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CAVE-DWELLING CIXIIDAE (HOMOPTERA, FULGOROIDEA) FROM THE AZORES

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With 11 figures

ABSTRACT. Two new troglobitic *Cixius* species are described from lava tubes on the Azores: *Cixius cavazoricus* n. sp. from Faial Island, and *Cixius azopicavus* from Pico Island. Both species belong to the *C. azoricus* LINDBERG-group. Epigean relatives within this group are known from Terceira, São Jorge and Pico, but not from Faial. Both species are regarded non-relictual troglobites. Notes on the ecology of the two species are given.

Key words: *Cixius cavazoricus*, *Cixius azopicavus*, non-relictual troglobites, lava tubes, Azores.

RESUMO. CIXIÍDEOS TROGLÓBIDOS (HOMOPTERA, FULGOROIDEA) DOS AÇORES. Neste trabalho descrevem-se duas novas espécies troglóbias do género *Cixius* provenientes de furnas dos Açores: *Cixius cavazoricus* n. sp. da ilha do Faial e *Cixius azopicavus* da ilha do Pico. Ambas as espécies pertencem ao grupo de *C. azoricus* LINDBERG. Espécies próximas epígeas são conhecidas das ilhas Terceira, São Jorge e Pico, mas não do Faial. As duas espécies aqui descritas são consideradas como troglóbios não relíquias. São ainda dadas notas sobre a ecologia de ambas as espécies.

INTRODUCTION

The Cixiidae, with about 2,000 species, is one of the largest Fulgoroidea (planthopper) families. A total of 15 cavernicolous species has been described from Madagascar (1 sp.), Hawaii (2 spp.), Mexico (2 spp.), New Zealand (1 sp.), Canary Islands (1 sp.) and Australia (8 spp.).

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Recent biological expeditions to the Azores in 1987 and 1989 organized by P. ASHMOLE, University of Edinburgh, and P. OROMÍ, University of La Laguna (Tenerife), revealed the existence of 2 cave-dwelling cixiid species from lava tubes on the islands of Faial and Pico. Both species belong to the genus *Cixius* LATREILLE, which is represented in the epigean fauna of the Azores Islands by 2 monophyletic and endemic groups, the *C. insularis* LINDBERG 1954 - and the *C. azoricus* LINDBERG, 1954 - groups of species. These two groups reflect the two evolutionary lines within *Cixius* that have originally colonized the island (REMANE & ASCHE, 1979).

The cavernicolous *Cixius* species from the Azores are strongly modified in external characters, which usually undergo alterations during cave-adaptation (reduction of compound eyes and ocelli, wings and bodily pigment). The male genital morphology places the two new species into the *Cixius azoricus* group.

In the data given for the nymphs, Arabic numerals refer to the number of specimens, Roman numerals to the instar.

Cixius cavazoricus n. sp.
(Figs. 1-9)

