

***Megagidiella azul*, a new genus and species of cavernicolous
amphipod crustacean (Bogidiellidae) from Brazil, with remarks on its
biogeographic and phylogenetic relationships**

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Abstract.—*Megagidiella azul*, a new genus and species, is described from Gruta do Lago Azul, a cave in central-western Brazil. With a body length of more than 16 mm, this species is the largest bogidiellid recorded to date. In addition to its large size, the absence of a mandibular palp is a unique diagnostic character for the family Bogidiellidae and alone merits recognition of a new genus. The occurrence of *Megagidiella azul* in an isolated, inland cave habitat marks another exceptional biogeographic record of a bogidiellid amphipod from South America.

Recent biological exploration of caves by speleologists in several karst areas in Brazil has revealed many new localities for gammaridean amphipod crustaceans and other subterranean organisms (Pinto-da-Rocha 1995). One such investigation in the Serra da Bodoquena Karst of central-western Brazil resulted in the discovery of a new stygobiont amphipod genus of the family Bogidiellidae, described below. The specimens were collected from a deep, subterranean lake in Gruta do Lago Azul (Blue Lake Cave).

Megagidiella, new genus

Diagnosis.—Eyes absent. Body smooth, unpigmented. Uronites not fused. Coxal plates longer than wide, not overlapping. Coxal gills occurring on pereopods 4–6; sternal gills absent. Oostegites on pereopods 2–5, sublinear. No sexual dimorphism. Interantennal (lateral) lobe of head narrowly rounded anteriorly. Mandibular palp absent. Maxilla 1: palp 2-segmented; outer plate with 7 serrate spines; inner plate with 3 apical plumose setae. Gnathopod 1 propodus much larger than gnathopod 2 propodus. Pereopods 5–7 with narrow bases.

Pleopods and uropods unmodified. Pleopods biramous; outer ramus 3-segmented; inner ramus reduced, 1-segmented. Uropods biramous; peduncle of uropod 1 with several ventrolateral (basofacial) spines; uropod 3 relatively long. Telson about as long as broad, with shallow excavation.

Type species.—*Megagidiella azul*, new species by monotypy; gender feminine.

Etymology.—The generic name, referring to the relatively large size of the type species, is a combination of the Greek prefix “mega” (= large) and part of the family name.

Remarks and relationships.—Bogidiellids are relatively small amphipods, their body lengths generally range between 1–3 mm, occasionally exceeding 5 mm. With adult specimens reaching a body length of 16.2 mm, *Megagidiella* is an extraordinary exception. The more significant diagnostic character, however, is the absence of a mandibular palp, a morphological reduction to date not reported in the family Bogidiellidae (sensu Stock 1981). Apart from its size and absence of a mandibular palp, *Megagidiella* closely resembles the typical morphology of *Bogidiella*, s. str., e.g., gnatho-

