

First record of troglobitic Hemiptera (Fulgoromorpha: Cixiidae) from La Réunion Island

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Abstract – A new species of troglobitic Cixiidae (Hemiptera: Fulgoromorpha), *Brixia briali* n. sp. is described from a lava tube on La Réunion Island. Information on its ecology, distribution, and comments on its tentative systematic placement into the genus *Brixia* is provided. The new discovery from La Réunion is placed into the context of cavernicolous Fulgoromorpha of the world, their zoogeography, ecology and biology.

Résumé – Première mention d'un Hémiptère troglobie (Fulgoromorpha : Cixiidae) de l'île de la Réunion. – Une nouvelle espèce de Cixiidae troglobie, *Brixia briali* n. sp. provenant d'un tunnel de lave, est décrite pour la première fois à l'île de La Réunion. Des informations sur son écologie, sa distribution ainsi que des éléments permettant d'expliquer sa position systématique dans le genre *Brixia* sont apportées. Cette découverte est replacée dans le contexte zoogéographique, écologique et biologique des Fulgoromorpha cavernicoles recensés dans le monde.

Tropical caves have long been regarded as being largely devoid of obligately cavernicolous invertebrates. Research in lava tubes and limestone caves in the tropics carried out since the 1970ies have challenged this view (Howarth 1972, 1986). Rich and diverse terrestrial and aquatic cave-adapted faunas are now known from many parts of the world, including many tropical regions, including Australia, Mexico, Jamaica, the Pacific Islands (Hawaii, Galápagos) and the Caribbean Islands, to name only a few. Contrary to long-held beliefs that cave-adaptation requires extinction or extirpation of surface populations (e.g., Barr 1968), Howarth showed in his pioneering studies on Hawaiian lava tubes (Howarth 1986) that cave colonization is the result of an adaptive shift, e.g., the exploitation of a precious unutilized food resource, rather than a reaction to unfavorable climatic conditions on the surface. Howarth (1980) synthesized his observations into a semantic model to explain and to predict the zoogeography of specialized cave animals. According to this "bioclimatic model" terrestrial troglobites can be expected "in any region which is old enough and in which there are extensive caves with an adequate mois-

ture supply and a continuous equitable environment and food supply for colonization" (Howarth 1980: 403). All these conditions apply to La Réunion. Logically, the discovery of the first eye- and pigmentless, brachypterous cixiid species on La Réunion did not come totally by surprise, but is another piece in the big puzzle of our knowledge of subterranean biodiversity and the evolution of cave life.

Zoogeography of cavernicolous Fulgoromorpha

The taxon concerned here, the Fulgoromorpha or *plant-hoppers*, have evolved obligately cavernicolous species in many parts of the world (Hoch 2002). In addition to the Cixiidae (> 30 species), four families contain endogean or cave-dwelling species: the Hypochthonellidae (1 species), the Delphacidae (1 species), the Kinnaridae (3 species), and the Meenoplidae (> 10 species). Table 1 summarizes their geographic distribution.

Biology and ecology of cave-dwelling Fulgoromorpha

Cavernicolous Fulgoromorpha suck sap from roots of epigeal vegetation and thus are primary consumers within the cave ecosystem (Howarth 1972, 1981).

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Endogean and truly cave-dwelling Fulgoroidea are found to occur in a variety of subterranean habitats: the interstitial of soil, the mesocavernous rock system, lava tubes, and limestone caves (Hoch 2002). Size and substrate (volcanic or sedimentary rock) of the underground space seem to play a far lesser role than e.g., food availability (occurrence of roots) and humidity. The fact that most obligately cavernicolous Fulgoromorpha species have been found in open lava tubes and limestone caves, may be a collectors' bias, and it is well conceivable that small voids and cracks in the mesocavernous rock system, largely unaccessible to human exploration, are the main habitat, and cave planthoppers only venture in "caves" when the other conditions are replicated (Howarth 1983).

