

**Complementary description
of *Habrophlebia vaillantorum* Thomas, 1986
in comparison with *H. fusca* (Curtis, 1834)
[Ephemeroptera, Leptophlebiidae]**

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Keywords : *Habrophlebia*, systematics, morphology, adults, last-instar larva, egg, SEM.

The male adult of *Habrophlebia vaillantorum* is described for the first time. The larvae mainly differ from those of *H. fusca* by the morphology of the mouthparts (maxillae, labium), femoral and tibial bristles, tarsal claws, marginal spines of abdominal terga, and gills, the latter being adapted to flowing water in *H. vaillantorum*. Feathery bristles on maxillary palpi and internal side of tibiae (filtering structure) are reduced or absent in *H. vaillantorum* in comparison with *H. fusca*.

Scanning electron microscopy (SEM) investigation permitted to highlight the chorionic pattern in both species (the egg of *H. fusca* being also described for the first time). Among the various characteristics useful for a proper diagnosis, the most outstanding feature is represented by the ribs, less numerous and wider in *H. fusca* than in *H. vaillantorum*.

Description complémentaire d'*Habrophlebia vaillantorum* Thomas, 1986, comparative avec *H. fusca* (Curtis, 1984) [Ephemeroptera, Leptophlebiidae]

Mots clés : *Habrophlebia*, systématique, morphologie, adultes, larve au dernier stade, oeuf, MEB.

L'adulte mâle d'*Habrophlebia vaillantorum* est décrit pour la première fois. Les larves diffèrent principalement de celles d'*H. fusca* par la morphologie des pièces buccales (maxilles, labium), des soies des fémurs et des tibias, des griffes tarsales, des épines marginales des tergites abdominaux et des branchies, ces dernières étant adaptées aux eaux courantes chez *H. vaillantorum*. La structure filtrante constituée par les soies plumeuses des palpes maxillaires et de la face interne des tibias d'*H. fusca* est réduite ou absente chez *H. vaillantorum*.

Une étude de l'ornementation du chorion au microscope électronique à balayage (MEB) a permis de mettre en évidence les différents caractères utiles à la diagnose des deux espèces (l'oeuf d'*H. fusca* étant lui aussi décrit pour la première fois). Le caractère distinctif principal est représenté par les côtes, moins nombreuses et plus larges chez *H. fusca* que chez *H. vaillantorum*.

1. Introduction

The genus *Habrophlebia* was erected by EATON (1881), the type species being *H. fusca*, described by CURTIS (1834), s. n. *Ephemera*. *H. fusca* has been the subject of many entomological and hydrobiological papers, also in the light of its wide geographical distribution (PUTHZ, 1978). Indeed, this species has been recorded over latitudes from Finland (SAVOLAINEN, 1984 ; ENGBLOM, 1996) to North Africa (see the detail of records in THOMAS, 1998), and longitudes from Great Britain to the Near East. Nevertheless, a better definition of the diagnostic traits (JACOB & SARTORI, 1984 ; BELFIORE & GAINO, 1984) revealed that *H. fusca* has often been misidentified. As a consequence, its presence in several countries of Central and Southern Europe must be confirmed. According to RIGHETTI *et al.* (1997), many records, such as those from Southern France, probably correspond to *H. eldae* Jacob & Sartori (1984), a species well characterised, and subjected to morphological and fine structural analyses (GAINO, 1987 ; MAZZINI & GAINO, 1985 and 1988 ; GAINO & MAZZINI, 1984, 1989 and 1990 ; GAINO & REBORA, 1995). Great Britain is the *Terra typica* of *H. fusca*, and so far this latter represents the only species of *Habrophlebia* living there.

A few years ago, a small collection of larvae sampled in harsh ecological conditions (Moroccan High Atlas, between 2600 and 3000 m elevation) permitted the discovery of an endemic species of *Habrophlebia* : *H. vaillantorum* Thomas, 1986. It also represented the Southernmost record of this genus in the Euromediterranean region. The species was briefly described on the basis of the main morphological traits of the larva only (THOMAS & BOUZIDI, 1986) : no adults were collected from the high desert environment. Further sampling allowed us to attribute to *H. vaillantorum* adults and additional last-instar larvae. Herein we report their description together with scanning electron micrographs (SEM) of the egg by comparing some structures useful for discrimination from the actual *H. fusca* (study specimens from Great Britain). The life cycle of *H. vaillantorum* has been studied by OUAHSINE (1993).

2. *H. vaillantorum* Thomas, 1986

Material preserved in 70 % alcohol.

MALE IMAGO

Head

Medium brown, darker between the ocelli. Ocelli whitish, not circled at base. Eyes : lower portion blackish, upper portion light reddish pink. Antennae brown, distal three quarters of funiculus whitish.