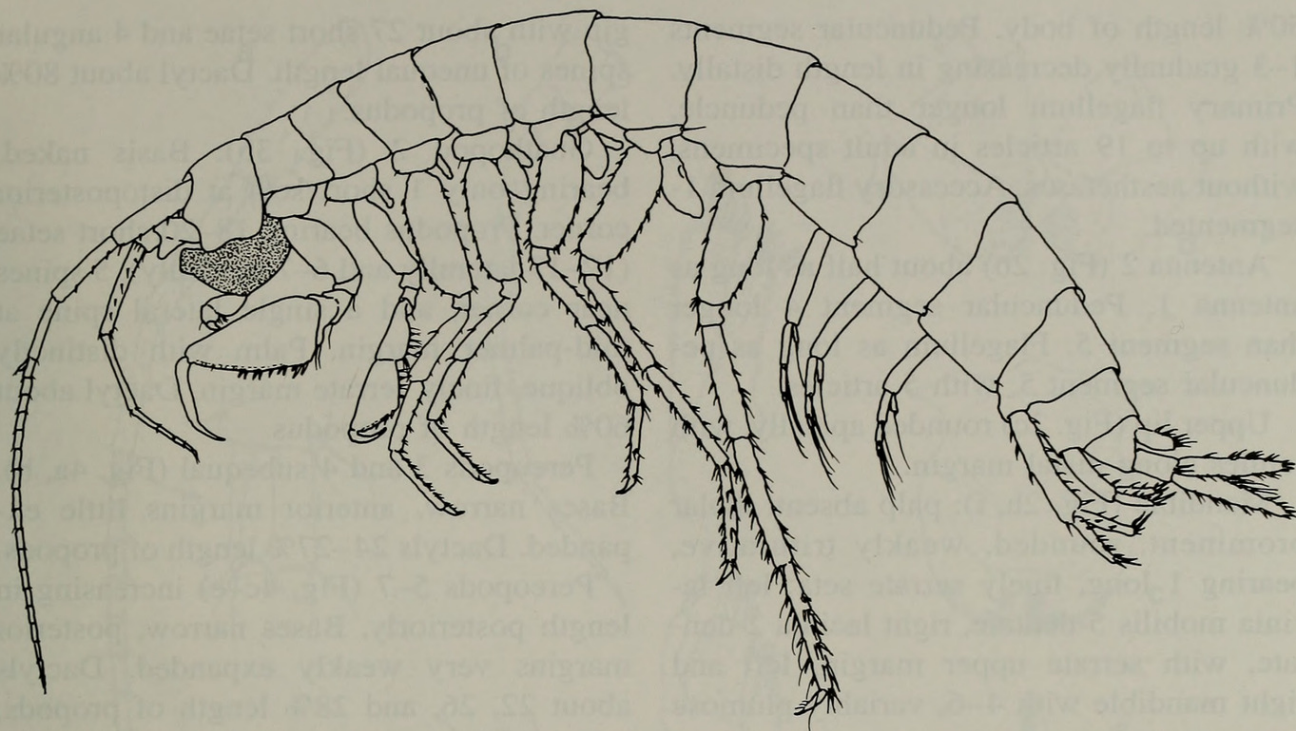


Fig. 1. *Megagidiella azul*, n. sp., holotype female (16.2 mm) from Lago Azul Cave, Bonito, Estado Mato Grosso do Sul, Brazil. Note: buccal mass is shaded.

pod 1 larger than gnathopod 2; pereopods 3–7 with narrow bases; coxal plates not overlapping, wider than long; 3-segmented pleopodal outer ramus; reduced, 1-segmented pleopodal inner rami. Minor exceptions from the general bogidiellid model are a 1-segmented accessory flagellum and the armature of the telson. Of all described bogidiellid species, a 1-segmented accessory flagellum is known only in 4 genera: *Artesia* Holsinger (in Holsinger & Longley 1980), *Kergueleniola* Ruffo, 1970, *Marigidiella* Stock, 1981, and *Parabogidiella* Holsinger (in Holsinger & Longley 1980).

The armature of the telson shows a remarkable resemblance to that of *Spelaeogammarus* da Silva Brum, 1975, from caves in eastern Brazil: *Megagidiella* has 2–3 apical and 3–5 subapical (lateral) spines per telsonic lobe in comparison with 2 apical and 3–4 subapical spines in *Spelaeogammarus*. The combination of 2 apical spines with more than 2 subapical spines is exceptional for bogidiellids. Moreover, the armature and shape of uropods 1–3 show noteworthy similarities in both genera, for example, a row of long setae on the medial

margin of the outer ramus of uropod 3. Along with *Artesia*, from an Artesian Well in Texas, these are the only bogidiellids known with setae on the rami of uropod 3.

Megagidiella azul, new species

Figs. 1–4

Material examined.—Holotype female (16.2 mm), allotype male (15 mm), and 3 paratypes (1 male, 1 female, 1 juvenile), collected by Adrian Boller, 1 July 1991.

Type locality.—Gruta do Lago Azul, northwest of Bonito, Estado Mato Grosso do Sul, Brazil.

The holotype is dissected and mounted on microscope slides in Faure's medium. It is deposited in the Museu Nacional (UFRJ) in Rio de Janeiro, Brazil (MNRJ 13339). The allotype and paratypes are preserved in alcohol and will be retained in the research collection of JRH under the catalog no. H-3487.

Diagnosis.—With the characters of the genus. Largest male 15 mm, largest female 16.2 mm (Fig. 1).

Description.—Antenna 1 (Fig. 2a) about

50% length of body. Peduncular segments 1–3 gradually decreasing in length distally. Primary flagellum longer than peduncle, with up to 19 articles in adult specimens, without aesthetascs. Accessory flagellum 1-segmented.

Antenna 2 (Fig. 2b) about half as long as antenna 1. Peduncular segment 4 longer than segment 5. Flagellum as long as peduncular segment 5, with 5 articles.

Upper lip (Fig. 2c) rounded apically, with setules along distal margin.

