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DESCRIPTION OF THE NYMPH AND THE PHYLOGENETIC  
RELATIONSHIPS OF *CALLIARCYS* EATON FROM PORTUGAL  
(EPHEMEROPTERA: LEPTOPHLEBIIDAE)

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With kind regards  


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SUMMARY

The nymph of *Calliarcys* is described for the first time from specimens collected in Portugal. The distribution and biology of *C. humilis* are given. The phylogenetic relationships of *Calliarcys* to other Palearctic and related Oriental Leptophlebiidae are discussed. A new nymphal key to these genera is included.

RESUMO

A ninfa de *Calliarcys* é descrita pela primeira vez a partir de espécimes colhidos em Portugal. Indica-se a distribuição e biologia de *C. humilis*. São discutidas as relações filogenéticas de *Calliarcys* com outros Leptophlebiidae da região Paleártica e da Oriental relacionados com aquele. Inclui-se uma chave de identificação das ninfas para estes géneros.

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INTRODUCTION

Eaton (1881) established *Calliarcys* for a new species *C. humilis* which was known from a series of adults collected in Portugal. Until recently no other specimens of *Calliarcys* were collected and the nymph remained unknown.

One of us (Dr. Terra) collected nymphs of *Calliarcys* in Portugal and reared them. These specimens were discussed in Terra (1972). Herein we are describing the nymph of *Calliarcys* and discussing the distribution, biology and phylogenetic relationships of the genus.

RESULTS

Genus *Calliarcys*

*Calliarcys* Eaton, 1881:21; 1884 (1883-88):121; Lestage, 1917:350; Kimmins, 1960:296; Peters & Edmunds, 1970:184.

Mature nymph. — Head prognathous. Antennae  $3\frac{1}{2}$  times as long as maximum length of head. Mouthparts: long, dorsal hair on labrum as in Fig. 9; submedian areas of hair ventrally; anteromedian emargination without denticles,

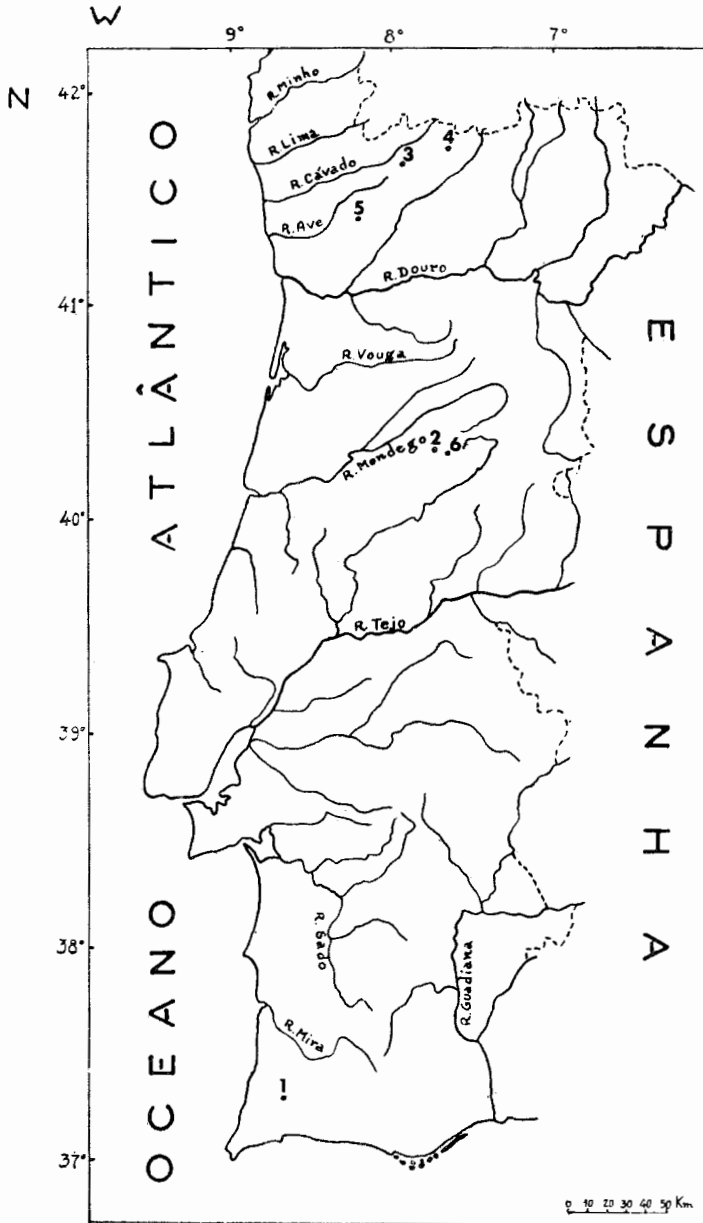


Fig. 1. Distribution of *Calliarcys humilis* Eaton in Portugal. Small numbers correspond to locality numbers in text.