Thorax

Bright medium brown on the whole, with the exception of : pronotum, dull and darker ; lateral edges of scutum, black ; and prosternum and anterior part of mesonotum, darker. Fore wing transparent, sometimes slightly bistre ; pterostigmatic area practically concolorous ; neuration similar to *H. fusca* (see : EATON, 1883, pl. 13 ; KIMMINS, 1954, fig. 9, p 33 ; KIMMINS 1972, fig. 24, p 60 ; Kimmins del. in ELLIOTT & HUMPHREYS, 1983, fig. 26, p 49). Hind wing with a conspicuous costal process and a weak transverse neuration, similar to *H. fusca* (KIMMINS, id.). Legs : femora dull brown, darker distally and along the inferior edge ; tibiae uniform dull medium brown ; tarsi uniform greyish brown, the last segment generally whitish. Approximate length ratios of fore tarsal segments to tibia, respectively : 0.38-0.40, 0.36-0.37, 0.30, 0.14-0.15. Coxae 2 and 3 medium brown, posterior edge darker.

Abdomen

Rather uniform brown, darker than thorax. However on terga, two parasagittal lines generally contrast with small light patches, at least on the anterior two-thirds of the segments, up to the 7th included. 10th tergum lighter, yellowish brown with a medial dark brown line. Pleurae with a dark brown line, interrupted at the articulations of segments. Lateral pattern of terga : fig. 1. Sterna dark brown, translucent (nervous ganglia visible) ; two small white parasagittal patches at mid-length of segments. Cerci greyish white with brown articulations.

Genitalia : forceps strong, article 1 moderately bulging internally. Forceps base with a deep superficial excision, V shaped or only slightly U shaped (fig. 2A, B), but not as wide opened as in *fusca* (see : KIMMINS 1954, fig. 9 and 1972, fig. 24 ; JACOB & SARTORI, 1984, fig.9 ; SAVOLAINEN, 1984, photo 2), and a posterior edge nearly rectilinear or only a bit prominent towards the excision. Penis lobes slightly divergent or subparallel ; distal part long, thin (fig. 3 and 4), and somewhat curved ventrally/rearward at apex (fig. 5) and lying in the second U shaped excision.

FEMALE IMAGO

Unknown.

SUBIMAGOS

Wings dull greyish brown.

Male

In comparison with the imago, the dorsal parasagittal lines are weaker and the light patches are on the contrary more conspicuous. Scutum lighter with lateral edges largely brown. Three pairs of light dots on pronotum, the medial one coalescent.

A light line extends over the whole length of the femora, between two dark lines.

Genitalia : fig. 6.

Female

Coloration rather similar to male. Scutum lighter. Abdomen darker, with two anterior patches on terga 3 to 7, on both sides of a narrow light sagittal line. Sterna with a light posterior part and with two small light patches in the anterior part.

Size

Wing length : male = 6.2 to 6.5 mm ; female (subimago) = 6.5 mm.

EGG

The egg of *H. vaillantorum* measures about 200 μm in length and 120 μm in width. The chorionic surface is uniformly decorated with longitudinal ribs (photo 1a), which are variable in length : some of them connect the two egg poles whereas others end in the equatorial or subequatorial region. Merging ribs give rise to a Y-like configuration (photo 1b). The ribs show a smooth surface and a sinuous pattern (photo 1c), with the width varying from 1 to 2 μm . A finely granular matrix characterizes the chorion interposed between the ribs (photo 1c). Adjacent ribs are separated by a distance of about 3-4 μm . The micropyle, located in the subequatorial region (photo 1a), consists of a ring (about 8 μm) delimited by ribs (photo 1d). Mucous material tends to adhere to the chorionic surface and may partially shadow the micropylar opening (photo 1d).

A comparison of the egg of this species with that of *H. fusca* revealed some notable differences. The egg of *H. fusca* measures about 230 μm in length and 100 μm in width ; this last value greatly reduces towards the poles. As in *H. vaillantorum*, the chorion is decorated by ribs (photo 2a),