Mandible (Fig. 2h, i): palp absent; molar prominent, rounded, weakly tritulative, bearing 1 long, finely serrate seta; left lacinia mobilis 5-dentate, right lacinia 2-dentate, with serrate upper margin; left and right mandible with 4–6, variably plumose accessory spines.

Lower lip (Fig. 2d) bearing setules on outer lobes and on distal margins of inner lobes; inner lobes small but distinct; lateral processes short with bluntly rounded corners.

Maxilla 1 (Fig. 2e): Palp 2-segmented, with 3 apical setae. Outer plate with 7 comblike spines (Fig. 2f), bearing loosely inserted setules on surface and in row along medial margin. Inner plate with marginal setules and 3 apical plumose setae.

Maxilla 2 (Fig. 2g): Outer plate with approximately 24 naked apical setae; apical margin of inner plate bearing about 17 naked setae and 3 plumose setae; both plates with fine setules.

Maxilliped (Fig. 2j): Palp 4-segmented; 3 blunt spines along apical margin of outer plate; apical margin of inner plate with 2 bifid (y-shaped) spines, 4 plumose setae, and 1 naked seta.

Gnathopod 1 (Fig. 3a): Basis naked, bearing only 1 short seta at distoposterior corner. Carpus short, triangular shaped, with 2 setae on pointed posterior lobe. Propodus almost twice as long as broad, approximately twice the size of gnathopod 2 propodus. Palmar margin oblique and even, finely serrate along whole margin, with 5 medial and 5–6 lateral spines; medial mar-

gin with about 27 short setae and 4 angular spines of unequal length. Dactyl about 80% length of propodus.

Gnathopod 2 (Fig. 3b): Basis naked, bearing only 1 short seta at distoposterior corner. Propodus bearing 18–20 short setae (12–13 laterally and 6–7 medially), 5 spines near corner, and a single lateral spine at mid-palmar margin. Palm with distinctly oblique, finely serrate margin. Dactyl about 60% length of propodus.

Pereopods 3 and 4 subequal (Fig. 4a, b). Bases narrow, anterior margins little expanded. Dactyls 24–27% length of propods.

Pereopods 5–7 (Fig. 4c–e) increasing in length posteriorly. Bases narrow, posterior margins very weakly expanded. Dactyls about 22, 26, and 28% length of propods, respectively.

All pereopod bases apparently without lenticular organs.

Coxal plates small, wider than long; plates 1–4 rectangular, plates 5–7 at least 2 times wider than long.

Coxal gills (Fig. 4a, d) present in 3 pairs, ovate on pereopods 4 and 5 and sack-shaped on pereopod 6.

Oostegites (Fig. 3b, 4a, c) small, sublinear, occurring on pereopods 2–5 (not setose in material examined).

Epimeral plates (Fig. 3c) with small, but distinct distoposterior corners, bearing 1 setule each in groove immediately above corner.

Pleopods 1–3 (Fig. 4f) similar. Inner ramus reduced, 1-segmented, with terminal plumose seta. Outer ramus 3-segmented, with 2 terminal plumose setae per segment.

Uropod 1 (Fig. 4g) biramous, outer ramus slightly shorter than inner ramus; rami about 64% length of peduncle. Peduncle bearing 14–15 spines, 3 of which inserted along ventrolateral (basofacial) margin. Outer ramus with 12 lateral spines and 4 apical spines. Inner ramus with 4–5 apical and 5 dorsomedial spines.

Uropod 2 (Fig. 4h): Inner and outer rami subequal, slightly longer than peduncle. Peduncle with 6 spines. Outer ramus bearing

