



Active postlarval forms of plume-footed *Eatoniana* (Trombidiformes: Parasitengona, Erythraeidae) in the Eocene Baltic amber

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... we were happy to be among those, who could draw from your enthusiasm for life and passion for science
thank you, Katya

Abstract

The discovery of active postlarval forms (deutonymph and adult) of erythraeid *Eatoniana* in Eocene Baltic amber is associated with the first description of named fossil species assigned to that genus. Species of *Eatoniana*, having the plume-like setae on terminal segments of leg IV, reveal the high consistency of characters, confirmed both for extinct and extant members of the genus. The main difference between *Eatoniana crinita* sp. nov. and other “plume-footed” congeners is the shape of modified setae arising at genu and tibia IV.

Keywords: Fossil mites, succinite, Erythraeoidea, new species

Introduction

Increased research on fossil arachnids in recent years (Penney 2016; Dunlop *et al.* 2018a) has resulted in a significant increase in the number of described terrestrial Parasitengona mites (Konikiewicz & Małkol 2014, and data summarized therein; Bartel *et al.* 2015; Konikiewicz *et al.* 2016a, 2016b; Dunlop *et al.* 2018b; Konikiewicz & Małkol 2018; Małkol *et al.* 2018). Representatives of nine out of 19 families currently assigned to terrestrial parasitengones (Małkol & Wohltmann 2012) have been recorded from the Cretaceous, and/or Paleogene deposits. Despite the limited data, which would allow the inference on relative abundance of these mites in the fossil materials, each new record adds to our knowledge of terrestrial Parasitengona diversity in the past.

Predatory, active postlarval instars of erythraeid mites, due to the presence of relatively long legs which enable the more efficient movement compared to other terrestrial Parasitengona, seem to be especially adapted to dwell the forest floor but also the tree trunks. The latter made them also susceptible to fixation in the amber-forming resins of forest ecosystems. In turn, the probability of fixation of parasitic larvae with their arthropod hosts in the resin is depended on the lifestyle and microhabitats of their hosts.

Four named species of fossil Erythraeidae have been described to date: *Pararainbowia martilli* Dunlop, 2007, from Early Cretaceous Crato Formation of Brazil, *Proterythraeus southcotti* Vercammen-Grandjean, 1973, from Canadian Cretaceous amber, *Burerythrites pankowskii* Konikiewicz & Małkol, 2018 and *Burphanolophus joergwunderlichi* Konikiewicz & Małkol, 2018, both from Burmese Cretaceous amber (Vercammen-Grandjean 1973; Dunlop 2007; Konikiewicz & Małkol 2018). Of those, *P. martilli*, *B. pankowskii* and *B. wunderlichi* have been based on active postlarval forms, whereas *P. southcotti* has remained known exclusively from a single larva. The identifications of several other amber erythraeids were limited to family or genus.

The first information (photo of habitus, dorsal view) on postlarval form of *Eatoniana* sp. in Baltic amber was provided by Weitschat & Wichard (2002). Here we present the description of *Eatoniana crinita* sp. nov. based on an adult and deutonymph found in Eocene Baltic amber deposits.

Material and methods

Two samples of fossil resin originating from Yantarny, Sambian peninsula, Kaliningrad region, Russia, were analyzed. Each sample contained one mite, no syninclusions were detected. The samples were trimmed and polished according to the protocols provided by Sidorchuk (2011, 2013). Morphological analyses of qualitative and quantitative traits of mites were carried out in Nikon Eclipse E600 and 80i. Drawings were prepared using camera lucida coupled with Nikon Eclipse E600 and graphically processed with the GIMP software.

Stacks of images were taken with an AmScope MU900 or Nikon D7000 digital cameras installed on a Nikon Eclipse 800 compound microscope, mostly with a 60x water immersion lens. Stacks were corrected for color, brightness and noise with Adobe Lightroom, then processed with Helicon Focus 5.0, using algorithm A with subsequent manual addition of significant details from the individual focal planes, and combined into the plates with the aid of InkScape 0.48.

The neotype of *Eatoniana plumipes* (L. Koch, 1856) [female (ID: TUR/26/2014), ref. Małkol & Sevsay (2015)] served for comparative analysis. Morphological notations follow Southcott (1961) and Małkol *et al.* (2012).