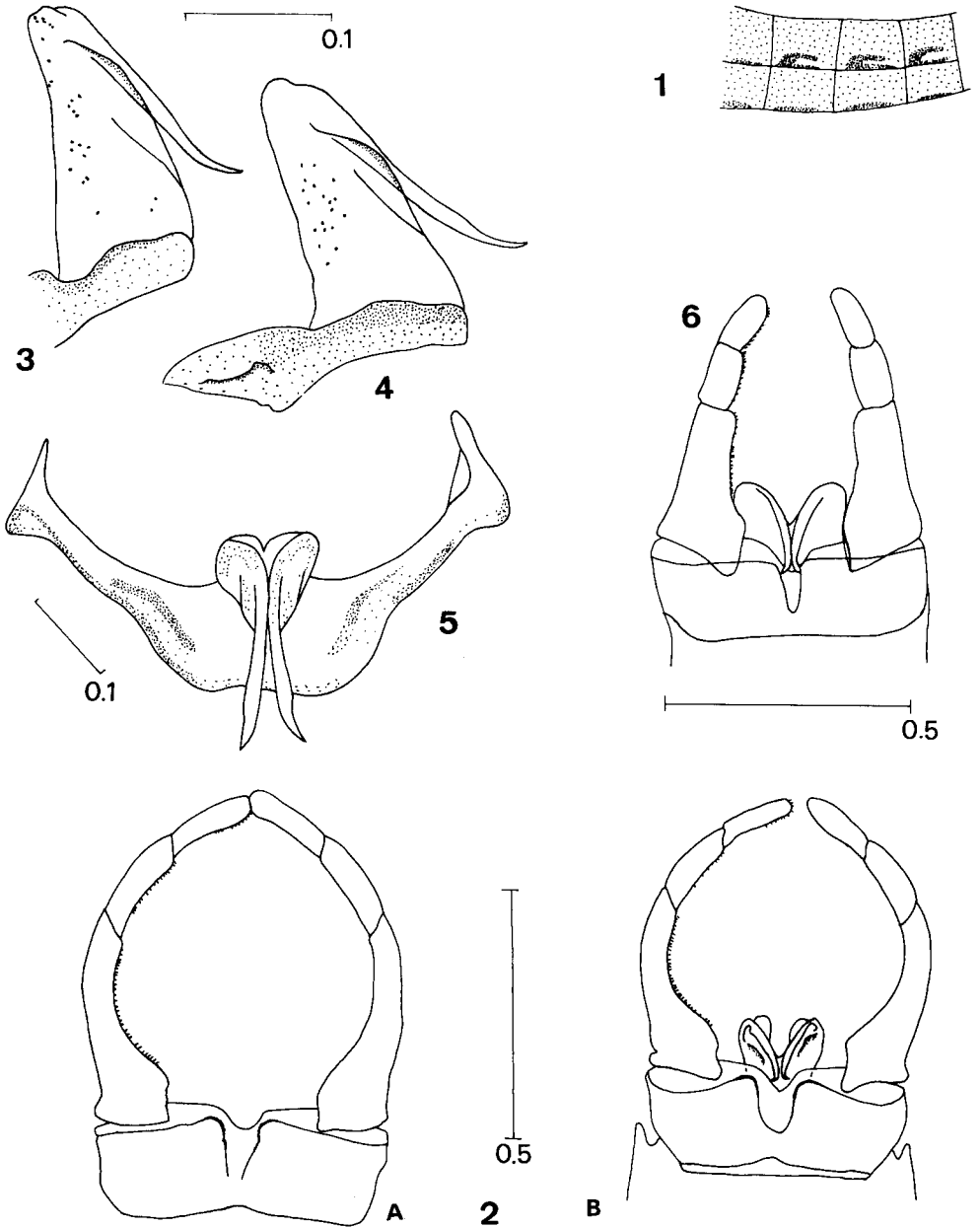


Fig. 1 to 6. — Structures of male adults of *H. vaillantorum* (1-5 : imago ; 6 : subimago). Scale in mm.
 1 : lateral pattern of terga. 2A, B : genitalia, ventral view. 3 and 4 : penis lobes of two individuals, profile.
 5 : penis lobes, caudal view. 6 : genitalia, ventral view.

Fig. 1 à 6. — Structures d'adultes mâles d'*H. vaillantorum* (1-5 : imago ; 6 : subimago). Echelle en mm.
 1 : pigmentation latérale des tergites. 2A, B : genitalia en vue ventrale. 3 et 4 : lobes péniens de deux individus, de profil. 5 : lobes péniens, en vue caudale. 6 : genitalia en vue ventrale.