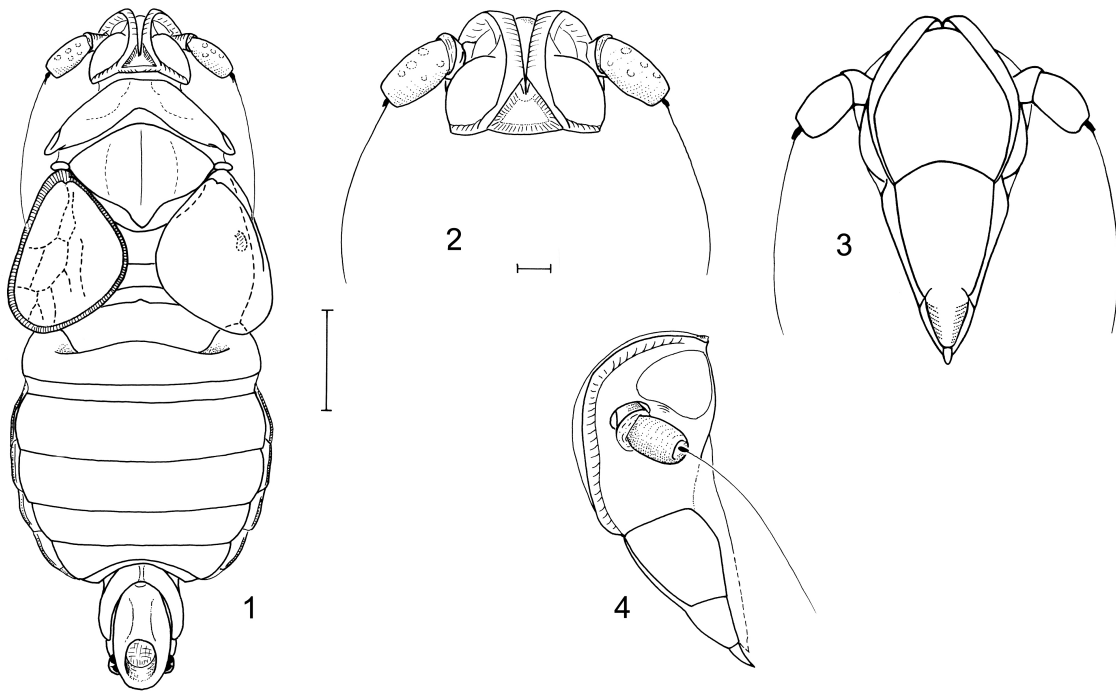
The cavernicolous Fulgoromorpha from La Reunion Island

***Brixia briali* n. sp., Hoch & Bonfils**

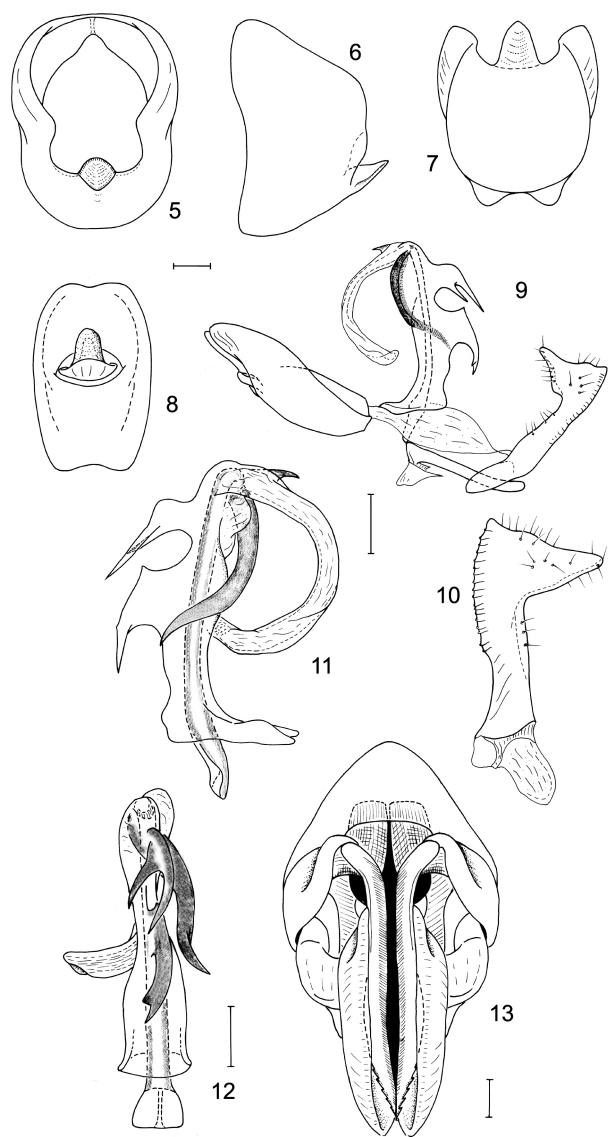
Type material – Holotype male, La Réunion, Caverne de la Tortue (Chemin de Bruniquet), Le Labyrinthe, 9.III. 1997, P. Brial, C. Guillermet & Ledoux leg. (Museum national d'Histoire naturelle, Paris). –