Systematic palaeontology

Superorder Acariformes Zakhvatkin, 1952
Order Trombidiformes Reuter, 1909
Suborder Prostigmata Kramer, 1877
Cohort Parasitengona Oudemans, 1909
Subcohort Erythraeina Welbourn, 1991
Superfamily Erythraeoidea Robineau-Desvoidy, 1828
Family Erythraeidae Robineau-Desvoidy, 1828
Subfamily Erythraeinae Robineau-Desvoidy, 1828
Genus *Eatoniana* Cambridge, 1898

Type species. *Eatonia scopulifera* Cambridge, 1897
[for nomenclatural notes see Małkol & Wohltmann (2012)]

For generic postlarval diagnosis see Southcott (1961) and Małkol & Sevsay (2015) [part.].

Eatoniana crinita sp. nov.

Figs 1–3.

Type material and repository. Holotype, male (specimen CCHH-1335-1, from Christel and Hans Hoffeins collection), complete specimen, visible in dorsal and ventral view, deposited in the Senckenberg Forschungsinstitut und Naturmuseum in Frankfurt (SMF), Frankfurt, Germany, under coll. no. SMF Be 13211a. Paratype, deutonymph (TW-344, from Thomas Weiterschan collection), an incomplete specimen, visible in ventral view (lacking basifemur – tarsus of left leg IV and terminal segments of right legs II, III and IV; idiosoma dorsum obscure, covered with milky substance), deposited at the Geologisch-Paläontologisches Institut der Universität Hamburg (GPIH), now: CeNak (Center of Natural History), Hamburg, Germany, under coll. no. 4545.

Derivation of name. The specific epithet “*crinita*” refers to Latin “*crīnītus* (*feminine* *crīnīta*) denoting hairy or long-haired.

Age and occurrence. Ypresian to Priabonian, Eocene, 56–33.9 Ma (Weitschat & Wichard 2010); Baltic amber, Sambian peninsula, Kaliningrad region.