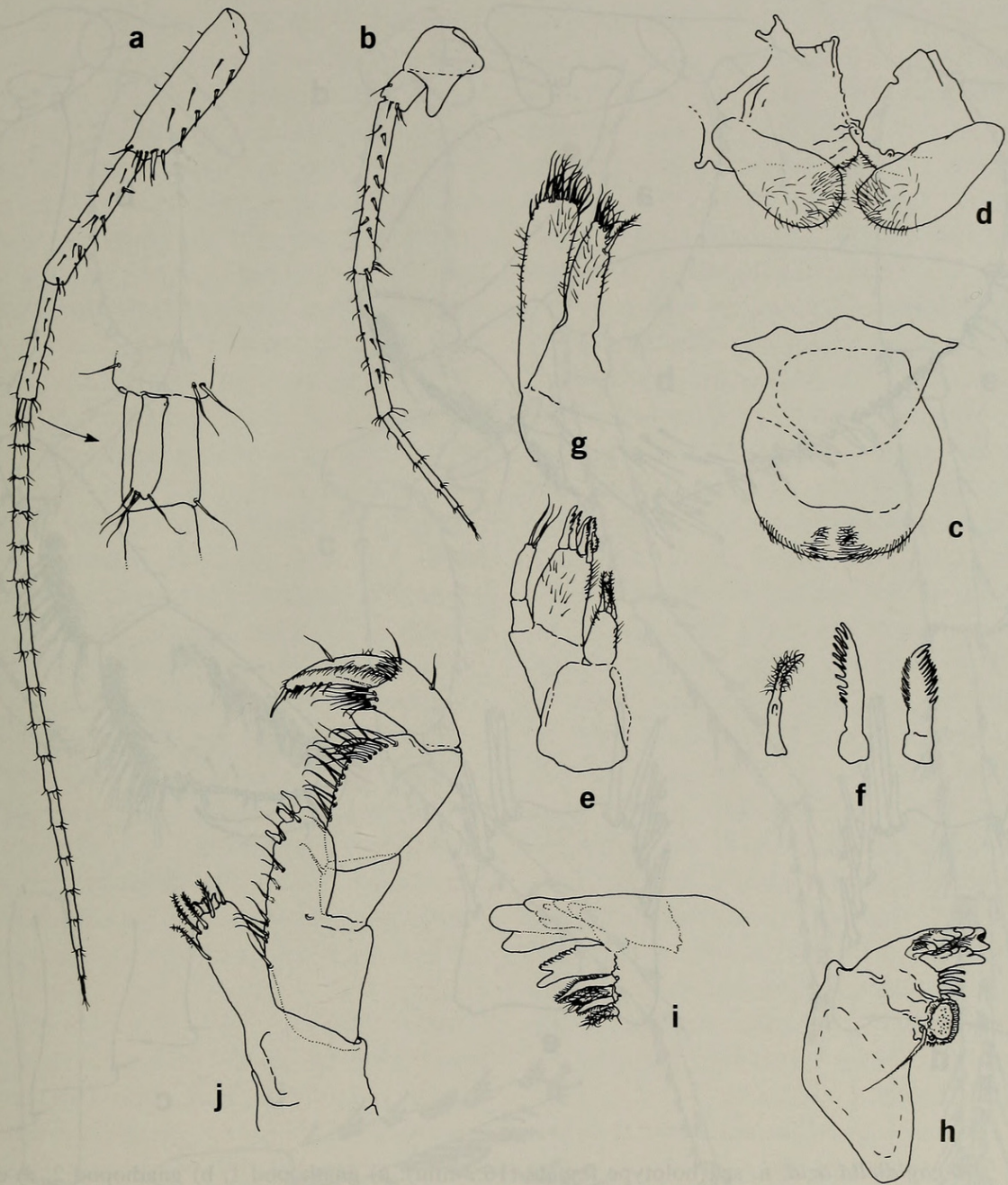


Fig. 2. *Megagidiella azul*, n. sp., holotype female (16.2 mm): a) antenna 1 (accessory flagellum enlarged), b) antenna 2, c) upper lip, d) lower lip, e) maxilla 1, f) enlarged spine and seta types of maxilla 1, g) maxilla 2, h) left mandible, i) incisor, lacinia mobilis, and spine row of right mandible, j) maxilliped.

8 lateral spines and 4 apical spines (2 long ones and 2 short ones). Inner ramus bearing 5 spines along medial and lateral margins and 5 apical spines (3 long ones and 2 short ones).

Uropod 3 (Fig. 4i) long, with subequal, 1-segmented rami. Peduncle about 48% length of rami, with 2–4 spines. Outer ramus with 6 apical spines and 6 sets of spines along lateral margin (with 1–5 spines per set); medial margin bearing 4–5 long

plumose setae. Inner ramus with 6–7 apical spines and about 19 medial and lateral spines (some doubly inserted).

Telson (Fig. 3d, e) about as broad as long; apex with shallow excavation (8% length of telson); each half bearing 2 plumose setae, 2 (sometimes 3) apical and 3–5 subapical spines.