Table 1 – Geographic distribution of cavernicolous Auchenorrhyncha (Hoch, 2002).

Hypochthonellidae	Zimbabwe	China & Fennah (1952)
Delphacidae	New Caledonia	Fennah (1980a)
Kinnaridae	Mexico	Fennah (1973b)
	Jamaica	Fennah (1980b)
Meenoplidae	Australia	Fennah (1973 b)
		Hoch (1990, 1993)
	New Caledonia	Hoch (1996)
	Western Samoa	Hoch & Asche (1988)
	Canary Islands	Remane & Hoch (1988)
		Hoch & Asche (1993)
	Cape Verde Islands	Hoch <i>et al.</i> (1999)
Cixiidae	Madagascar	Synave (1953)
	Canary Islands	Remane & Hoch (1988)
		Hoch & Asche (1993)
	Azores	Hoch (1991)
	Mexico	Fennah (1973b)
		Hoch (1988)
	Hawaii	Fennah (1973a)
		Hoch & Howarth (1999)
	Galápagos	Hoch & Izquierdo (1996)
	Argentina	Remes Lenicov (1992)
	Australia	Hoch & Howarth (1989a)
		Hoch & Howarth (1989b)
	New Zealand	Fennah (1975)
	[Balears]	Racovitza (1907)
		(unconfirmed record)
	[Southern France,	unpublished data
	New Guinea]	



Figures 1-4
Brixia briali n. sp., holotype male. – 1, habitus. – 2, head, dorsal aspect. – 3, same, ventral aspect. – 4, same, lateral aspect. (Scale line = 0.5 mm)



Figures 5-13

Brixia briali n. sp., paratype male. – 5, genital segment, caudal aspect. – 6, same, left lateral aspect. – 7, same, ventral aspect. – 8, anal segment, caudal aspect. – 9, male genitalia, left lateral aspect (anal segment removed). – 10, right paramer, total aspect. – 11, aedeagus, right lateral aspect. – 12, same, ventral aspect. – 13, *Brixia briali* n. sp., paratype female. Female genitalia, ventral aspect. (Scale line = 0.1 mm)

Paratypes: 5 males, 2 females, same data as holotype; 9 males, 2 females, same data as holotype, except 4.V.1997, *P. Brial*, *B. Reynaud* & *J.F. Vayssieres* leg. (Museum national d’Histoire naturelle, Paris; Museum für Naturkunde, Humboldt-Universität, Berlin); 3 males, 1 female, La Reunion, Caverne de La Tortue (Chemin de Bruniquet), Salle du Museum, 4.V. 1997, *P. Brial*, *B. Reynaud* & *J.F. Vayssieres* leg. (Museum national d’Histoire naturelle, Paris).

Additional material: 1 nymph (V instar), same data as holotype, except 4.V.1997, *P. Brial*, *B. Reynaud* & *J.F. Vayssieres* leg. (Museum national d’Histoire naturelle, Paris).

Description – In general appearance highly troglomorphic small cixiid: eye- and pigmentless, brachypterous.

Coloration. Frontal and dorsolateral portions of head pale yellow, area of vertex, lateral portion of head and antennae white. Pro- and mesonotum pale yellow, metanotum white, tegmina translucent. Legs pale yellow. Abdominal segments pale yellow, except for the first abdominal segment which is white. External parts of male and female genitalia pale yellow; ovipositor darkly sclerotized, brownish.

