A REDESCRIPTION OF THE IMAGO OF *CASTANOPHLEBIA* BARNARD, 1932 FROM SOUTH AFRICA (EPHEMEROPTERA: LEPTOPHLEBIIDAE: ATALOPHLEBIINAE)

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A redescription of the ♂ and ♀ imagos of *Castanophlebia calida* BARNARD, 1932 is given based on specimens collected in Western Cape Province, South Africa. A revised generic description of the imagos of *Castanophlebia* is included. Phylogenetic analysis indicates *Castanophlebia* is most closely related to the *Terpides* lineage in northern South America and together these genera represent the most primitive grouping of the Atalophlebiinae.

INTRODUCTION

BARNARD (1932) established *Castanophlebia* for a new species, *C. calida*, collected from the south-western Cape Province, South Africa. Both the generic and specific descriptions included the nymph and ♂ and ♀ imagos; however, no types of *C. calida* were designated. Later BARNARD (1940) described a second species, *C. albicauda*, based on the nymph and ♂ and ♀ imagos collected in the same province and again no types were designated. If syntypic material exists for either species, such material is probably in the Albany Museum, Grahamstown, but not all of Barnard's potential lectotypes have been located (McCafferty, pers. comm.).

PETERS & EDMUNDS (1964) gave a generic revision of *Castanophlebia* based on a small collection of nymphs of *C. calida*. No imagos were available and the generic description of the imagos in PETERS & EDMUNDS (1964) was based entirely on the description and illustrations of BARNARD (1932).

In 1988, Dr. Jackie King, Principal Scientific Officer, Freshwater Research Unit, University of Cape Town, collected and reared ♂ and ♀ imagos of *C. calida* from Window Stream on the slopes of Table Mountain in Western Cape Province. As the imaginal description of *Castanophlebia* was not adequate for phylogenetic analysis, such a description is given herein. Further, a redescription of the ♂ and ♀ imagos of *C. calida* is included and the phylogenetic relationships of *Castanophlebia* are discussed.

DESCRIPTIONS

Castanophlebia BARNARD, 1932 (Figs 1-10)

BARNARD, 1932, Trans. roy. Soc. S. Afr. 20: 244-246.
ULMER, 1932, Stettin ent. Ztg. 93: 214.
BARNARD, 1940, Ann. S. Afr. Mus. 32: 631-633.
PETERS & EDMUNDS, 1964, Trans. R. ent. Soc. Lond. 116: 239-241.

Imago. Length of ♂: body (excluding head) 5.0-6.5 mm; fore wings 7.0-9.0 mm. Length of ♀: body (excluding head) 6.0-9.0 mm; fore wings 6.5-11.0 mm. Eyes of ♂ meet on meson of head, dorsally upper portion circular-shaped, lower portion of eyes $^1/_2$ length of upper portion; eyes of ♀ separated on meson of head by a distance 4 times as great as maximum width of an eye. Wings (Figs 1-4): maximum width of fore wings a little less than $^1/_3$ maximum length; vein Rs of fore wings forked a little more than $^1/_4$ of distance from base to margin; vein MA forked a little less than $^2/_3$ of distance from base to margin, fork slightly asymmetrical, distal portion of vein MA sagged posteriorly; veins Rs and MP forked equidistant from base of wings (Figs 1, 4); fork of vein MP symmetrical to base of MP_2 attached at base to vein MP_1 by a cross vein (see discussion); vein I Cu_1 attached to vein CuA with a cross vein, remainder of Cu-A area as in Figs 1, 4; cross veins few. Costal projection of hind wings well developed, rounded, apex located $^2/_3$ distance from base; apex of wings acute, rounded; cross veins few, cross veins in cells C and Sc exceptionally crowded in middle of each cell under costal projection,