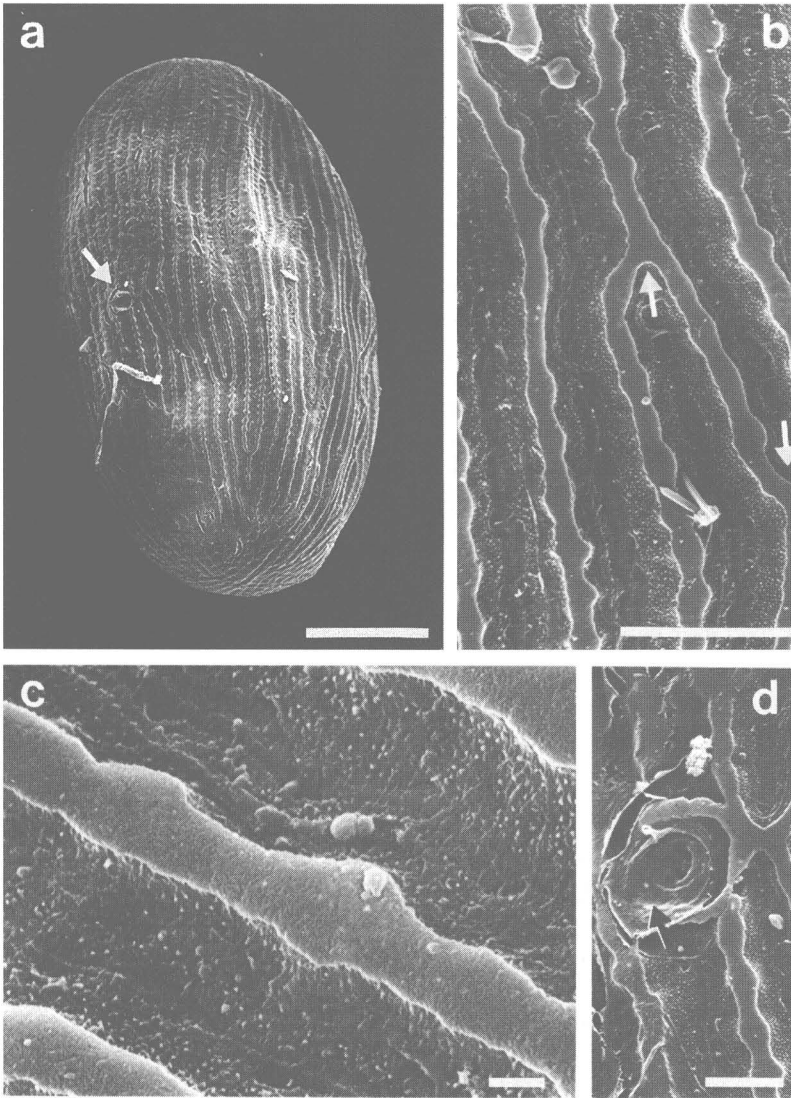


Photo plate 1. — Scanning electron microscopy view of the egg of *H. vaillantorum*.
 a : egg shape ; bar = 50 μm ; note the micropyle (arrow) in the subequatorial region. b : choriion decorated by ribs whose merging originates a Y-like configuration (arrows) ; bar = 10 μm . c : smooth surface of a rib and the granular matrix of the spaces interposed between adjacent ribs ; bar = 1 μm . d : detail of the micropyle partially shadowed by mucous material (arrow) ; bar = 5 μm .

Planche photos 1. — Photos au microscope électronique à balayage de l'œuf d'*H. vaillantorum*. a : vue d'ensemble de l'œuf ; échelle = 50 μm ; remarquer le micropyle (flèche) dans la région subéquatoriale. b : choriion décoré de côtes induisant une structure en Y (flèches) ; échelle = 10 μm . c : surface lisse d'une côte et matrice granuleuse des espaces situés entre les côtes ; échelle = 1 μm . d : détail du micropyle partiellement masqué par du matériel muqueux (flèche) ; échelle = 5 μm .

but they are less numerous and wider, varying from 2.5 to 3.8 μm , according to their sinuous arrangement (photo 2b). In particular, the peripheral borders of the ribs tend to be much more indented and the surface is characterized by little holes (photo 2c). The space between adjacent ribs measures from 7.5 to 10 μm . The micropyle (6.5 μm in diameter) is located in the equatorial region and is uplifted on the chorionic surface being bound by a rim similar to the ribs (photo 2d).

Remark

The egg of *H. vaillantorum* stands out among the other congeneric species known so far (GAINO & MAZZINI, 1984), through the close arrangement of the ribs, their size and morphology.

This study allowed the egg of *H. fusca* to be investigated under SEM. Indeed, previous observations on the chorionic pattern of this species have been carried out on the Italian representatives (GAINO & MAZZINI, 1984 ; MAZZINI & GAINO, 1985), further attributed to the new species *H. eldae* Jacob & Sartori, 1984. The present work represents the first contribution to the knowledge of the egg of *H. fusca*. Whereas the chorionic pattern of *H. eldae* and *H. fusca* seems to be closely related, the arrangement of the ribs of *H. vaillantorum* contributes to a proper diagnosis of this species, thus stressing the relevance of the egg decorations in mayfly taxonomy.

LAST-INSTAR LARVA

Coloration : body dark brown devoid of light areas, with the exception of two small light anterior parasagittal patches on abdominal terga 3 to 7, and of four whitish dots on each sternum. Last tergum with a short dark brown sagittal line.

Head

Pedichel much darker than the rest of the antenna. Labrum and mandibles : similar to those of *H. fusca* (see MACAN, 1952, fig. 2F). Maxilla narrower than in *H. fusca* ; palpus with a more prominent basis, segment 1 also narrower and segment 3 more progressively conical than in *fusca* (fig. 7v and 7f ; see also MACAN, 1952, fig. 1F). Segment 3 devoid of small feathery bristles contrary to *H. fusca*. Hypopharynx : lateral projections (fig. 8v) nearly as prominent as in *H. fusca* (fig. 8f ; see also JACOB & SARTORI, 1984, fig. 22) and *H. eldae* (see BELFIORE & GAINO, 1984, fig. 3-4). Labium : glossae similar in the two species ; paraglossae wider in *H. vaillantorum* (fig. 9v and 9f ; see also MACAN, 1952, fig. 1f) ; palpi larger in *H. vaillantorum* : segment 1 more prominent internally, segments 2 and 3 wider than in *H. fusca*.

Thorax

Femora dark brown, with a longitudinal yellow line. Posterior margin (fig. 10v) bearing long and strong acute bristles (rounded at apex in *H. fusca* : fig. 10f) ; anterior margin (fig. Av) with short conical bristles (rounded in *H. fusca*, Af, together with some feathery bristles, often fallen off). Tibiae dull brown, protibiae clearly darker than meso and metatibiae. Internal side of tibiae (in particular protibiae : fig. 11v) with numerous bristles very finely plumose -hence appearing smooth at moderate magnification, or without a contrast device- (much more feathery in *H. fusca* : fig. 11f), showing an adaptation of the two species to clearly different trophic resources. Tarsi yellowish. Tarsal claws bearing denticulations, generally between 13 and 16, the 3 to 5 (sometimes 6) most distal ones showing a more or less reduced size (fig. 12a to d ; see also THOMAS & BOUZIDI, 1986, fig. 8). Variability seems to be lowest in the hind legs and highest in the fore legs.