Variation.—Morphological variation, apart from usual differences between juveniles and adults (e.g., number of spines on

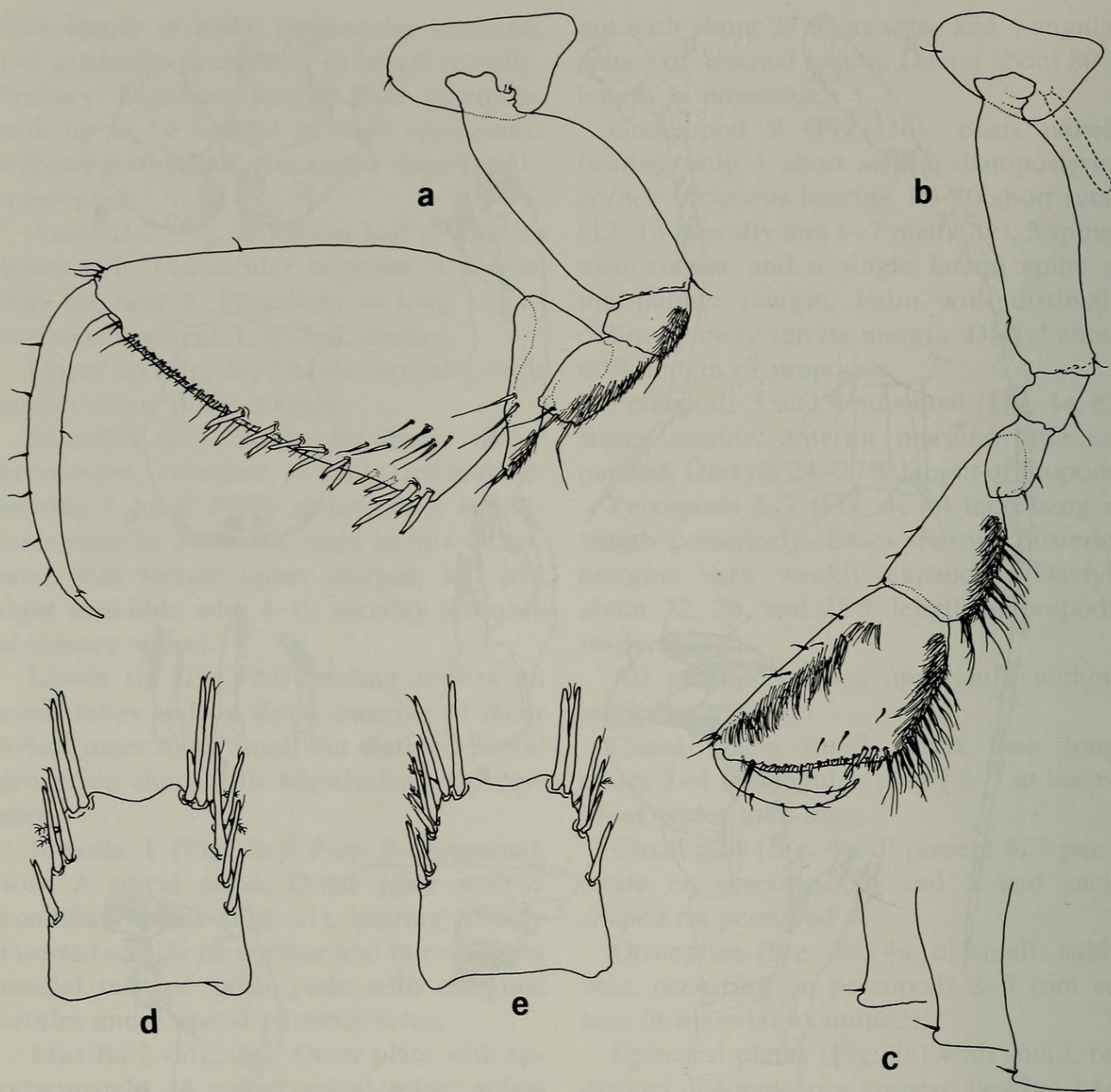


Fig. 3. *Megagidiella azul*, n. sp., holotype female (16.2 mm): a) gnathopod 1, b) gnathopod 2, c) epimeral plates, d) telson, e) telson, allotype male (15 mm).

appendages, flagellum articles, etc.), was observed most obviously in the armature of the telson. The number of subapical spines in the adult females (16 mm in length) varied from 2 to 5 per side, whereas both adult males (15 and 11 mm in length) had a constant number of 3 subapical spines. In the holotype female, a short third apical spine was inserted on the left telsonic apex (Fig. 3d).

Etymology.—The epithet *azul* is based on the name of the type locality and is used as a noun in apposition.