those in cell Sc slanted towards apex of wings (Figs 2-3). Legs: ratios of segments of ♂ fore legs, 0.90: 1.00 (2.0 mm): 0.05: 0.35: 0.30: 0.25: 0.15. Claws of a pair dissimilar, one apically hooked, other obtuse, pad-like. Male genitalia (Figs 5-8): segment 2 of forceps 1-1/2 length of segment 3, segment 2 1/7 length of segment 1, apex of segment 3 blunt and a little indented, base of forceps broad, its inner margin smoothly curved near base; length of styliger plate along median line a little less than 1/3 maximum width, lateral margins of styliger plate well developed laterally around base of forceps (Fig. 6); penes divided except at base (Fig. 6), penis lobes broad, apex of each lobe broadly rounded, ventral and dorsal surfaces of penis lobes with broad-based ridges as in Figs 5-6, apical 1/3 of penis lobes with an internal broad-based spine as in Figs 6-8. Ninth sternum of female deeply incised apically (Fig. 9); posterior margin of 7th sternum broadly expanded with small genital extension (Figs 9-10). Terminal filament slightly longer than cerci.

Discussion

The above description is based entirely on the imagos of *C. calida* collected by Dr. King. In 1932, BARNARD indicated that the broad-based spine on each penis lobe was ventral, but after examining genitalia mounted in Canada balsam (Figs 7-8) and floating in glycerine (Figs 5-6), this spine appears to be an internal structure within a lateral duct opening; however, on one penis lobe of one ♂ it is missing. This structure must be the subject of future study. In the fore wing of one ♀ imago, the base of vein ICu1 ended freely in the membrane past the cross vein attachment to vein CuA, and in another ♀, vein ICu1 extended to the basal cross vein between veins CuA and CuP (Fig. 4). In the other four ♀ wings and in all fore wings of the three ♂ imagos studied, vein ICu1 is as described in this paper (Fig. 1) and in BARNARD (1932). However, the symmetry in the fork of MP illustrated by BARNARD (1932) is atypical, and in imagos studied here MP was either slightly asymmetrical (Fig. 4) or MP2 was attached at base to vein MP1 by a cross vein (Fig. 1). The small genital extension on sternum 7 of the ♀ was drawn from a specimen preserved with eggs extruding; on the other ♀ imagos, sternum 7 was equally broad but the extension was less evident.

As noted by PETERS & EDMUNDS (1964) the imagos of both species of *Castanophlebia* are quite similar; however, some differences are apparent in the nymphs. Until imagos and nymphs of *C. albicauda* can be studied, the imaginal characters of *C. albicauda* are not included in the above description.