Abdomen

Dark brown, with two anterior small whitish spots on terga 3 to 7, located on both sides of a light sagittal line often visible. Posterior margin of terga with arrangement of spines allied to *H. lauta* (see BELFIORE & GAINO, 1984, fig. 12) but with even smaller spines (fig. 14v), so clearly distinct

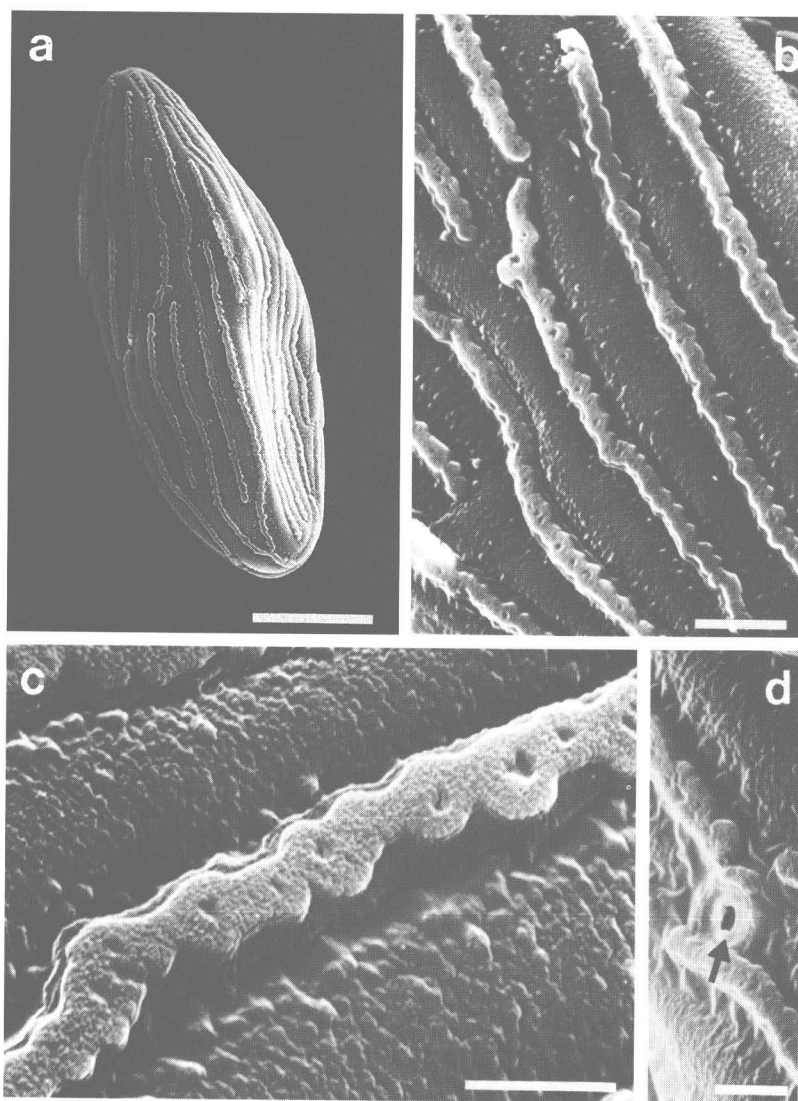


Photo plate 2. — Scanning electron microscopy view of the egg of *H. fusca*. a : egg shape ; bar = 50 μm . b : chorion decorated by ribs ; bar = 10 μm . c : a chorionic rib showing its indented profile and the sequence of little holes on its surface ; bar = 5 μm . d : detail of the micropyle (arrow) located in the space between two consecutive ribs ; bar = 5 μm .

Planche photos 2. — Photos au microscope électronique à balayage de l'œuf d'*H. fusca*. a : vue d'ensemble de l'œuf ; échelle = 50 μm . b : chorion décoré par des côtes ; échelle = 10 μm . c : une côte du chorion montrant son profil indenté et sa séquence de perforations superficielles ; échelle = 5 μm . d : détail du micropyle (flèche) situé dans l'espace séparant deux côtes consécutives ; échelle = 5 μm .

