. It is unknown whether the posterior margin was spinose, although Clarke (1890: pl. II, fig. 3) restored its outline with three small spines.

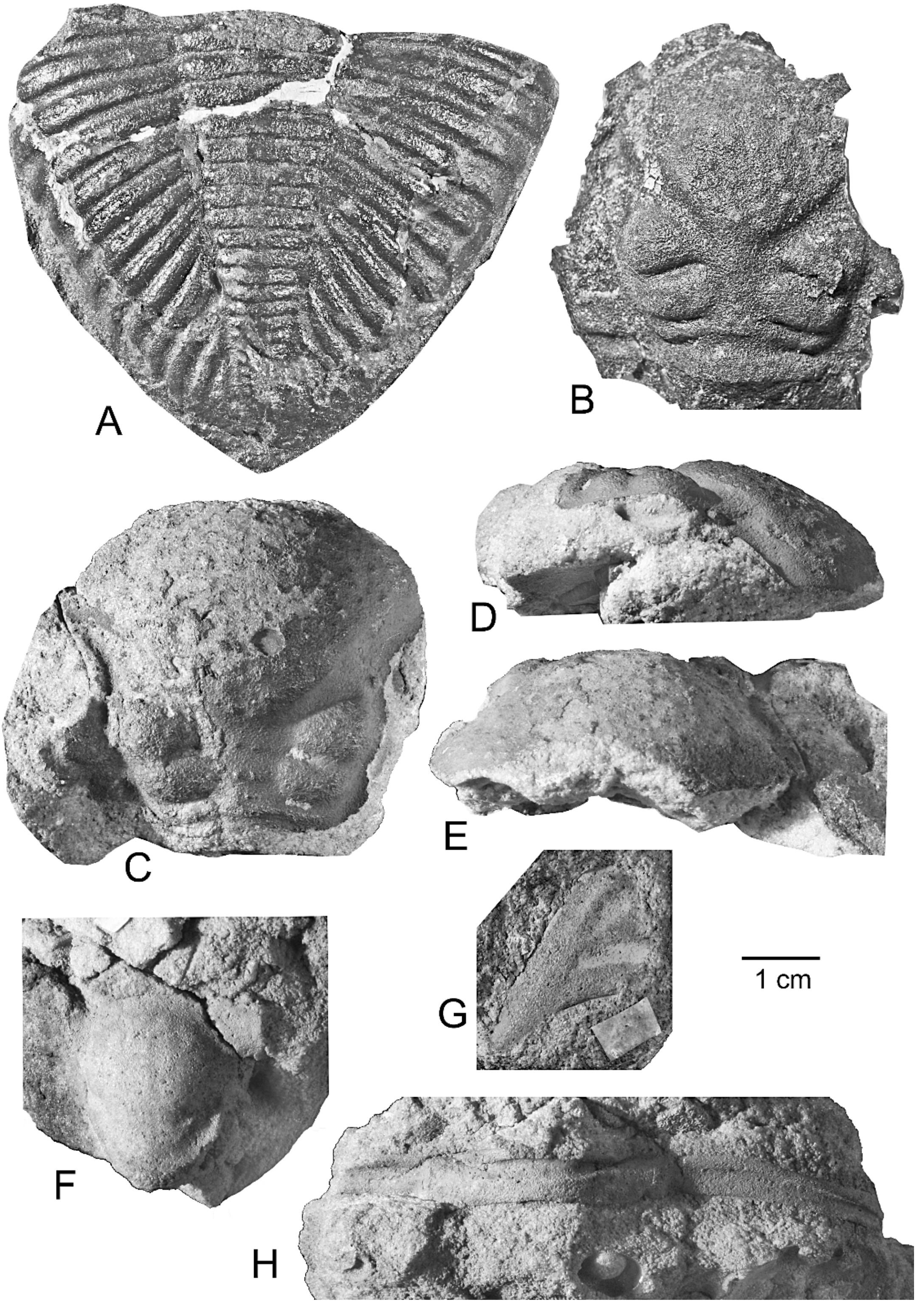
The thorax is represented only by an incomplete internal mold of a single segment lacking the pleural termination. The axial ring is broad (tr.), rounded and thickened near the axial furrow, which is shallow and moderately wide. The posterior margin of the axial ring is gently convex posteriorly while its anterior part is depressed medially and merges with the articulation furrow. The depression expands toward the sagittal line, where it is approximately equal in length to the remainder of the ring. The lateral part of the articulation furrow/apodemal pits has a markedly oblique orientation. The posterior edge of the articulating half ring is transverse and sharply defined over its medial two-thirds. The pleural furrow is well developed, deep, wide, and symmetrical in cross section. The anterior portion of the pleura adjacent to the axial ring is almost transverse, then deflected gently backward and outward.