Head. Vertex triangular, at posterior margin about twice as wide as medially long; area shallowly concave. Areolae and transverse carinae at transition to frons not recognizable. Lateral carinae of vertex tape-like, flattened, apically diverging and continuously narrowing into lateral frontal carinae which are sharply ridged and directed anterolaterad. Frons smooth, slightly longer medially than maximally wide. Post- and anteclypeus smooth, together slightly longer than frons. Frontoclypeal suture very shallowly arcuate. Rostrum slightly surpassing metatrochanters. Compound eyes and ocelli absent, former position of compound eye marked by a distinctly vaulted area (no ommatidia recognizable). Basal segment of antennae short, 2nd antennal segment cylindrical, about 2.6 times longer than 1st; flagellum very long: ca. 5.7 times as long as 2nd antennal segment. 2nd antennal segment with placoidal sense organs inconspicuous, beset with fine hairs.

Thorax. Pronotum about 5.7 times wider than medially long, medially about 1.7 times as long as vertex, about as wide as head, posteriorly shallowly incised, surface ± smooth, without median carina, lateral carinae indistinct. Tegulae minute. Mesonotum medially about 3 times as long as pronotum, surface ± smooth, with 3 vanishing carinae. Tegmina strongly reduced, posteriorly not surpassing cephal margin of 2nd abdominal tergite, veins rudimentary. Surface of tegmina smooth. Wings vestigial. Metatibiae laterally unarmed, apically with 6 teeth; 1st and 2nd metatarsal segment apically with 4 teeth, the lateral ones being pronounced strongest. 1st metatarsal segment 1.4 times as long as 2nd and 3rd metatarsal segments together. Pretarsal claws small, slender, aroliae vestigial.

Male genitalia. Genital segment bilaterally symmetrical, in caudal aspect ovate, slightly higher than wide (1.47: 1), ventrally about 5.7 times longer than dorsally; medioventral process spatula-shaped, apically rounded, dorsal surface convex, smooth. Anal segment in dorsal aspect longish ovate, 2.75 times longer than maximally wide, ventrally shallowly concave. Parameres with slender bases, distally dilated into a triangular process; medioventral margin finely ribbed. Aedeagus: basal part (shaft) with two ventral projections which are variable in shape (figs. 9, 11-12), and a long, slender, moveable spine arising from near its apex, in repose curved ventrolaterad to the right side. Moveable, distal part of aedeagus (flagellum) long, slender, in repose curved ± semicircularly to the left side, phallosome distally, with a short, yet strong, rigid spine arising dorsally, near transi-

tion to aedeagal shaft, in repose directed straight dorsolaterad to the right side.

Female genitalia. 7th sternite in ventral aspect triangular, posterior caudal margin straight; ovipositor well developed, orthopteroid, tergite IX truncate, wax-producing area small, weakly defined.

Body length. Male: 2.7–3.45 mm (3.16 ± 0.225 mm), $n = 9$. Female: 3.3–3.6 mm (3.41 ± 0.16 mm), $n = 3$.

Etymology – The species is named after Pierre Brial, member of the “Société d’étude scientifique des cavernes de La Réunion”, who first discovered these insects in La Caverne de la Tortue.

Ecology and distribution – *Brixia briali* n. sp. is known only from Caverne de la Tortue (Chemin Bruniquet), Saint-Paul, Hauts de Plateau Cailloux, La Réunion. Inside the cave, specimens were found in two sections: Le Labyrinthe, and La Salle du Museum (fig. 14, circled areas “A” and “B”, respectively). Both sections are characterized by a high relative humidity (> 97%) and high temperature (medium temperature: 26°C). Adults were observed walking on the floor and the roof of the cave. Only one nymph was observed close to fine rootlets of an unidentified plant, the rootlets mainly being located in the small fissures within the roof of the cave.

Systematic position – The cixiid fauna of La Réunion can be regarded as comparatively well known (e.g., Synave 1959, 1965; Williams 1975; Attié *et al.* 2002). It is still

largely unclear, however, whether the taxa currently interpreted as “genera” are monophyletic groups, as well as the phylogenetic relationships among them and to taxa outside La Réunion. An additional challenge to generic placement poses the strongly modified external morphology of obligate cavernicolous. As observed in nearly all troglotic Fulgoromorpha, characters of the external morphology of the cavernicolous cixiid species from La Réunion strongly differ from those in epigean species: loss of compound eyes, ocelli, bodily pigmentation, as well as the reduction of tegmina and wings. Associated with these obvious troglomorphies are other modifications in body structure and proportion: e.g. a generally depress body shape, reduction of carination of head and thorax. Thus a well-supported placement into any of the existing genera is presently impossible.