thickened hairs present on lateral margins (Fig. 10). Left mandible as in Fig. 7. Lingua of hypopharynx rectangular with deep, median and paired, submedian clefts (Fig. 8); superlingua of hypopharynx as in Fig. 8, with a row of hair along anterior margin, lateral margins acute. Segment 2 of maxillary palpi a little longer than segment 1; segment 3 of palpi subequal to length of segment 2, triangular; hair on maxillae as in Fig. 6. Labium as in Fig. 11; paired, large, bulbous lobes on venter of mentum as in Fig. 11; segment 2 of palpi  $\frac{3}{4}$  length of segment 1; segment 3 a little longer than segment 2, triangular; glossae ventral to paraglossae. Long, fine hair on entire body. Legs (Figs. 2-3): apex of claws hooked and narrow, denticles on claws equal sized (Fig. 3); pale, long hair dense on prothoracic tarsi. Gills on segments 1-7 alike, slender, gills forked  $\frac{1}{2}$  length of lamellae; main trunk of tracheae along median line of lamellae, main trunk branched, tracheae pigmented. Posterolateral spines on abdominal segments 8 and 9. Terminal filament a little longer than cerci; long dense hair along entire length of caudal filaments; length of caudal filaments equal to length of head and body.

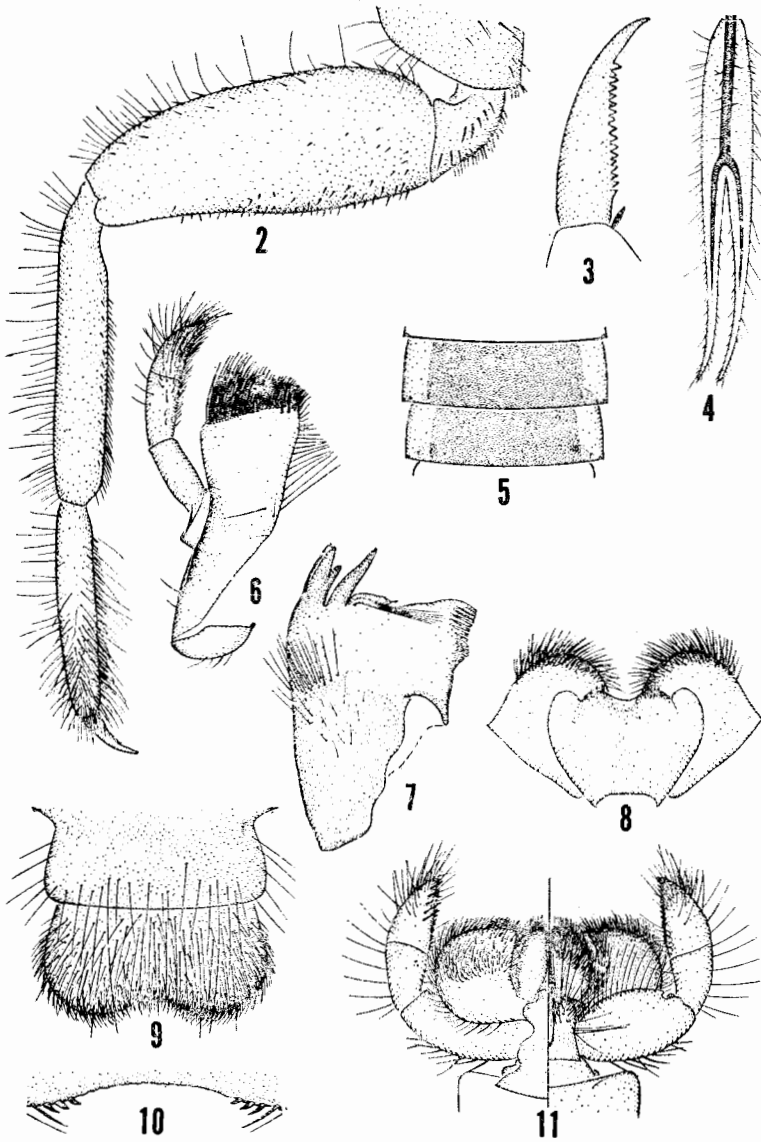
*Calliarcys humilis* (Figs. 2-11)

Mature nymph. — Head light brown, dorsum washed lightly with darker brown. Thorax light brown, carinae darker. Legs light brown. Abdomen: light brown, terga washed uniformly with dark brown except along lateral margins, light anteromedian and anterosubmedian marks on terga 2-9 as in Fig. 5; sterna washed with brown. Gills opaque, tracheae black. Caudal filaments light brown.