The pygidium is triangular in outline, approximately 125% as wide as long (sag.) and moderately convex (tr.), with gently rounded margins and an obtuse posterior angle. The axial furrow is well developed, shallow, and narrow. The axis is gently convex in transverse profile, tapered evenly backward, and its anterior width is slightly less than 30% of the maximum pygidial width. The axis includes 16–17 axial rings plus a blunt terminal piece that does not reach the posterior margin of the pygidium. The first three axial rings are arched gently forward medially, but subsequent ones are transverse. The pleurae are gently arched (tr.) and almost flat proximally, but curve more conspicuously toward the margin. There are 11 well-developed pleural furrows plus an inconspicuous final one. The first three pleural furrows curve smoothly to the margin, but subsequent furrows are almost straight and are directed successively more strongly backward, with the last one running very close to the axis. The pleural furrows are wide and deep, shallow distally, and probably symmetrical in cross section, but this is not clear from the specimen. The pleural ribs become obsolete before reaching the margin. Interpleural furrows are narrow and weakly defined, and the subsequent ones are line-like. There are indistinct nodes scattered over some ribs in an apparently random pattern. The marginal area is smooth, scarcely developed into a faint border. Terminal spine or mucro is absent.

Comparison of *A. maecurua* with other North American synphoriinids:

Odontocephalus selenourus (Eaton, 1832), from the Lower Devonian of New York (Onandaga Limestone) is readily distinguished from *A. maecurua* by having an anterior cephalic border that bears a series of distally broadened and coalesced processes, and the pygidium bears a distinct pair of pointed or blunt spines posteriorly (see Whiteley et al., 2002: pl. 125).

Anchiopsis anchiopsis (Green, 1832), from Lower Devonian of New York (Schoharie Formation) differs from *A. maecurua* by having L2 and L3 highly elevated and more or less completely fused; S1 and S2 with adaxial pits connected by transglabellar furrows; the occipital ring bears a median spine; and the pygidium has a long posterior process (see Lespérance and Bourque, 1971: pl. 27, figs. 1–3, 10–11; Whiteley et al., 2002, pl. 120).


A
B
C
D
E
G
1 cm
F
H

Synphoroides biardi (Clarke, 1907) from the Lower Devonian of the Gaspé Peninsula, Canada, differs from *Amazonaspis maecurua* in possessing a trifid anterior cephalic process and crenulated lateral cephalic margin. In addition, its pygidium ends in a blunt, triangular, slightly upturned spine (see Clarke, 1907: pl. 6, figs. 1–12).

Comparison with Malvinokaffric synphoriinids from South America:

These include *Dalmanitoides drevermanni* (Thomas, 1906) from the Lower Devonian of the Talacasto Formation, Jáchal, Argentina and *Fenestraspis amauta* Branišа and Vaněk (1973) from the Lower Belén Formation (Lower Devonian), of Chacoma, Bolivia.

Dalmanitoides drevermanni (see Thomas, 1906: pl. 11, figs. 1–3) is readily distinguished from *A. maecurua* by having five very short frontal processes on the cephalon; S1–S3 connected by indistinct transglabellar furrows; well-developed longitudinal glabellar furrow; a slender pygidial axis reaching the posterior end and extending into a short, slightly upturned point, as well as a higher number of pygopleurae (14).

Branisa and Vanek (1973) suggested that *Dalmanites maecurua* may belong to their new genus *Fenestraspis*, but Eldredge and Ormiston (1979) considered the Brazilian species to be distinct and referred it to a new genus aff. *Fenestraspis.* We are in agreement with Eldredge and Ormiston (1979) that the Brazilian and Bolivian species deserve separation at genus level.