Discussion

The type material was collected at a depth between 6 and 12 m from a deep, turquoise-blue lake inside Blue Lake Cave. The cave is located at the southern edge of the world's largest wetland area along the Serra da Bodoquena in central-western Brazil (Pinto-da-Rocha 1995). Because of the large cave entrance, the lake, about 50 m inside the cave, receives light during some hours of the day (Pires 1987). The water in the lake presumably marks the upper portion of a subterranean aquifer.

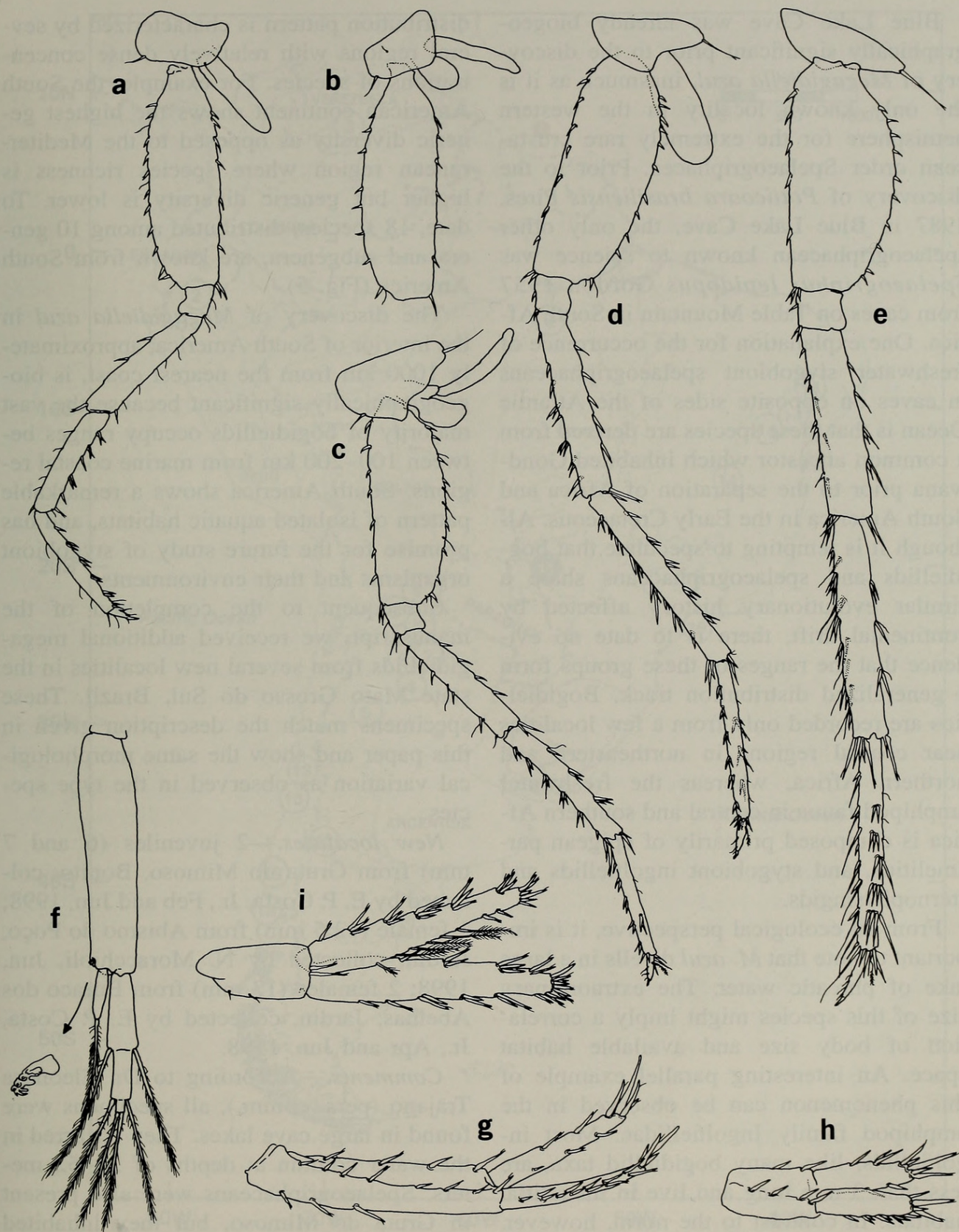


Fig. 4. *Megagidiella azul*, n. sp., holotype female (16.2 mm): a) pereopod 3, b) pereopod 4, c) pereopod 5, d) pereopod 6, e) pereopod 7, f) pleopod 2, g) left uropod 1, h) left uropod 2, i) left uropod 3.