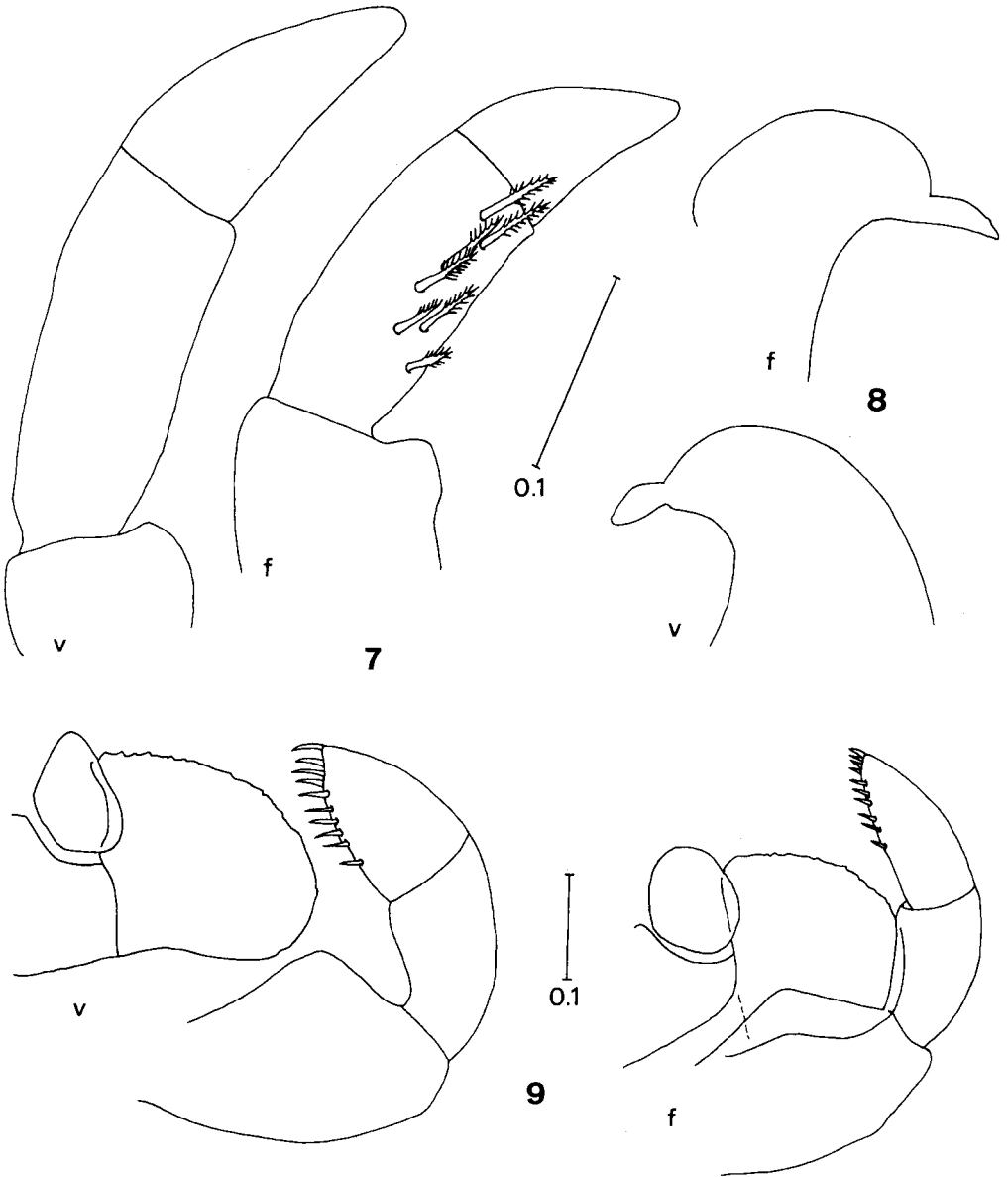


Fig. 7 to 9. — Larval structures (last instar) of *H. vaillantorum* (v) and *H. fusca* (f). Scale in mm.
7 : maxillar palpus (non feathery bristles are not represented), 8 : hypopharynx, 9 : labium.

Fig. 7 à 9. — Structures larvaires (au dernier stade) d'*H. vaillantorum* (v) et d'*H. fusca* (f).
Echelle en mm.

7 : palpe maxillaire (les soies autres que plumeuses ne sont pas représentées). 8 : hypopharynx.
9 : labium.