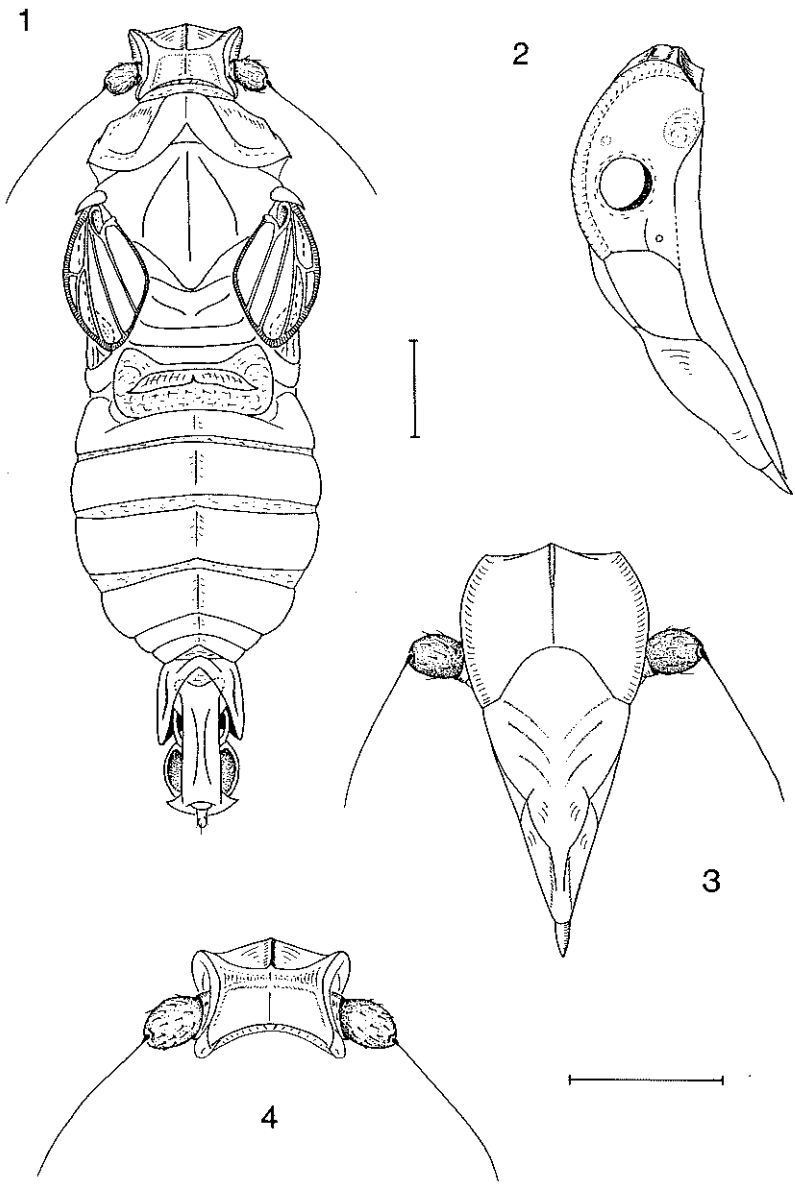
DESCRIPTION

Male: Body light yellow, without any darker pigmentation; tegmina very reduced, translucent, venation light yellow.