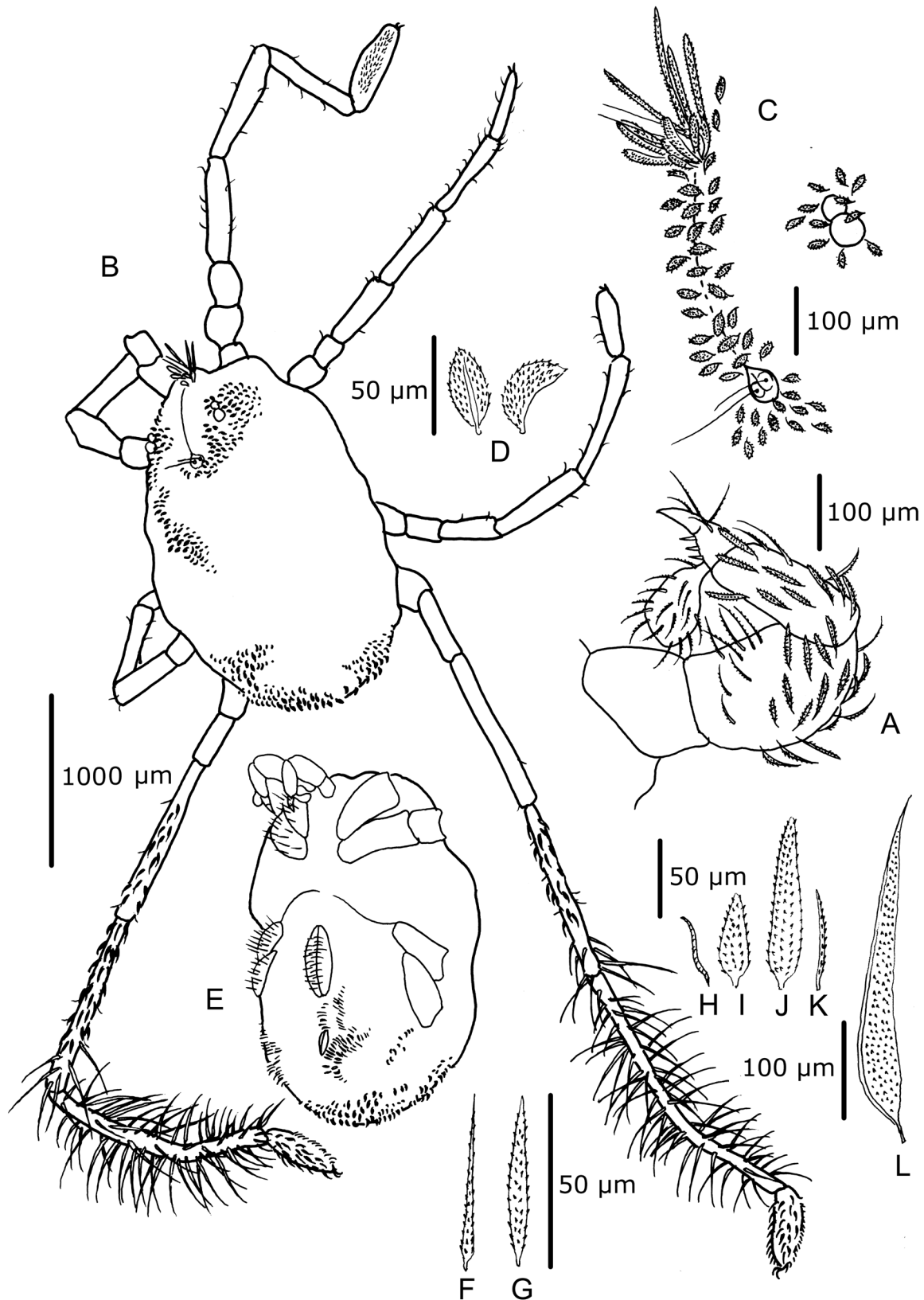


FIGURE 1. *Eatoniana crinita* sp. nov. (holotype, male, coll. no. SMF Be 13211a). A. palp; B. idiosoma and legs, dorsal aspect (setation partly omitted); C. crista metopica and eye (one side of symmetry axis); D. dorsal idiosomal setae; E. gnathosoma and idiosoma, ventral aspect (setation partly omitted); F. seta (coxae and genital valves); G. ventral seta (posterior part of idiosoma), H–L. setae on legs: H. specialized seta; I. seta on basal leg segments; J. seta on distal leg segments; K. seta of tarsus I; L. plumelike seta on tibia IV.