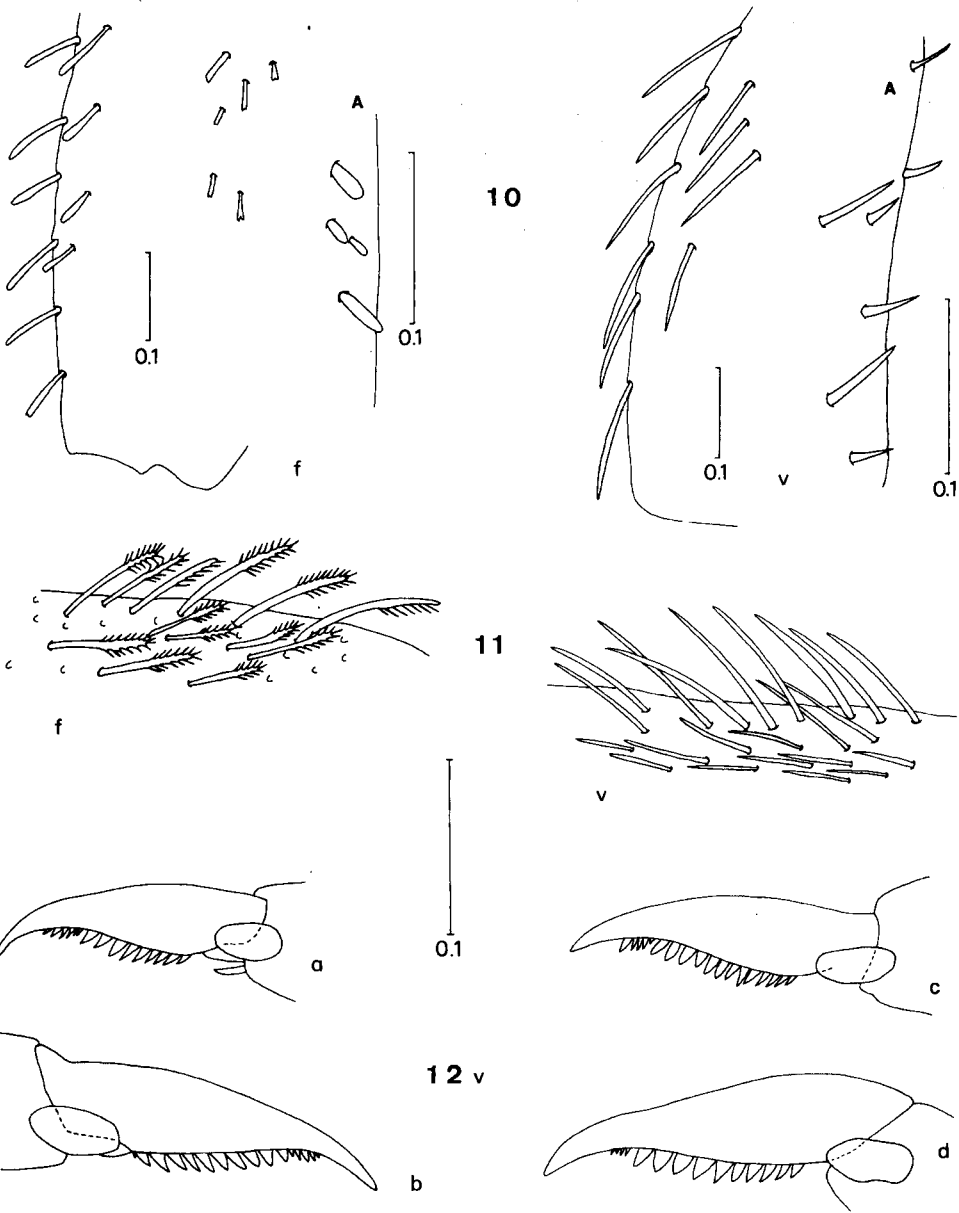


Fig. 10 to 12. — Larval structures (last instar) of *H. vaillantorum* (v) and *H. fusca* (f). Scale in mm.
 10 : posterior margin of femora ; A : bristles on anterior/internal margin of femora. 11 : apex of protibia, internal side. 12 a to d : tarsal claw of four individuals.

Fig. 10 à 12. — Structures larvaires (au dernier stade) d'*H. vaillantorum* (v) et d'*H. fusca* (f). Echelle en mm.
 10 : bord postérieur des fémurs ; A : soies/écailles du bord antérieur des fémurs. 11 : apex du protibia, côté interne. 12 a à d : griffe tarsale chez quatre individus.