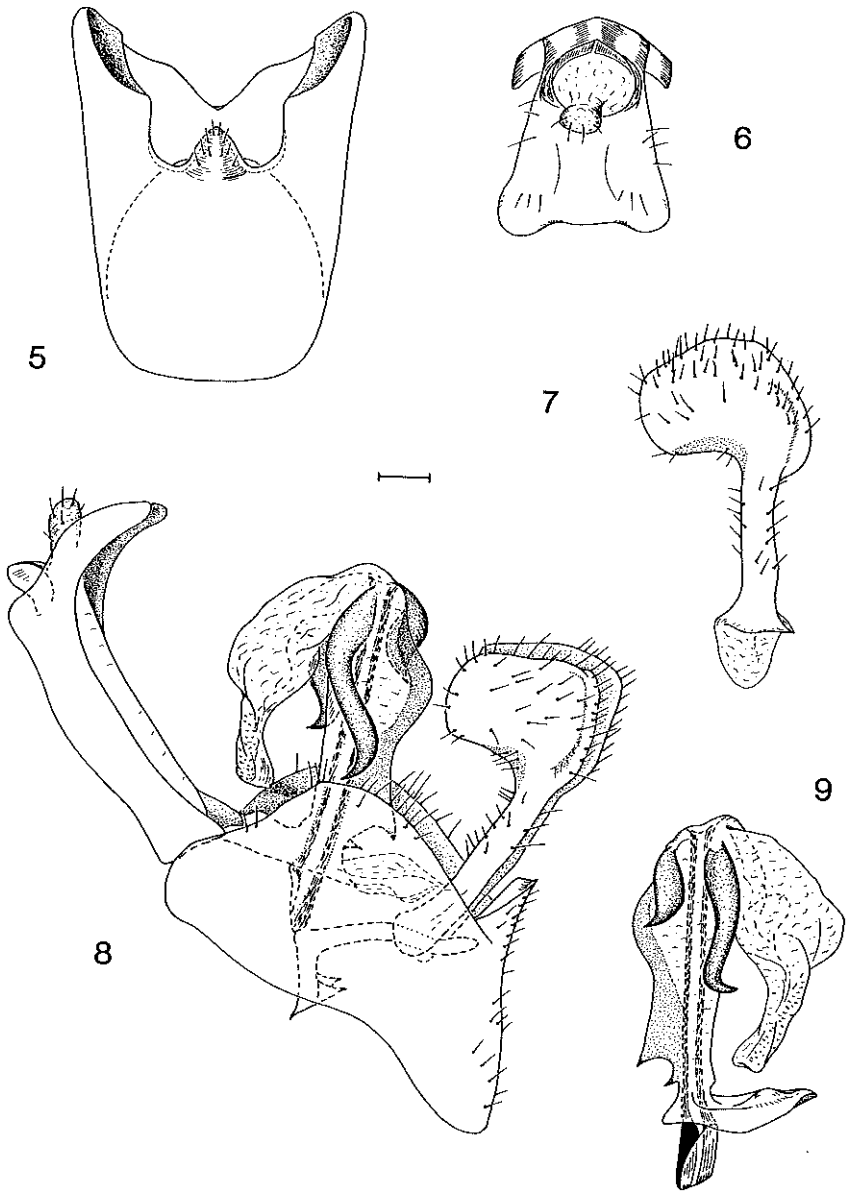
Head (Figs. 1-4): vertex short, about 2.5 x wider than long in middle line, median and transverse carina obsolete, posterior compartments shallowly concave, areolae small. Posterior margin of vertex shallowly concave, vertex separated from frons by a weak transverse carina. Frons about 0.65 x as high as maximum width, surface convex, smooth; lateral carinae distinct, slightly convex, ridged, directed slightly anterolaterad; median carina weakly developed; frontoclypeal suture highly arched. Frontal ocellus absent, lateral ocelli rudimentary. Post- and anteclypeus without a distinct median carina, together medially about twice as long as frons; postclypeus vaulted. Rostrum surpassing post-trochanters. First antennal segment very short, ring-like, 2nd antennal segment ovoid, sensory fields indistinct. Compound eyes absent, former position faintly recognizable by a small vaulted area.

Thorax (Fig. 1): pronotum tricarinate with lateral carinae diverging posteriorly and vanishing laterally; medially slightly shorter than vertex, about 2.7 x wider than head at transverse carina. Mesonotum tricarinate with carinae obsolete, medially about 5 x longer than pronotum. Tegulae rudimentary. Tegmina very short, leaving drumming organ exposed; venation rudimentary. Wings vestigial. Hind tibiae laterally

with 3, distally with 6 spines. Postbasitarsus about 0.9 x length of posttarsal segments



Figs. 1-4. – *Cixius cavazoricus* n. sp., holotype: 1 - Habitus; 2 - Head, left lateral aspect; 3 - Same, ventral aspect; 4 - Same, dorsal aspect. Scale line: 0.5 mm.



Figs. 5-9. – *Cixius cavazoricus* n. sp., male genitalia (holotype): 5 - genital segment, ventral aspect; 6 - anal segment, caudal aspect; 7 - Paramere, maximal aspect; 8 - genital segment, anal segment, aedeagus, connective, parameres, *in situ*, left lateral aspect; 9 - aedeagus, right lateral aspect. Scale line: 0.1 mm.

II and III together. Postbasitarsus and 2nd posttarsal segments each with 4 distal spines. Pretarsal claws slender, arolia small.

Body length: 4.0 mm.

Male genitalia (Figs. 5-9): genital segment in caudal view slightly higher than wide, medially slightly dilated, ventrally about 7 x as long as dorsally. Medioventral process tongue-shaped. Anal segment in dorsal view 3.1 x longer than wide, lateral margins parallel, distally bent ventrad, somewhat dilated, triangular in caudal view. Shaft of aedeagus distally with a median, ear-shaped ridge on its ventral side, near its ventral base with two pairs of short acute teeth. Shaft distally on left side with a movable, sturdy, S-shaped spine, in repose reaching basad to basal 1/3; on right side with two movable spines: dorsal one hook-shaped, about half as long as shaft, in repose directed basad with tip pointing mediad; ventral spine short (about half as long as dorsal spine), stout, in repose pointing ventrad. Movable distal part of aedeagus long, in repose on dorsal side of shaft almost reaching base, left lateral side with a membraneous velum, distal portion around phallotrema granulate, without any spinose processes. Connective submedially slightly bent caudad. Parameres of typical *Cixius*-shape with narrow rod-like base, expanding in distal third to a spoon-shaped structure.