Blue Lake Cave was already biogeographically significant prior to the discovery of *Megagidiella azul*, inasmuch as it is the only known locality in the western hemisphere for the extremely rare crustacean order Spelaeogriphacea. Prior to the discovery of *Potiicoara brasiliensis* Pires, 1987 in Blue Lake Cave, the only other spelaeogriphacean known to science was *Spelaeogriphus lepidopus* Gordon 1957 from caves on Table Mountain in South Africa. One explanation for the occurrence of freshwater stygobiont spelaeogriphaceans in caves on opposite sides of the Atlantic Ocean is that these species are derived from a common ancestor which inhabited Gondwana prior to the separation of Africa and South America in the Early Cretaceous. Although it is tempting to speculate that bogidiellids and spelaeogriphaceans share a similar evolutionary history affected by continental drift, there is to date no evidence that the ranges of these groups form a generalized distribution track. Bogidiellids are recorded only from a few localities near coastal regions in northeastern and northern Africa, whereas the freshwater amphipod fauna in central and southern Africa is composed primarily of epigean parameletids, and stygobiont ingolfiellids and sternophysingids.

From an ecological perspective, it is important to note that *M. azul* dwells in a large lake of phreatic water. The extraordinary size of this species might imply a correlation of body size and available habitat space. An interesting parallel example of this phenomenon can be observed in the amphipod family Ingolfiellidae. Most ingolfiellids, like many bogidiellid taxa, are less than 3 mm long and live in interstitial habitats. In contrast to the norm, however, species of the ingolfiellid genus *Trogloleupia* live in large "open" cave lakes in central and southern Africa and may reach 23 mm in length (Griffiths 1989).

Bogidiellid amphipods have a near world-wide distribution pattern, occurring exclusively in subterranean habitats. Their

distribution pattern is characterized by several regions with relatively dense concentrations of species. For example, the South American continent shows the highest generic diversity as opposed to the Mediterranean region where species richness is higher but generic diversity is lower. To date, 18 species, distributed among 10 genera and subgenera, are known from South America (Fig. 5).

The discovery of *Megagidiella azul* in the interior of South America, approximately 1000 km from the nearest coast, is biogeographically significant because the vast majority of bogidiellids occupy ranges between 100–200 km from marine coastal regions. South America shows a remarkable pattern of isolated aquatic habitats, and has promise for the future study of stygobiont organisms and their environments.

Subsequent to the completion of the manuscript, we received additional megagidiellids from several new localities in the state Mato Grosso do Sul, Brazil. These specimens match the description given in this paper and show the same morphological variation as observed in the type species.

New localities.—2 juveniles (6 and 7 mm) from Gruta do Mimoso, Bonito, collected by E. P. Costa, Jr., Feb and Jun, 1998; 1 female (12.5 mm) from Abismo do Poço, Jardim, collected by N. Moracchioli, Jun, 1998; 2 females (13 mm) from Buraco dos Abelhas, Jardim, collected by E. P. Costa, Jr., Apr and Jun, 1998.

Comments.—According to Dr. Eleonora Trajano (pers. comm.), all specimens were found in large cave lakes. They occurred in the water column at depths of 20–52 meters. Spelaeogriphaceans were also present in Gruta do Mimoso, but they inhabited only the benthic sediments of the lake.