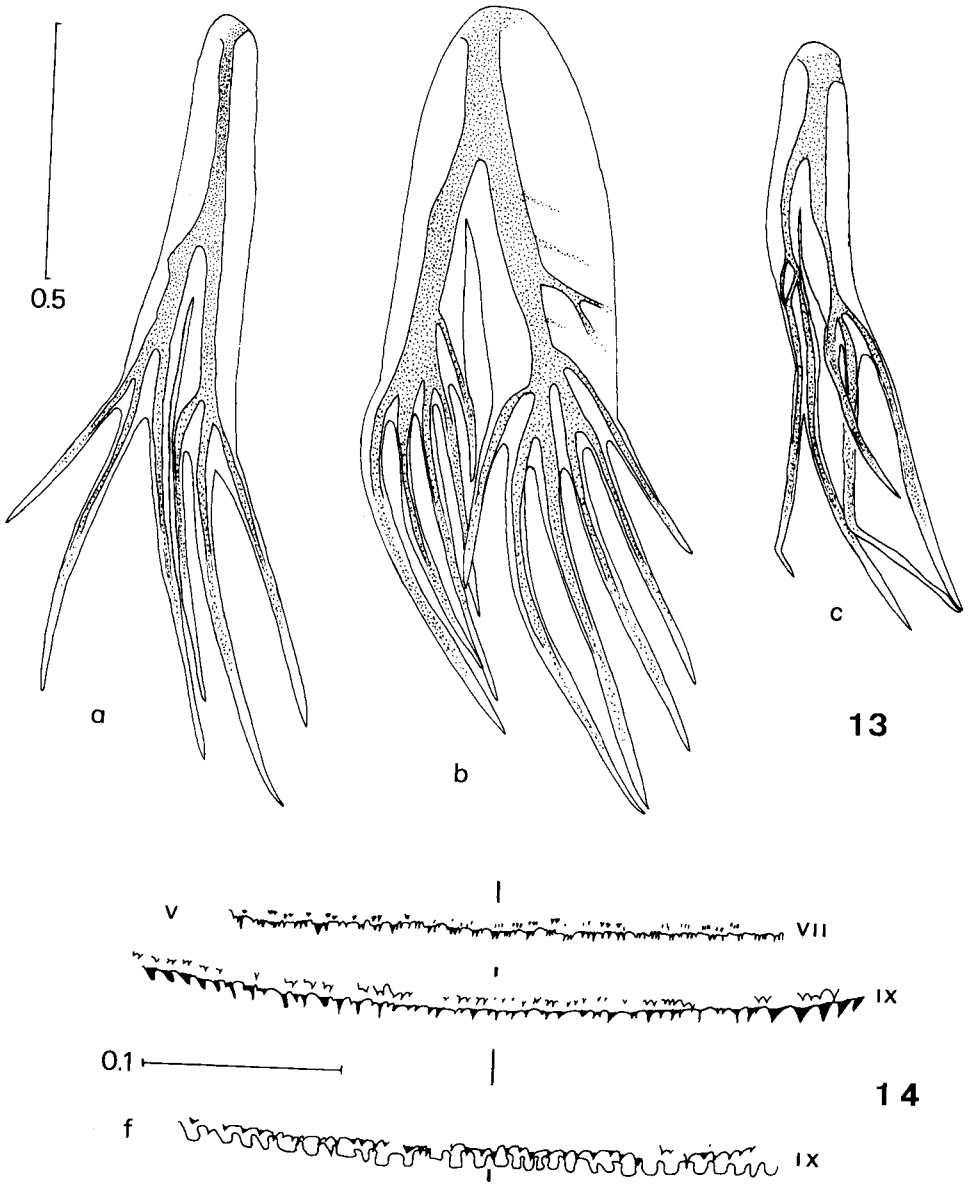


Fig. 13-14. — Larval structures (last instar) of *H. vaillantorum* (v) and *H. fusca* (f). Scale in mm.
 13 : posterior margin of terga VII and IX. 14a, b and c : gills 1, 4 and 7 of *H. vaillantorum*.
 Fig. 13-14. — Structures larvaires (au dernier stade) d'*H. vaillantorum* (v) et d'*H. fusca* (f).
 Echelle en mm.
 13 : bord postérieur des tergites VII et IX. 14 a, b et c : branchies 1, 4 et 7 d'*H. vaillantorum*.

from *H. fusca* (fig. 14f ; see also : JACOB, 1984 ; JACOB & SARTORI, 1984 ; BELFIORE & GAINO, 1984). Gills adapted to flowing water, with two long and strong lobes bearing few filaments, short (fig. 13a, b, c) in comparison with *H. fusca* (see MACAN, 1952, fig. 3F). Cerci medium to light brown.

Hence, the larva of *vallantorum*, the most rheophilic and the most alticolous species within the genus *Habrophlebia*, appears to be rather characteristic owing to its adaptation to flowing water at high elevations (sudden flooding at snow melt, high gradients, high dissolved oxygen contents) : the reduction of gill filaments and the strengthening of gill lobes. Moreover, the filter constituted by the bristles of the fore tibiae is also much reduced in comparison with *H. fusca*, living in richer biotopes, in particular among dead leaves (MACAN, 1952).

Remark

Bill Peters provided us with the following information regarding the material used for the figures of «*H. fusca*» in two previous works (PETERS & EDMUNDS, 1970 ; PETERS, 1979) :

- male genitalia (fig. 75, p 186, 1970 and fig. 4, p 52, 1979) belong to a specimen coming from Sardinia, in fact *H. eldae*.

- hypopharynx (fig. 199, p 216, 1970 and fig. 10, p 53, 1979) and tarsal claw (fig. 267, p 224, 1970) belong to specimens from Liguria. It also concerns *H. eldae*.

The detailed plate of BELFIORE (1983, fig. 56a-e, p 99) refers also to *H. eldae*.

MATERIAL EXAMINED

Habrophlebia vallantorum

The species is apparently endemic to the Moroccan High Atlas, and was probably found for the first time by PIHAN & MOHATI (1983), s. n. *Habrophlebia* sp. (no collections preserved). A large part of the material listed below is in poor condition. I = imago ; S = subimago ; L = larva ; N = last-instar larva.

a) Catchment of the Ourika Oued (= wadi)

- The Tiferguine Assif (= torrent) headwaters, 2700 m elevation (H. Ouahsine & A. Thomas leg.) : 25-VI-1984 : 10 L and N ; 13-VI-1986 : 1 L and 1 N ; 30-VII-1985 : 2 N.

- a spring (unnamed), 2650 m elevation, on Mount Tougroudadene (A. Mohati leg.), 9-VIII-1985 : 1 male I, 1 N.

b) Catchment of the N'Fiss Oued

- A cold spring, tributary of the N'Ouarzane Assif, 3000 m elevation, near the Lepiney Refuge (A. Bouzidi leg. ; A. Boumezzough & A. Ajakane leg.), 21/22-VII-1988 : 7 male I, 1 male S, 3 female S, 15 N.

Habrophlebia fusca

T.T. Macan coll., deposited at the Freshwater Biological Association, Windermere.

This material was used for the description of *H. fusca* by MACAN (1952).

R. Cart, LA, Waterfoot, 14-VII-1954 : 1 female I and its larval cast skin. Daggons Brook, DT/SH, 23-V-1939 : 6 N. Halton Bridge, R. Ribble, MY, 3-VII-1950 : 1 N cast skin. Hog House Beck WL, 8-VII-1939 : 1 N cast skin.

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We are indebted to Malcolm Elliott (Freshwater Biological Association, Ambleside, UK) for the loan of specimens of *H. fusca* (T.T. Macan coll.). Bill Peters (Department of Entomology, Florida A & M University, Tallahassee, USA) kindly provided data on the origin of the material figured in Peters & Edmunds (1970) and in Peters (1979). We also thank the team of the Laboratory of Animal Ecology (University of Marrakech, Morocco) for help in fieldwork provided to the senior author and for the gift of specimens of *H. vaillantorum*.

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