Specimens. — The descriptions were based on the following specimens from Portugal: 26 nymphs, Ribeira d'Alva, Serra da Estrela, nr. Sabugueiro, 1000 m, 1-VI-1971; 4 nymphs, Rio Vizela, nr. Golães, 250 m, 19-IV-1973. All specimens were collected by Dr. Terra and are in alcohol. Additional specimens are listed in Terra (1972) and are in Dr. Terra's collections. Association of the nymphs and adults is by rearing. Ten nymphal specimens each are deposited in the collections of Florida A & M University and the University of Utah, Salt Lake City. Five nymphal specimens each are deposited in the collections of the National Museum of Natural History, Washington, D. C., and the British Museum of Natural History, London.

Distribution and biology. — Rev. A. E. Eaton collected the first specimens of *Calliarcys humilis* during a field trip to Portugal in 1880. He collected imagos in Serra do Monchique, Algarve, the southernmost province, and Serra da Estrela, near Sabugueiro, in the center of Portugal.

Fig. 1 is a map listing all localities where *C. humilis* has been collected. Locality numbers correspond to numbers in Fig. 1.



Figs. 2-11, nymph of *Calliarceys humilis* Eaton. Fig. 2, fore leg. Fig. 3, fore claw. Fig. 4, gill 4. Fig. 5, abdominal segments 5-6, dorsal view. Figs. 6-11, mouthparts: Fig. 6, ventral view of right maxillae; Fig. 7, mandible; Fig. 8, hypopharynx; Fig. 9, dorsal view of labrum and clypeus; Fig. 10, anteromedian emargination of labrum enlarged; Fig. 11, labium, with ventral surface on right and dorsal surface on left side of drawing.

1. Serra do Monchique, Algarve, on the northern slopes of Foia, 700 m (collections by Eaton).
2. Serra da Estrela, Ribeira d'Alva, south of Sabugueiro, 1000 m (collections by Eaton and Terra).
3. Rio do Saltadouro, Ruivães, 500 m (collections by Terra).
4. Serra do Barroso, Rio Beça, Barracão, 800 m (collections by Terra).
5. Rio Vizela, nr. Golães, 250 m (collections by Terra).
6. Serra da Estrela, Ribeira de Loriga, near Loriga, 1000 m (collections by Terra).

*C. humilis* can be found at altitudes as low as 250 m, but the species prefers and is most abundant at altitudes over 700 m. At these higher altitudes *C. humilis* is found in the swift rocky mountain streams and is likely to choose the less swift waters near banks, living among the roots of marginal vegetation, where some organic matter and silt accumulate.

On 16-IV-1971 during a flood in Rio do Saltadouro, a mountain brook at 500 m, nymphs could scarcely be found in the main stream, but were rather abundant in a diversion channel to a water mill. This is a small channel no more than 1.5 m wide and 40 cm deep with gravel bottom, and the nymphs were found mainly in a bend where some debris accumulated against the marginal grass.

Except at very high altitudes mature nymphs can be found from March through April. In a small river, Rio Beça, at an altitude of about 800 m, adults were emerging massively on 18-IV-1973. I (Terra) could not visit this station again until the end of June, and neither nymphs nor adults of *Calliarcys* could be found. On the other hand at higher altitudes I have not made any collections before June. In Serra da Estrela at 1000 m altitude I found abundant nymphs on 1-VI-1971, in Ribeira d'Alva, near Sabugueiro. On 19-VI-1973, I could not find any nymphs at this locality or in Ribeira de Loriga at the same altitude, but in this latter locality I collected some adults.

Other Leptophlebiidae nymphs are found living in the same streams as those of *Calliarcys*, but generally not at the same time though their nymphal periods may partially overlap. Such species are *Paraleptophlebia submarginata* (?), *Habrophlebia* sp., and *Habroleptoides nervulosa* (?).