Fenestraspis amauta (interpreted here largely on the basis of specimens in the AMNH collections) differs from *Amazonaspis maecurua* in the presence of small crenulations on the anterior cephalic margin (the anterior margin is smooth in *A. maecurua*); the shape of S1 and S2, which in *F. amauta* are deeper adaxially forming suboval impressions that do not reach the axial furrows (in *A. maecurua* S1 and S2 distinctly meet the axial furrow); the occipital ring bears three spines in *F. amauta*, but is smooth in *A. maecurua*; finally the exoskeleton is densely and coarsely tuberculated in *F. amauta* (the tubercles are not as coarse in *A. maecurua*). The pygidium of *F. amauta* has at least 20 rings and is extended posteriorly over the pygidial margin to form a stout, upwardly directed spine (*A. maecurua* has 16–17 rings and the axis ends in front of the posterior margin, which is smooth and lacks a mucro or spine); there are stout, upwardly directed paired spines on several axial rings situated toward or at the distal ends of the pleural ribs (such spines are absent in *A. maecurua*); and the pygidial apodemes are deeply impressed (exsag.) and connected with the axial furrow (they are comparatively shallow and are not connected to the axial furrow in *A. maecurua.*)

Lespérance (1975) excluded *Fenestraspis* from the Synphoriidae despite the fact that it possesses at least one of the characters he regarded as diagnostic of the family (fusion of L2 and L3). Significantly, it also has S2 reduced in width (tr.) and forming a suboval impression; the distance between cephalic apodemes S1 and S2 is more than 1.5 times that between the occipital and S1 apodemes; and the genal spine does not have a longitudinal furrow, all features now considered diagnostic of the Synphoriidae (Campbell, 1977; Holloway, 1981).

Comparison with Silurian synphoriinids:

Additionally, two Silurian synphoriinid taxa were compared with *A. maecurua*, *Lygdozoon collatum* Holloway, 1981, and *Delops obtusicaudatus* (Salter, 1849). Like *A. maecurua*, these forms have a rounded anterior cephalic margin, a smooth, entire pygidial

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Fig. 3. A–H. *Amazonaspis maecurua* (Clarke, 1890), Upper Lontra Member, Eifelian, Maecuru Formation, Pará State, Brazil. **A**. Paralectotype, MN 3387-I, internal mold of pygidium, dorsal view; **B**. Latex cast of external mold of an incomplete cephalon, UFRJ 115-Tr, dorsal view. **C–E**. Lectotype, MN 3383-I, internal mold of an incomplete cephalon; **C**, dorsal view; **D**, lateral view; **E**, frontal view. **F**. Paralectotype, MN 3384-I, internal mold of an almost complete hypostome, ventral view. **G**. Paralectotype, MN 3382-I, internal mold of part of the left librigena including genal spine, dorsal view. **H**. Paralectotype, MN 3385-I, internal mold of an incomplete thoracic segment, dorsal view.

margin, and the pygidium is not mucronate. However, both forms differ from *A. maecurua* in certain features.

L. collatum from the St. Clair Limestone (Wenlock) of Arkansas differs from *A. maecurua* in having a longer, more slender genal spine; an ornamented occipital ring (with a small tubercle medially and weak nodes distally); a smaller pygidium (9–11 axial rings and 9 pleural furrows); and the hypostome has a deeper posterior border furrow.

Delops Rickards 1965 was originally assigned to the subfamily Zeliskellinae within the Dalmanitidae, but Holloway (1981) considered it to be a synphoriinid. The type species *Delops obtusicaudatus* (Salter, 1849) is readily distinguished from *Amazonaspis maecurua* by several features; the frontal glabellar lobe protrudes in front of the outline of the cheeks; the genal spine is slender; L2 and L3 are fused abaxially; S2 does not reach the axial furrows; the pygidium is smaller (11–13 axial rings and 9 pleural furrows), and the posterior extremity of the pygidial axis reaches the posterior margin of the pygidium.

Three other Devonian species, *Gamonedaspis scutata*, from the Devonian of Bolivia, *Gamonedaspis accola* (Clarke, 1913) from the Ponta Grossa Formation of the Paraná Basin, Brazil, and *Gamonedaspis boehmi* (Knod, 1908) from the Voorstehoek Formation of South Africa were previously assigned to the Subfamily Synphoriinae. However, *Gamonedaspis* Branisa and Vanek. 1963, is now considered a dalmanitinid rather than a synphoriinid (Edgecombe, 1993).