Female: Unknown.

Type material. Holotype male, Azores: Faial, "Furna dos Concheiros" (UTM 03421/42742. Geographic 28° 49' / 38° 36'), 13.X.1989, P. BORGES *leg.*, in col. University of the Azores, Terceira.

Ecology and Distribution. Known only from "Furna dos Concheiros" on the island of Faial, near Vulcão dos Capelinhos.

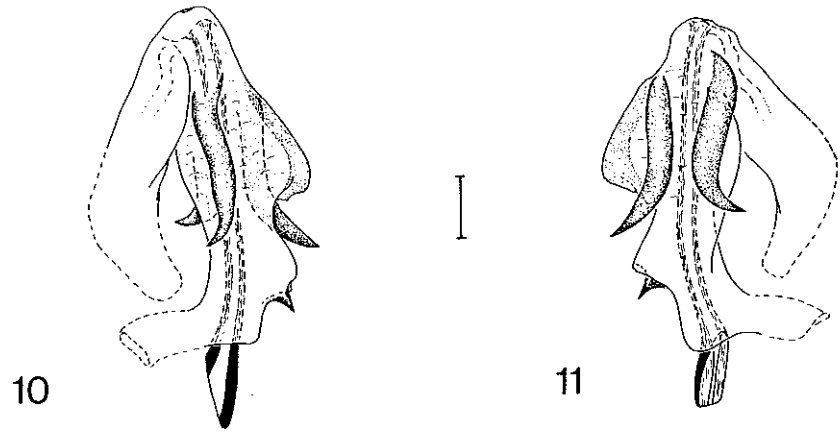
The 37 m. long cave is at 263 m. a.s.l., within a prehistoric lava flow. The only known specimen was collected 31 m. from the entrance, on roots of *Erica azorica* (P. BORGES pers. comm.).

Remarks. *C. cavazoricus* differs from the epigean species of the *C. azoricus*-group in characters evolved during cave-adaptation (the loss of compound eyes and ocelli, the strong reduction of tegmina, wings and bodily pigment) as well as in the shape of the aedeagus.

Cixius azopicavus n. sp.
(Figs. 10-11)

The only two adults specimens of this species were collected during the adult moult, and -- except for their genital structures - are not yet fully sclerotized. Nevertheless, it is recognizable that the species display similar troglomorphies as

C. cavazoricus. The reduced tegmina however, seem - although not fully developed - to be proportionally longer than in *C. cavazoricus*, and display darkly pigmented bristles along the veins.



Figs. 10-11. – *Cixius azopicavus* n. sp., male genitalia (holotype): 10 - Aedeagus, left lateral aspect; 11 - Same, right lateral aspect. Scale line: 0.1 mm.

DESCRIPTION

Male genitalia (Figs. 10-11): only the aedeagus is sufficiently sclerotized, and the spine configuration is readily recognizable. Shaft of aedeagus similar to *C. cavazoricus* medioventrally with an ear-shaped ridge; distally on left side with a movable, sturdy spine, in repose directed basad with tip pointing dorsad, on right side with two movable sturdy spines: dorsal one about half as long as shaft, in repose directed basad with tip pointing mediad, ventral spine inserting basad of dorsal spine, slightly longer and curved ventrad. Basis of shaft and movable distal part of aedeagus damaged.

Female genitalia: although the female genitalia in the only examined specimen are still very soft and partly damaged, maceration in 10% KOH revealed that the ductus receptaculi displays a number of windings >10 (probably 11) (for genital morphology of Azorean cixiids, see REMANE & ASCHE, 1979).