Castanophlebia calida BARNARD, 1932

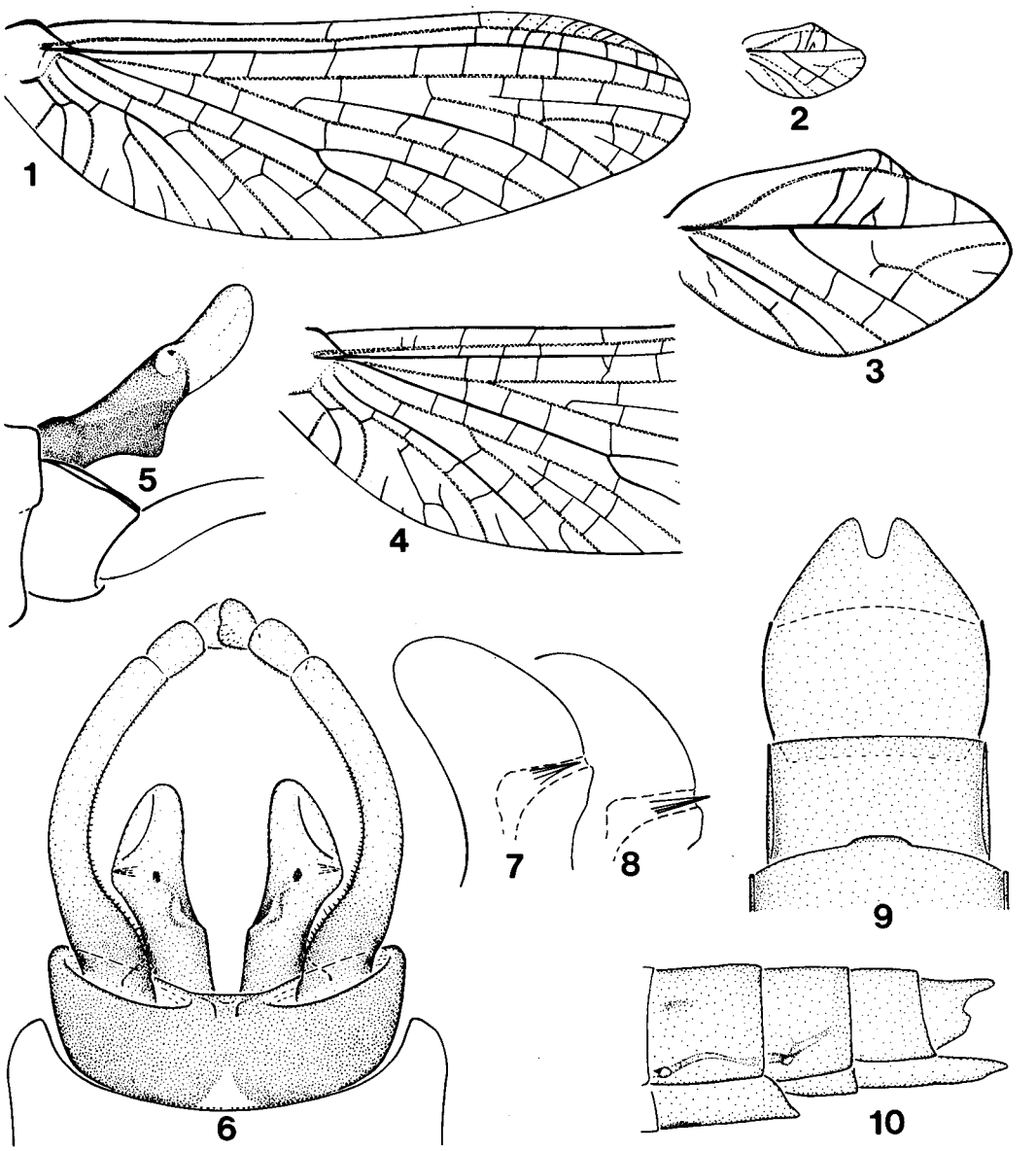
BARNARD, 1932, Trans. roy. Soc. S. Afr. 20: 240-247.

Male imago (in alcohol). Length: body 5.0-6.5 mm; fore wings 7.0-9.0 mm. Upper portion of eyes castaneous, lower portion black. Head and antennae castaneous. Thorax dark castaneous, carinae darker, sutures paler, pleura with a blackish macula near base of fore wings, metathoracic spiracles and thoracic ganglia washed with black. Coxae, trochanters and femora castaneous, remainder of legs paler. Wings (Figs 1-3): veins C, Sc and R1 of fore wings light castaneous, remainder of venation of fore and hind wings paler; wing membrane hyaline, except apical 1/3 of cells C and Sc of fore wings translucent, membrane light castaneous. Abdomen: uniformly castaneous, translucent, lateral margins of terga 1-7 with an oblique, blackish stripe, those on tergum 1 smaller, those on terga 6 and 7 faded; tracheae and spiracles on segments 1-8, and ganglion of segment 7 washed with black. Genitalia (Figs 5-8): styliger plate castaneous, remainder of genitalia paler except ventral ridge and apex of spine on penis lobes darker. Caudal filaments pale castaneous.

Female imago (in alcohol). Length: body 6.0-9.0; fore wings 6.5-11.0. Eyes black. Head and antennae castaneous. Thorax: color and marks as in ♂ imago. Color of legs as in ♂ imago except tibiae, tarsi and claws darker than in ♂ imago. Wings: color and marks as in ♂ imago except all longitudinal and cross veins in fore wings darker and all longitudinal and cross veins in anterior 1/2 of hind wings darker. Abdomen: castaneous, opaque; marks as in ♂ imago. Caudal filaments castaneous.