BIOGEOGRAPHIC CONSIDERATIONS

Lespérance (1975) suggested that the Family Synphoriidae was exclusively Devonian and almost restricted to cratonic North America and the Appalachian Region; however, he also included in the family specimens assigned by Haas (1969: pl. 83, figs. 5–8) to *Synphoroides biardi* (Clarke, 1907), from the upper Pragian of Central Chihuahua, Northern Mexico, a region related to the Appalachian geosyncline. He excluded *Fenestraspis* from this family.

Holloway (1981) extended the stratigraphic range of the synphoriinids (and thus the family Synphoriidae) into the Silurian, by including *Lygdozoon* and *Delops*. Here we propose geographical extension of the family Synphoriidae into South America, including species from Argentina, Bolivia and Brazil (Amazon Basin).

Since the pioneering work of Katzer (1897) the affinities of the invertebrate fauna of the Maecuru Formation to both austral (Malvinokkafric) and boreal (Appalachian/Old World) faunas has become well-known (Loczy, 1966; Harrington, 1967; Boucot, 1975, 1988; Carvalho, 1975; Machado, 1990; Melo, 1988). In the Maecuru Formation this "mixed" faunal composition is particularly evident among the bivalves (e.g. *Ptychopteria*, *Leptodesma*, and *Pseudaviculopecten*) and brachiopods (e.g., orthids including *Platyorthis*, *Discomyorthis*, and *Tropidoleptus*; the strophomenids *Megastrophia* and *Protoleptostrophia;* the chonetids "*Chonetes*" *freitasi* and *Montsenets*; the spiriferids *Patriaspirifer*, *Mucrospirifer* and *Plicoplasia*; and terebratulids such as *Amphigenia*, *Derbyina,* and *Paranaia*). The high number of Appalachian genera among the brachiopods led Boucot (1975) and Boucot et al. (1969) to consider the Amazon Basin a southern paleogeographic extension of the Eastern Americas Realm, designated the Amazon-Colombian Subprovince. This faunal "mixing" is not as strongly expressed among the trilobites from the Maecuru Formation, since the majority of these show greater affinity with Malvinokaffric forms (Eldredge and Ormiston, 1979), especially with Bolivian calmoniids. Nevertheless, certain trilobites show some affinity to Appalachian and Old World forms (e.g., homalonotids and synphoriinids).

These Devonian Appalachian immigrants into the Amazon Basin (in the uppermost Maecuru Formation) may have migrated during a widespread Eifelian transgression from the northeast (formerly regarded as late Emsian-Eifelian by Melo, 1988; Carozzi et al., 1973), most probably related to transgression-regression cycle Id of Johnson et al. (1985), which thoroughly flooded this basin. In addition, a marine connection between Brazil and Bolivia may have developed at that time (Loczy, 1966; Melo, 1988; Isaacson and Sablock, 1990), as suggested by the presence