Based on the morphological similarities in male genital structures, however, we place the new cavernicolous species tentatively into the genus *Brixia* Stål.

Perspectives

The discovery of an obligately cavernicolous cixiid species from La Réunion not only complements our knowledge of the distribution of troglotic Fulgoromorpha, it also opens up new opportunities of research on the biology, ecology and evolutionary history of cave organisms.

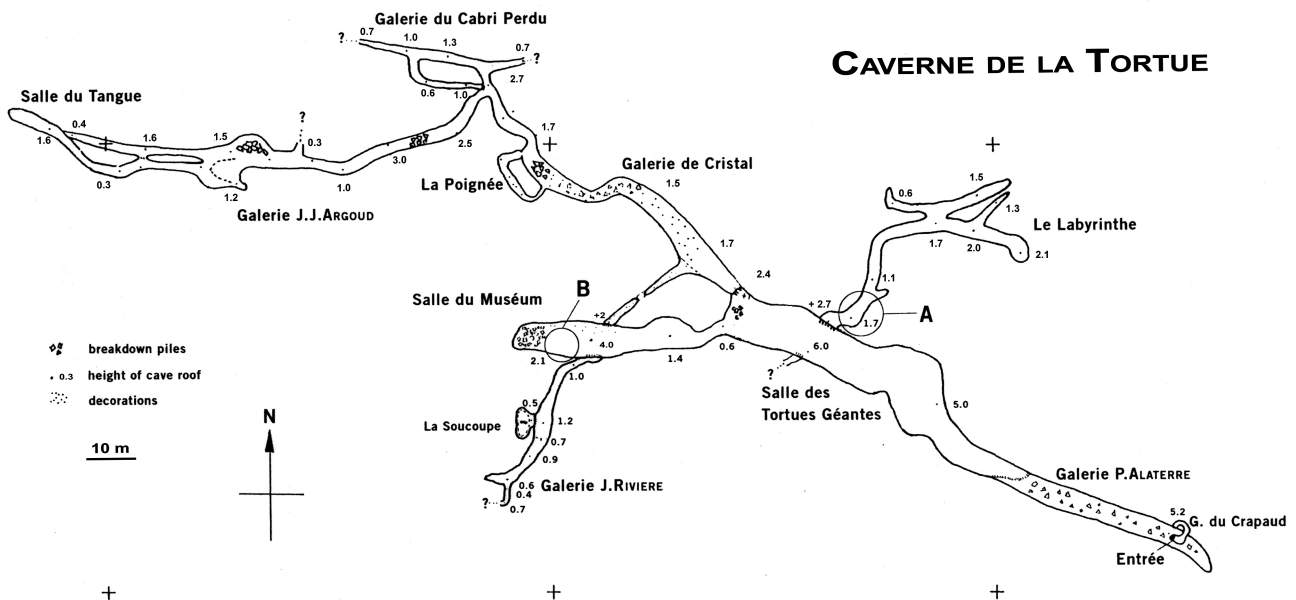


Figure 14
Topographic map of the Caverne de la Tortue, La Réunion Island. (Drawn by P. Brial (29 September 1995, 29 June and 13 July 1996))

So far, most of the existing information on the biology and ecology (e.g., host specificity, reproduction, mating behavior, life history, population structure, role in food web) of cavernicolous Fulgoroidea stems from research on a single taxon: the cixiid genus *Oliarus* on Hawaii (Howarth 1973, 1981; Hoch 2000, Hoch & Howarth 1993, 1999). Supported by the favourable logistics of La Réunion, the accessibility of the study site and the expertise of a near-by university, *Brixia briali* n.sp. now presents a model case for the study of convergent evolution of terrestrial troglobites on young oceanic islands. The population in La Caverne de la Tortue presents a unique gene-pool and the conservation of its habitat must be made a top priority in developing pertinent strategies for the management of La Réunion's natural resources.

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