Rio Beça is a small river which has its higher course at a mean altitude of 800 m near the top of the mountain. The bed is mainly rocky and runs through heaths and altitude pastures, and a little lower through improved and watered meadows (this is all-year watering to prevent freezing in winter). At this locality I found *Paraleptophlebia* quite abundant in November, 1972. In a collection of nymphs made on 9-IV-1973, I still found one nymph of *Paraleptophlebia* among those of *Calliarcys*. The habitat of *Paraleptophlebia* is a little different as it chooses swifter

waters preferring the stones on the bottom. On a more recent occasion (5-IV-74) I collected some male imagos of *Paraleptophlebia* in a tributary stream of Rio Beça. It was before noon and the imagos were flying near the stream, some going rather high. The nymphs were also very abundant in the water.

*Habrophlebia* is the most widespread leptophlebiid in Portugal. It is more common at low altitudes where it is found mainly in small streams of little flow and slow waters, but it can also be found at high altitudes in rocky streams. In Rio Beça some young nymphs were collected with those of *Calliarcys* on 18-IV-1973, but *Habrophlebia* is mature and more abundant during June and July. In mountain streams *Habrophlebia* frequents the same habitats as *Calliarcys* looking for calmer waters near the banks. The adults emerge mainly in July.

*Habroleptoides* is found more or less in the same conditions as *Habrophlebia* though less common and with a preference to mountain streams. In Rio Beça one very young nymph was found on 18-IV-1973, but mature nymphs occur mainly during July; however, I have collected one male imago on 24-V-74 in Ribeira de Cortes, near Paúl, in the southern slopes of Serra da Estrela at an altitude of 450 m.

I have made a large collection of imagos of *Calliarcys* only once. This was on 18-IV-1973, and in that portion of Rio Beça which flows through watered meadows («lameiros»). The slope of the river bed is gentler there, and the rocky bottom alternates with gravel deposits. The water leaves, in mid-stream, some tufts of grassy soil. Mature nymphs were quite numerous especially in the rocky parts which were partially covered with water mosses. The imagos and subimagos were found by the river bed among the vegetation, but mainly in a bushy slope on the right bank of the river to which they were being pushed by the wind. They were swarming, though a little scattered, in late afternoon and evening not more than 1.5 m above the bushes, or about 2.0-2.5 m above the ground. The next morning only some individuals could be found among the bushes.

In Serra da Estrela I have collected five imagos (3 males, 2 females) in Ribeira de Loriga at 1000 m altitude on 19-VI-1973. They were found in the vegetation around a small pool formed by the rocks of this mountain brook.

#### DISCUSSION

*Calliarcys* is most closely related to those genera of Leptophlebiidae listed by Peters & Edmunds (1970) as daughter line I. However, the nymphs of *Calliarcys* can be distinguished from these genera and all other genera of the Leptophlebiidae by the following combination of characters, (1) the middle abdominal gills are long, slender, and bifurcated (Fig. 4); (2) paired, large bulbous lobes occur on the venter of the mentum (Fig. 11); (3) long hair is dense on the prothoracic tarsi (Fig. 2); and (4) lingua of hypopharynx is rectangular with median and paired, submedian clefts (Fig. 8).

Peters & Edmunds (1970) indicated that *Calliarcys* is most closely related to *Habroleptoides* and *Habrophlebia* (daughter line IA 2). They noted that daughter line IA 2 can be distinguished from daughter line IA 1 by the costal projection of the adult hind wings, and the prognathous nymphal head. However, further study of the North American *Paraleptophlebia* has shown that various species possess hypognathous to prognathous heads. Apparently the head position is dependent on the habitat of each species. Daughter line IA 2 can be distinguished in the nymphs by the well developed lateral portions of the superlingua (Fig. 8), and the long row of denticles on the claws (Fig. 3).

The phylogeny of daughter line I is difficult to understand as the nymphs of all genera are «*Paraleptophlebia*-like» with few secondary adaptations and most genera are hard to distinguish. The adults are readily distinguishable to genus, but many morphological characters are dependent upon the size of the species. Smaller species of *Paraleptophlebia* appear morphologically similar to *Habrophlebiodes* except for the male genitalia and female ovipositor. A detailed study of all species of daughter line I, especially those of *Paraleptophlebia*, is needed to better understand their phylogeny.

In this paper we will only discuss daughter line IA 2 further. Peters & Edmunds (1970) indicated in their phylogeny diagram that *Habrophlebia* and *Calliarcys* both independently arose from the *Habroleptoides* ancestor with *Habrophlebia* most closely related to *Habroleptoides*. The nymphs of all three genera are «*Paraleptophlebia*-like» in general appearance except for the modified gills of *Habrophlebia*.