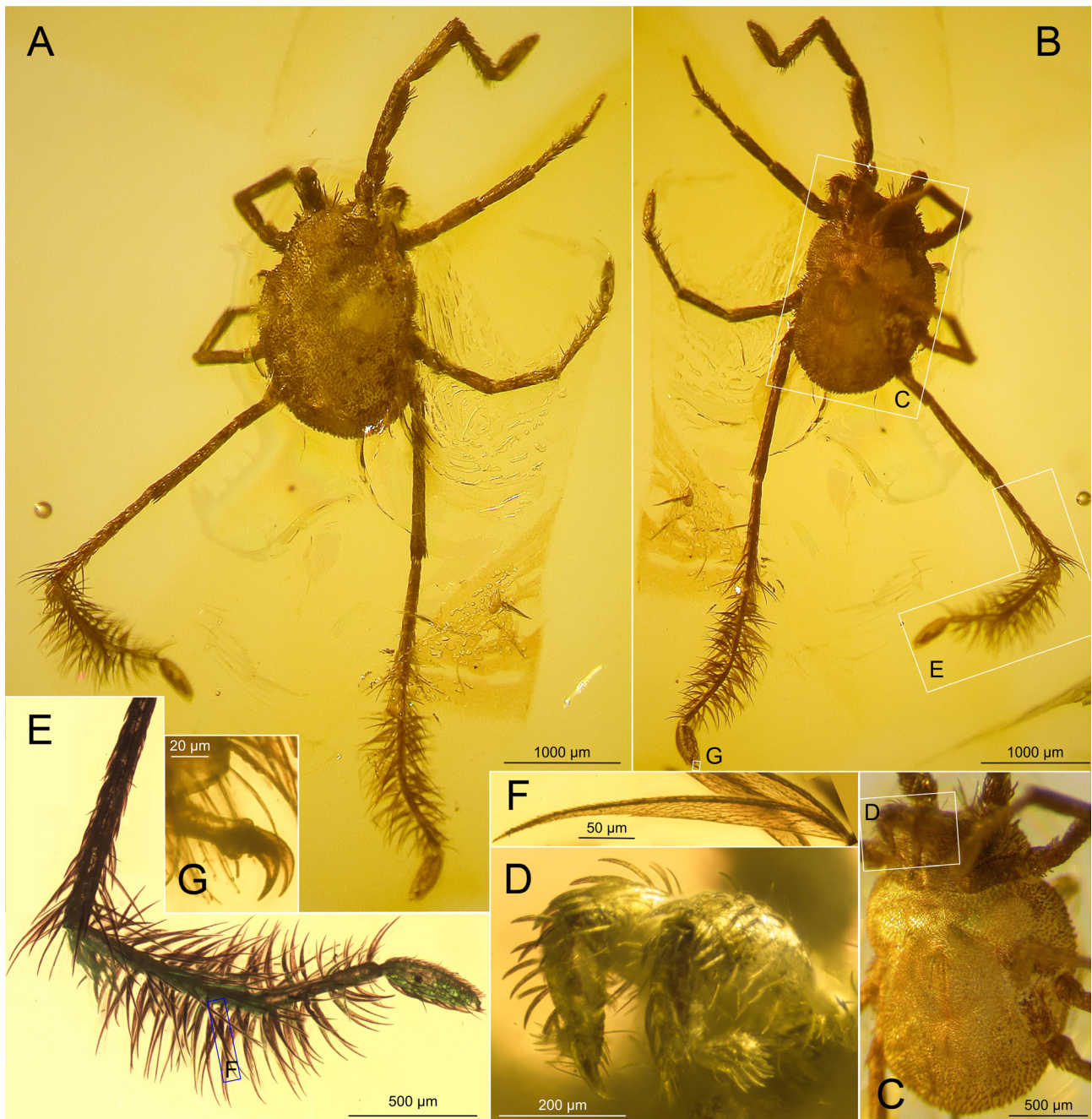


FIGURE 2. *Eatoniana crinita* sp. nov. (holotype, male, coll. no. SMF Be 13211a), light micrographs. A. habitus, dorsal aspect; B. habitus, ventral aspect; white frames indicate positions of subfigures C, E and G; C. idiosoma, ventral view (note the genital opening at the level of coxae III–IV and anus, located posterior to GOP); white frame indicates position of subfigure D; D. gnathosoma, antero-lateral aspect; E. leg IV, genu (part) - tarsus; dark frame indicates position of subfigure F; F. modified seta on tibia IV; G. termination of tarsus IV.

Diagnosis. Adult male. Palptibia with [?]3 conical, smooth-sided, spinose setae distributed along the ventral surface of the segment. Eyes, each composed of double lens, placed on either side of the laterally to crista, at the midpoint of the crista rod. Dorsal idiosomal setae uniform, thick, leaf-like in front view and slightly bent in side view, covered with short thorn-like projections on entire surface. Genital orifice surrounded with sclerotized plates, located between coxae III–IV. Long, lanceolate, distinctly widened setae present on the distal end of genu IV and on entire length of tibia IV. *Deutonymph.* General appearance as in adult. Setation of idiosoma and of legs sparser. Position of external genital plate not detected. Other qualitative traits as in adult. *Larva.* Not known.