Acknowledgments

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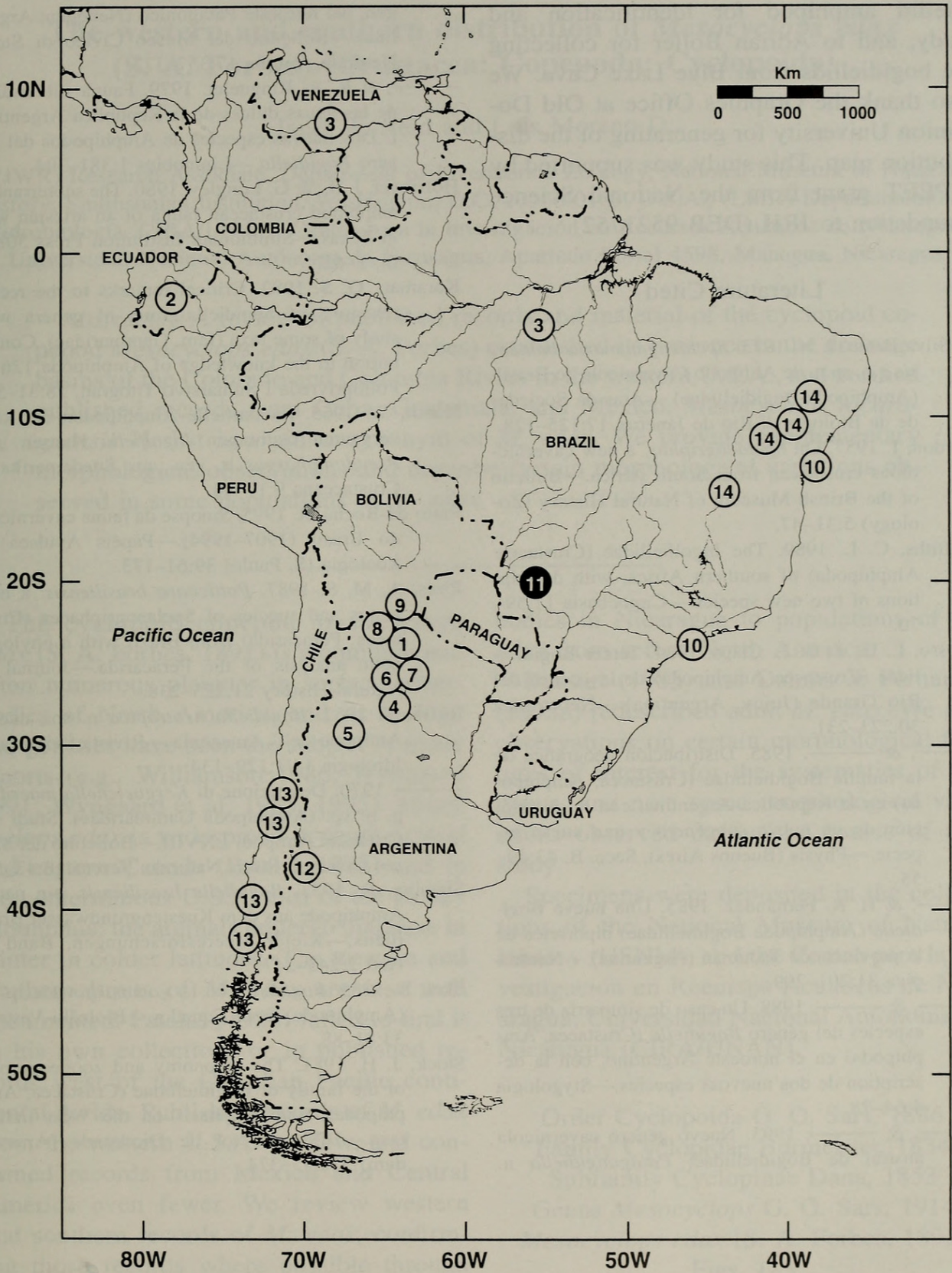


Fig. 5. Geographic distribution of bogidiellid amphipods in continental South America: (1) *Bogidiella cooki* Grosso & Ringuelet (1979); (2) *B. gammariformis* Sket (1985); (3) *B. neotropica* Ruffo (1952); (4) *B. (Dyctiocogidiella) ringueleti* Grosso & Fernández (1988); (5) *B. (Dyct.) talampayensis* Grosso & Claps (1985); (6) *B. (Mesochthongidiella) tucumanensis* Grosso & Fernández (1985); (7) *B. (Stygogidiella) hormocollensis* Grosso & Fernández (1988); (8) *B. (Styg.) lavillai* Grosso & Claps (1984); (9) *Eobogidiella purmamarcensis* Karaman (1982); (10) *Marigidiella brasiliensis* Stock (1981; see also Siewing, 1953); (11) *Megagidiella azul*, n. gen., n. sp. (background darkened for emphasis); (12) *Patagongidiella danieli* Grosso & Fernández (1993) and *P. mauryi* Grosso & Fernández (1993) (both in same locality); (13) *Pseudingolfiella chilensis* Noodt (1965); (14) *Spelaeogammarus bahiensis* da Silva Brum (1975) and *S. spp.*

idiellid amphipod for identification and study, and to Adrian Boller for collecting the bogidiellids from Blue Lake Cave. We also thank the Graphics Office at Old Dominion University for generating of the distribution map. This study was supported by a PEET grant from the National Science Foundation to JRH (DEB-9521752).

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