*Habroleptoides* and *Habrophlebia* are most closely related as indicated by the following characters they possess in common. In the nymphs, (1) superlingua of the hypopharynx has well developed lateral extensions, (2) mentum and submentum are about equal width, (3) the venter of the mentum is without appendages, and (4) long hair on prothoracic tarsi and caudal filaments is sparse. In the adults, (1) the Cu-A angle of the fore wings is angular and well developed, (2) a ventral appendage arises from the apex of each penis lobe of the male genitalia, and (3) claws of a pair are dissimilar; one is pad-like, while the other is apically hooked.

*Calliarcys* is more specialized based on the following characters. In the nymphs, (1) superlingua of the hypopharynx has angular lateral areas (Fig. 8), (2) submentum is greater in width than mentum (Fig. 11), (3) paired, large, bulbous lobes occur on the venter of the mentum (Fig. 11), and (4) long hair on prothoracic tarsi and caudal filaments is heavy (Fig. 2). In the adults, (1) the Cu-A angle of the fore wings is smoothly curved and not well developed, (2) the penis lobes of the male genitalia are without appendages, and (3) claws of a pair are dissimilar; one is pad-like, while the other is apically hooked with an opposing hook.

Peters & Edmunds (1970) included generic keys to the adults and nymphs



of the Eastern Hemisphere Leptophlebiidae. A new nymphal key to the genera belonging to daughter line I is given herein. The key includes the newly discovered nymphs of *Calliarcys* and *Dipterophlebiodes*, and corrects several mistakes made by Peters & Edmunds (1970). References to figures in brackets between 197 and 291 refer to figure numbers in Peters & Edmunds (1970). This key is written for species occurring in the Eastern Hemisphere, but not for representatives occurring in North America.

## MATURE NYMPHS

- |    |   |                          |
|----|---|--------------------------|
| 1. | Middle abdominal gills plate-like and broad [Figs. 289, 291] ... ..   | 2                        |
| —  | Middle abdominal gills long, slender, and bifurcated (Fig. 4) ... ..  | 3                        |
| 2. | Middle abdominal gills terminated in 3-10 slender, filamentous processes [Fig. 291]; superlingua of hypopharynx with well developed lateral areas [Fig. 199] ... ..                         | <i>Habrophlebia</i>      |
| —  | Middle abdominal gills terminated in one slender, filamentous process [Fig. 289]; superlingua of hypopharynx without well developed lateral areas [Fig. 197] ... ..                         | <i>Leptophlebia</i>      |
| 3. | Well developed posterolateral spines on abdominal segment 9; no metathoracic wing pads present ... ..   | <i>Dipterophlebiodes</i> |
| —  | Well developed posterolateral spines on abdominal segments 8 and 9; metathoracic wing pads present ... ..   | 4                        |
| 4. | Paired, large bulbous lobes on venter of mentum (Fig. 11); superlingua of hypopharynx with lateral areas angular (Fig. 8); long hair dense on prothoracic tarsi (Fig. 2) ... ..             | <i>Calliarcys</i>        |
| —  | Mentum without lobes [Figs. 154, 156]; superlingua of hypopharynx with lateral areas rounded [Figs. 196, 198]; long hair sparse on prothoracic tarsi ... ..                                 | 5                        |
| 5. | Even row of hair along dorsal, anterior margin of labrum [Fig. 244]; long, heavy spines on inner margin of segment 3 of labial palp [Fig. 156]; Oriental ... ..                             | <i>Habrophlebiodes</i>   |
| —  | Hair along dorsal, anterior margin of labrum not in even row [Figs. 240, 242]; long, heavy spines on mid-dorsal surface of segment 3 of labial palpi [Figs. 152, 154]; Palearctic .....     | 6                        |
| 6. | Superlingua of hypopharynx without well developed lateral areas [Fig. 196]; outer margin of mandibles straight [Fig. 218]; denticles only on basal $\frac{1}{2}$ of claws [Fig. 264] ... .. | <i>Paraleptophlebia</i>  |
| —  | Superlingua of hypopharynx with well developed lateral areas [Fig. 198]; outer margin of mandibles curved [Fig. 220]; denticles on entire length of claws, except at apex [Fig. 266] ...    | <i>Habroleptoides</i>    |

## ACKNOWLEDGEMENTS

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