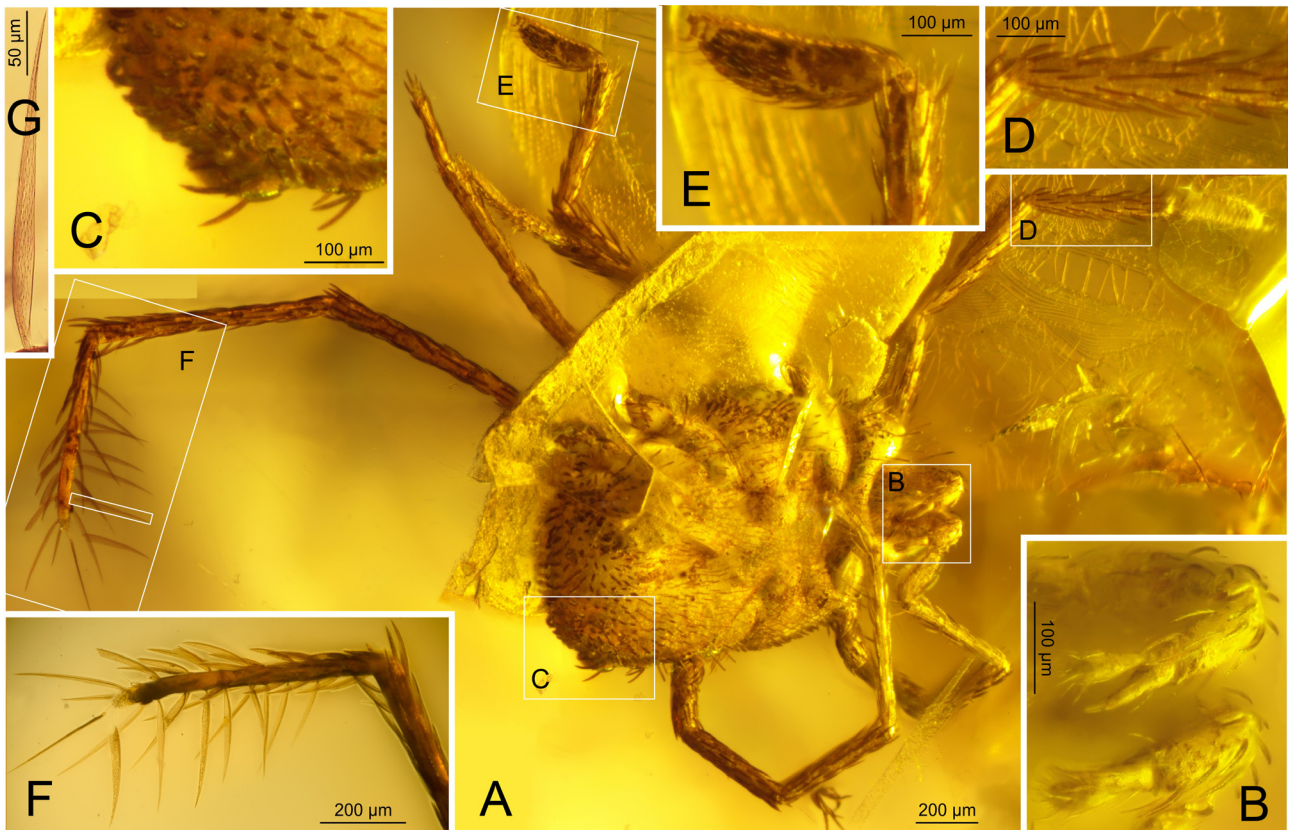


FIGURE 3. *Eatoniana crinita* sp. nov. (paratype, deutonymph, coll. no. 4545), light micrographs. A. habitus, ventral aspect (note the genital opening at the level of coxae III–IV and anus, located posterior to GOP); white frames indicate positions of subfigures B, C, D, E, F, G; B. gnathosoma, antero-ventral aspect; C. setae on postero-ventral part of idiosoma; D. tibia I; E. tibia (part) and tarsus I; F. genu (part) and tibia IV; G. modified seta on tibia IV.

Description

Adult male (holotype). Figures 1–2. Metric data in Table 1.

Habitus (Figs 1B, 2A, 2B). Gnathosoma (Figs 1A, 2D). Palpal segments with slender, elongate, delicately barbed setae; on dorsal side of palpfemur (PaFe) and palpgenu (PaGe) setae thickened, covered with more distinct setules. Three robust, smooth, spine-like setae distributed along the ventral edge of palptibia (PaTi). Odontus simple. Palptarsus markedly widening distally and extending slightly beyond the tip of the odontus.

Idiosoma dorsum (Figs 1B–D, 2A). Crista metopica (Figs 1B, 1C) linear, with posterior termination reaching *ca* one fourth of the body length. Scutum absent. The shape of the anterior sensillary area undetermined due to setae, but with a pair of trichobothria (ASens) and twelve normal, elongate and thickened setae of different lengths. Posterior sensillary area tear drop shaped, bearing a pair of trichobothria (PSens). Anterior trichobothria slightly longer than the posterior ones, both are thin and smooth. Eyes (Fig. 1C) located laterally to crista, at the level of *ca* half length of the crista rod; each eye composed of two circular lenses, posterior lens [?] larger than the anterior one. Dorsal idiosomal setae (Fig. 1D) uniform, short and thick, leaf-like (ovoid) in front view, slightly bent in a lateral view, evenly covered with minute thorn-like projections (modified setules).