Discussion

BARNARD (1932) did not indicate in the imaginal description of *C. calida* if an oblique, blackish stripe occurred on the lateral margins of terga 1-7; however, he did note in the nymphal description, «Abdomen with a faint darker, slightly oblique stripe on either side of each segment, though usually obsolete on the posterior segments.» In figure 37a, BARNARD (1932) illustrated such oblique stripes on abdominal segments 2-8, but those on segment 1 were not illustrated as they were covered by the wing pads. None of the speci-



Figs 1-10. Imagos of *Castanophlebia calida*. 1: fore wing; 2: hind wing; 3: hind wing enlarged; 4: basal half of fore wing (♀); 5-8, ♂ genitalia (5, lateral; 6, ventral; 7-8, detail of apical half of penis lobe), 9-10, terminal abdominal segments of ♀ (9, ventral; 10, lateral). Concave longitudinal wing veins are stippled, convex veins are solid.

mens studied (imagos or nymphs) had oblique stripes on segment 8.

Specimens examined

3 ♂ imagos (reared), 2 ♂ subimagos (reared), 3 ♀ imagos (reared), 1 ♀ subimago (reared) and 13 nymphs, SOUTH AFRICA: Western Cape Prov., Window Stream on slopes of Table Mountain, 175 m., 5-11-XII-88, J. King. All specimens in alcohol. Vouchered specimens are in the collections of Florida A & M University (USA) and the Albany Museum (South Africa).

PHYLOGENY

All known genera of the Atalophlebiinae possess the apomorphic character state «lingua of hypopharynx with lateral projections» with the exception of *Castanophlebia, Terpides* DEMOULIN, and *Fittkaulus* SAVAGE & PETERS (PETERS, 1980). The lingua of the hypopharynx of these three genera do not have lateral projections, a character state common to all known genera of the Leptophlebiinae.

SAVAGE (1986) established and defined the monophyletic *Terpides* lineage that presently includes *Terpides, Fittkaulus* and undescribed genera from northern South America. He concluded that the *Terpides* lineage stems from the base of the Atalophlebiinae very near the basal furcation with the Leptophlebiinae.

With this redescription, the phylogenetic relationships of *Castanophlebia* can also be determined (Fig. 11). Phylogenetic analysis (Table 1) indicates that *Castanophlebia* is the sister group of the *Terpides* lineage and the two groups together represent the most basal and ancient furcation of all known Atalophlebiinae.

Castanophlebia and the *Terpides* lineage represent a monophyletic assemblage based on the following apomorphic character states: (1) cross veins in cells C and Sc of hind wing crowded in middle of each cell under the costal projection and slanted toward apex of wing (Figs 2-3); (2) penes with a ventral rod or ridge (Figs 5-6); and (3) nymphal claws with a large median denticle. Other derived characters not listed in Table 1 include (1) only one anal vein, or at most a second anal vein (concave vein actually representing the intercalary between AA_2 and AA_{3+4} according to KUKALOVÁ-PECK, 1985) present as a cross vein that reaches the wing margin; and (2) position of the attachment of ICu_1 to CuA basal to the forks of veins Rs and MP. These characters occur separately in other genera, but not in combination as they do in *Castanophlebia* and the *Terpides* lineage.

The phylogenetic analysis also indicates that *Castanophlebia* is not a member of the *Terpides* lineage based on apomorphic character states given in Fig. 11 and defined in Table 1; further apomorphies of the *Terpides* lineage are listed in SAVAGE (1986).

No known genus of the Atalophlebiinae in the Eastern Hemisphere or Southern South America appears to be closely related to *Castanophlebia,* including material under study from Australia, New Zealand, New Caledonia, Madagascar, Sri Lanka and India. Presently, *Castanophlebia* seems to be an ancient relict in the Eastern Hemisphere with only a distant relationship with northern South America.