Type material: Holotype male, Azores: Pico,"Furna da Agostinha", 8-12.Aug.1987, J. L. MARTIN, P. ASHMOLE, P. OROMÍ *leg.*, in coll. Zoology Department, University of La Laguna, Tenerife.

Paratypes. 1 female, same data as holotype, in coll. University of the Azores, Terceira.

Additional material.

Nymphs (eyeless, unpigmented): 7 V (3 males, 4 females), same data as adult specimens.

Azores: Pico, Furna do Soldão, 8 nymphs (eyeless, unpigmented): 2 V (1 male, 1 female), 6-10. Aug.1987, J. L. MARTIN, P. ASHMOLE, P. OROMÍ *leg.*, in coll. Zoology Department, University of La Laguna, Tenerife; 6 V (2 males, 4 females), 15.Aug.1989, I. IZQUIERDO *leg.*, in coll. Zoology Department, University of La Laguna, Tenerife.

Ecology and Distribution. Furna da Agostinha is 60 m. a.s.l. under a dense secondary forest of *Picconia azorica* and *Pittosporum* sp.. Nymphs and adults were found in the humid dark cave zone, on the ground, but roots were abundant hanging from the ceiling (P. OROMÍ pers. comm.).

Furna do Soldão is aproximately 30 m. a.s.l.. The surface vegetation above the 600 m. cave consists of a mixed forest with *Pittosporum* sp., *Pinus* sp. and *Erica azorica*. Nymphs were found in the vicinity of roots within the dark cave zone (P. OROMÍ, pers. comm.).

Remarks.

According to the configuration of the male genitalia (general spine configuration of the aedeagus) and also the female genitalia (number of windings of the ducts >10) *Cixius azopicavus* from Furna da Agostinha on Pico also belongs to the *C. azoricus* LINDBERG group. It differs from *C. cavazoricus* in external characters (apparently proportionally longer tegmina, darkly pigmented bristles along veins of tegmina) as well as in genital structures (shape of aedeagus spines). The eyeless nymphs of Furna da Agostinha are presumably conspecific.

It is not certain whether the nymphs from Furna do Soldão are also conspecific with *Cixius azopicavus*. This can only be decided after the examination of associated adult males, and perhaps by applying biosystematic methods, e. g. the analysis of species-specific communication signals (HOWARTH, HOCH & ASCHE, 1990).

DISCUSSION

According to the high degree of troglomorphy displayed by *C. cavazoricus* from Faial as well as by *Cixius azopicavus* from Pico, both species are likely to be restricted to the deep cave zone, and are therefore ecologically classifiable as troglobites (obligate cavernicoles). Although both species belong to the *C. azoricus*-group, each represents a separate evolutionary line that has adapted to the cave environment. Close relatives are still extant on the surface: epigean species of the *C. azoricus* group

have been found on São Jorge, Terceira (*C. azoricus*) and Pico (*C. azoricus azoropicoi* REMANE & ASCHE, 1979). Although no epigean *Cixius* species of the *azoricus*-group has so far been found on Faial (according to REMANE & ASCHE, 1979, records of *C. azoricus* from Faial by LINDBERG (1954) were based on misidentification), the evolution of cave-adapted *Cixius* taxa on the Azores seems due to adaptive shift rather than to extinction of close epigean relatives with a subsequent adaptation to subterranean habitats by troglophilic populations. Parallel cases have been described from other oceanic islands, e. g., Hawaii (HOWARTH, 1983, 1987) and the Canary Islands (MARTIN, IZQUIERDO & OROMI, 1989). Thus *C. cavazoricus* from Faial can at the most be regarded a "rélicte insulaire" (MARTIN, IZQUIERDO & OROMI, 1989), i. e., a cavernicolous species which today has no close epigean relatives on the same, but on neighbour islands.

It seems remarkable, however, that in the Azores the adaptive shift to subterranean habitats has so far been observed only in the *C. azoricus* group which is less speciose in surface habitats (2 taxa: 1 species, 1 subspecies) than the *C. insularis* group (6 taxa: 5 species, 1 subspecies) (REMANE & ASCHE, 1979). Considering the geological history and their colonization by epigean cixiids the Azores have a high potential for the discovery of many more troglobitic cixiid species.

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