Idiosoma venter (Figs 1E–G, 2B, 2C). Ventral setae are thinner than the dorsal setae, gradually become more robust, similar to the pDS, posteriorly. Coxal plates and genital valves covered with narrow and acuminate setae (Fig. 1F) that are slightly longer than VS (Fig. 1G). Coxal plates I–II and III–IV contiguous. Genital opening (Figs 1E, 2C) surrounded by external valves (epivalves), located at the level of coxae III and IV. Anal opening (Figs 1E, 2C) posterior to coxal plates.

TABLE 1. Morphometric data for *Eatoniana crinita* sp. nov.; measurements of structures located perpendicularly to the optical axis are indicated in bold; measurements of skewed structures - in normal font. ‘-’ measurements unavailable due to the distortion of sample.

specimen	holotype	paratype
character	male	deutonymph
	coll. no. SMF Be 13211a	coll. no. 4545
gnathosoma		
PaTr (L)	137	87
PaFe (L)	295	176
PaGe (L)	170	124
PaTi (L)	81	71
PaTa (L)	114	88
odontus (L)	71	38
idiosoma		
IL	1997	1272
IW	1300	766
IL/IW	1.54	1.66
CML	583	-
ASens	150	-
SBa	30	-
PSens	140	-
SBp	25	-
AL	-	-
ISD	493	-
aO	49	-
pO	56	-
DS	42	42
VS	45	41
GOP (L)	468	-
GOP ¹ (W)	178	-
AOP (L)	127	77
AOP ¹ (W)	-	-
legs		
Cx I (L)	421	222
Tr I (L)	253	-
bFe I (L)	391	-
tFe I (L)	601	409
Ge I (L)	679	565
Ti I (L)	618	481
Ta I (L)	514	250
Ta I (W)	165	98
leg I	3477	-
Cx II (L)	444	236
Tr II (L)	214	161
bFe II (L)	223	157
tFe II (L)	419	302

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TABLE 1. (Continued)

specimen	holotype male	paratype deutonymph
character	coll. no. SMF Be 13211a	coll. no. 4545
Ge II (L)	532	295
Ti II (L)	509	407
Ta II (L)	360	205
leg II	2701	1762
Cx III (L)	475	239
Tr III (L)	177	127
bFe III (L)	262	158
tFe III (L)	403	367
Ge III (L)	582	430
Ti III (L)	650	579
Ta III (L)	372	235
leg III	2921	2134
Cx IV (L)	444	163
Tr IV (L)	304	168
bFe IV (L)	389	219
tFe IV (L)	996	575
Ge IV (L)	1089	842
Ti IV (L)	1332	653 [partly broken]
Ta IV (L)	429	-
leg IV	4983	-
IP	14082	-

¹ includes the size of external valves.

Legs (Figs 1B, 1H–L, 2A, 2B, 2E–G). All legs composed of seven segments (including coxal plates). Legs IV distinctly longer than legs I–III (Figs 1B, 2A, 2B). Normal setae (except for those arising at coxae) thickened, narrowing apically, covered with delicate setules; setae on the trochanter to genu legs I–II and trochanter to telofemur legs III–IV relatively short and nearly uniform in shape and length (Fig. 1I); setae on tibia I–II and genu III–IV more elongate (Fig. 1J), occur between shorter ones, especially in distal parts of the segments. Tibia III with a few long setae oriented almost perpendicular to the long axis of the segment. Distinctly longer, plume-like setae present in the distal part of genu IV and still longer ones (*ca* 360 μ m), with membranous surface covered with bristles and with well-marked, more sclerotized outer margin (Fig. 1L)—along the entire length of tibia IV. Normal setae on tarsus I short (*ca* 50 μ m) and narrow (Fig. 1K). Specialized, needle-like (solenidia) and nude setae of eupathidium type (Fig. 1H) observed on telofemur to tarsus I, on basifemur to tarsus II and III, and on telofemur to genu IV; in addition to the latter ones, minute, smooth, spine-like setae were present on tarsus I. The detectable number of specialized setae on particular leg segments is the following: leg I—7 (tFe I), 7 (Ge I), 5 needle-like setae and *ca* 11 curved ones, distributed dorsally (Ti I), *ca* 50 minute (20 μ m) nude, spine-like setae (Ta I); leg II—[?]1 (bFe II), 3 (tFe II), 5 (Ge II), 11 (Ti II), 7 (Ta II); leg III—[?]1 (bFe III), 2 (tFe III), 5 (Ge III), 6 (Ti III), 3 (Ta III); leg IV—4 (tFe IV), 5 (Ge IV). All tarsi terminated with two simple claws (Fig. 2G).