SAVAGE (1986) noted that members of the *Terpides* lineage were isolated on the ancient

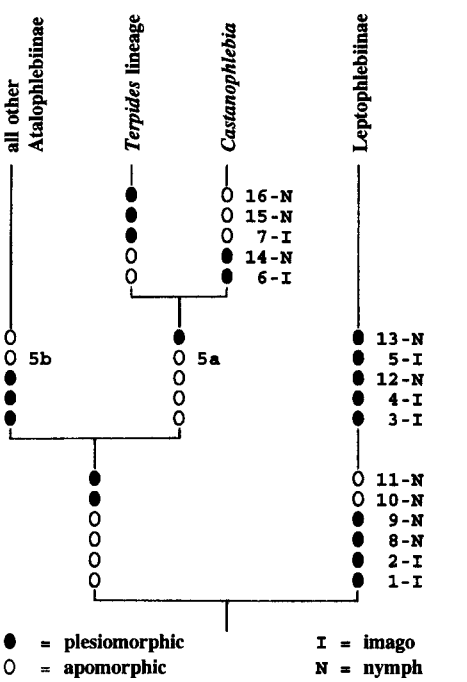


Fig. 11. Phylogeny of *Castanophlebia*. Numbers refer to character states in Table 1.

Guiana and Brazilian Shields of South America during the late Cretaceous and early Tertiary (about 80 m.y.B.P.). Approximately 100 m.y.B.P., the northern and southern portions of the South Atlantic began to open at equal rates (TARLING, 1981; DUNCAN & HARGRAVES, 1984). PETERS (1988) stated that the two subfamilies of Leptophlebiidae must have evolved by the mid-Cretaceous, or about 100 m.y.B.P. SAVAGE (1987) concluded that the ancestors of the Patagonian Shield genera of the Atalophlebiinae became isolated initially from Africa and Madagascar as the South Atlantic began to form. Considering that the ancestor of *Castanophlebia* and the *Terpides* lineage represents the earliest recognizable furcation in the evolution of Atalophlebiinae, it must predate the separation of subsequent lineages. Based on current dating of sea-floor spreading (STEVENS *et al.*, 1988), the ancestral evolution of the *Terpides* lineage and *Castanophlebia* must have started at least by 120 m.y.B.P. when sea-floor spreading commenced in the South Atlantic between Africa and South America. Therefore, the separation of the two subfamilies must predate 120 m.y.B.P.

Table 1. Character states used in Fig. 11 (● plesiomorphic, ○ apomorphic).

A -- Imaginal characters.		
1	●	Styliger plate of ♂ genitalia deeply cleft or deeply cleft ventrally.
	○	Styliger plate of ♂ fused.
2	●	Upper portion of ♂ compound eyes with hexagonal facets.
	○	Upper portion of ♂ compound eyes with square facets.
3	●	Cross veins in hind wings evenly spaced throughout cells C and Sc.
	○	Cross veins in cells C and Sc of hind wings crowded in middle of each cell under costal projection.
4	●	Penes of ♂ without a ventral rod or ridge.
	○	Penes of ♂ with a ventral rod or ridge.
5	●	Styliger plate of ♂ divided or divided ventrally.
	○	a - Styliger plate of ♂ fused, "dish-shaped" (posteromedian margin broad, concave; lateral margins extended as in Fig. 6). b - Styliger plate of ♂ fused, not extended laterally, (but often with posteromedian projections or dorsolateral projections as in *Homothraulus*-group).
6	●	Penes of ♂ separate, joined only at base.
	○	Penes of ♂ partially to entirely fused.
7	●	Claws of a pair alike.
	○	Claws of a pair dissimilar.

B -- Nymphal characters.		
8	●	Anterior maxillary brush with hair or spines scattered or unevenly arranged.
	○	Anterior maxillary brush with hair or spines evenly arranged in rows.
9	●	Labrum without modifications (denticles, cleft) on anterior margin.
	○	Labrum with denticles (or cleft) on anterior margin.
10	●	Venter of lingua of hypopharynx without hair patches.
	○	Venter of lingua of hypopharynx with hair patches (except *Paraleptophlebia*).
11	●	Anterior margin of labrum without heavy spines.
	○	Anterior margin of labrum with heavy spines.
12	●	Claws without large median denticle.
	○	Claws with large median denticle.
13	●	Lingua of hypopharynx without lateral projections.
	○	Lingua of hypopharynx with lateral projections.
14	●	Glossae of labium bulbous.
	○	Glossae of labium curved ventrolaterally.
15	●	Base of segment 3 of labial palpi of same width as apex of segment 2.
	○	Base of segment 3 of labial palpi much narrower than apex of segment 2.
16	●	Head hypognathous.
	○	Head prognathous.

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