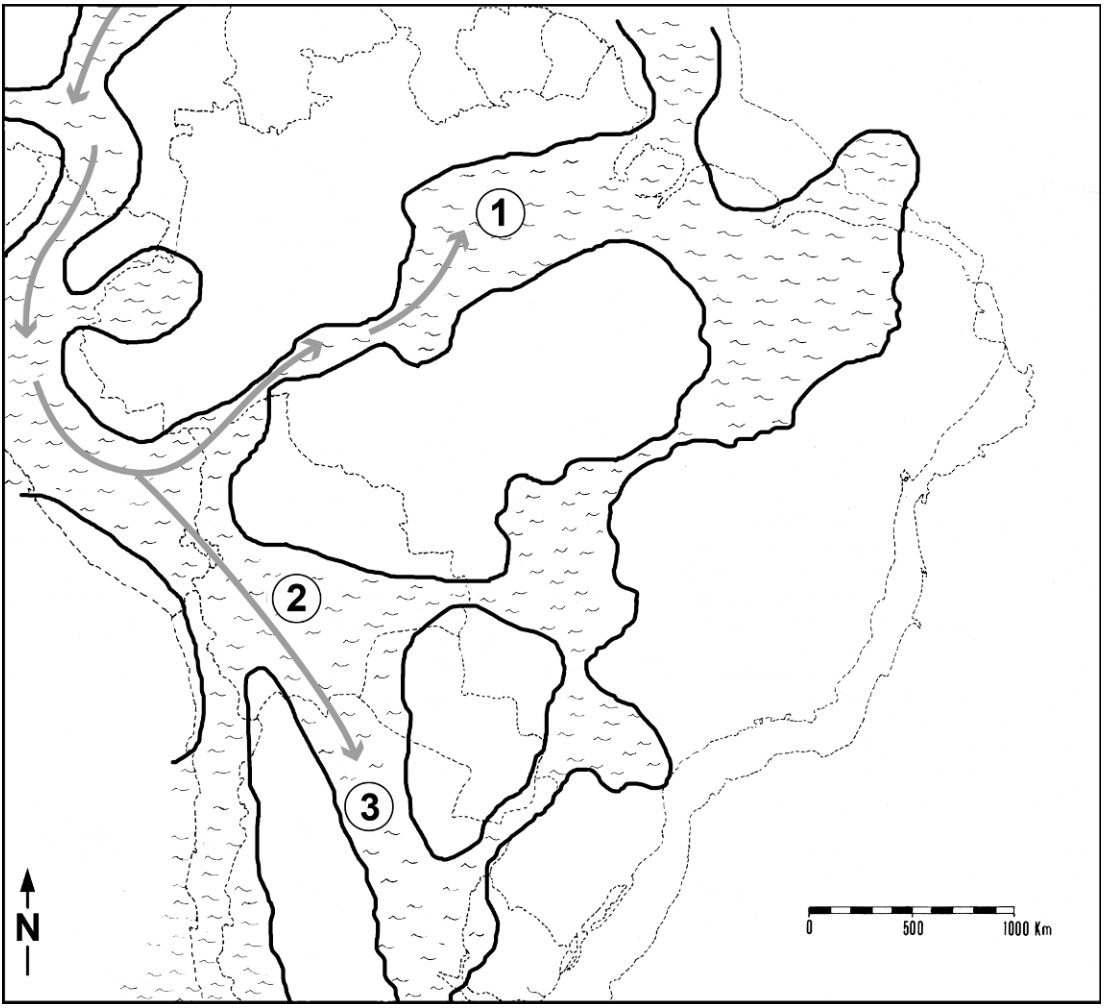

Fig. 4. Paleogeographic map of Brazil and adjoining areas of South America and Western Africa (indicated by dashed lines) in the late Emsian-Eifelian. Arrows indicate inferred migration routes of the Appalachian fauna into Brazil (Amazon Basin), Bolivia, and Argentina. **1**. Amazon Basin; **2**. Bolivia; **3**. Argentina. Ocean represented by wave symbols. Base map after Melo (1988).

of calmoniids similar those from Bolivia in the Maecuru fauna (see fig. 4).

CONCLUSIONS

1. Although *Amazonaspis maecurua* from Brazil is probably closely related to *Synphoria stemmata* from the Devonian of New York, the two forms are considered sufficiently distinct to merit separation at genus level.
2. The genus *Synphoria* is restricted to North America.
3. *Amazonaspis maecurua, Dalmanitoides drevermanni*, and *Fenestraspis amauta* are considered to be Malvinokaffric synphoriinids from South America.
4. The family Synphoriidae occurs in North America, Europe (England, Wales, Czech Republic), and also in South America.
5. Synphoriinids probably dispersed from the Appalachian Province into South America during a major Eifelian transgression.

6. The presence of Malvinokaffric, Eastern American, and Old World trilobites in the Amazon Basin corroborates its previous interpretation as a biogeographic boundary area.
7. The occurrence of synphoriinids in the Amazon Basin and Bolivia suggests a marine connection between these two areas during the Eifelian. This is also in agreement with previous works.
8. Within Gondwana, the Devonian synphoriinids are restricted to its northwestern area (northern Argentina, Bolivia, and the Amazon Basin of northern Brazil) and do not occur outside the Malvinokaffric Realm.

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