Deutonymph (paratype). Figure 3. Metric data in Table 1. Setation of idiosoma and legs sparser than in adult. Position of external genital plate was not observed. Other qualitative traits as in adult. The value of measurable traits smaller than in adult.

Discussion

Six extant species of *Eatoniana* are known for postlarval instars, of which five possess the „plume footed” habitus. Most of these are poorly described, and their status cannot be verified (Małkol & Wohltmann 2012; Małkol & Sevsay 2015). Nearly all extant species are found in and around the Mediterranean Region extending eastward into Armenia and Turkmenistan and southward to the tip of Africa (Koch 1856; Lucas 1864; Birula 1893; Cambridge 1897; Trägårdh 1905; Lawrence 1937; Małkol & Sevsay 2015). In addition, specimens have been reported from sand dunes on the west coast of France (Faucheux 1979), on two of the Channel Islands (Guernsey and Jersey), off the northern coast of France (George 1896; Browning 1956; Long 1980) and Switzerland (Haller 1885; Schweizer & Bader 1963). There are no other extant species of *Eatoniana* currently recorded from northern Europe (Haller 1885).

Eatoniana crinita sp. nov., with adult and deutonymph described, is the first named species of *Eatoniana* known from fossil deposits. An unnamed member of the genus from the Eocene imaged by Weitschat & Wichard (2002) appears to be an adult based on the general habitus and the density of setae.

Paleontologists sometimes propose new genera and families solely based on age (Penney 2016) and not on adequate comparisons with extant taxa. In the Erythraeidae, separating active postlarval instars at the species level can be challenging with extant species and fossil specimens make the process more difficult. The distinct, plume-like setae on distal genu and on the entire length of tibia IV is diagnostic for the active postlarval *Eatoniana*, whereas the taxonomic affiliation of the remaining species assigned to the genus (Małkol & Sevsay 2015) and lacking the plumose setae should be re-appraised.

Eatoniana crinita sp. nov. was compared with the redescribed *E. plumipes* (Małkol & Sevsay 2015). The new species can be separated from *E. plumipes* in having fewer and shorter plumose setae on tibia leg IV. In addition, the plume setae on tibia legs IV are lanceolate (Figs 1L, 2F, 3G), whereas the same setae on *E. plumipes* are linear or only indistinctly widened. Metric data are of limited value when dealing with single specimens and different sexes. The overall body size of the male *E. crinita* sp. nov. (1997 x 1300) and its deutonymph (1272 x 766) were smaller than the female *E. plumipes* and its deutonymphs. In addition, leg IV of the male *E. crinita* sp. nov. (4983) was significantly shorter than the female *E. plumipes* (6285), despite having legs I–III that were about the same length as or longer than the female of *E. plumipes*. The latter, however, may reflect the dimorphic trait. The legs of the deutonymphal *E. crinita* sp. nov. were incomplete and could not be compared, but the palp was significantly shorter (546) compared to *E. plumipes* which ranged in length from 799 to 926.

The holotype of the newly described species was identified as a male based on the position of genital opening. We could not detect the position of the external genital plate and the anus in the deutonymph. In the female but also in the deutonymph of *E. plumipes* the genital orifice is shifted to anterior part of idiosomal venter (Małkol & Sevsay 2015), whereas its position in males is between coxae III and IV in multiple specimens of one species (Welbourn, unpublished data). The position of the female genital orifice between coxal plates I and II had been previously reported by Cambridge (1897) and by Faucheux (1979, ref. fig. 17), however the latter author did not refer to the sex. Probably the location of the genito-anal region in female and in male is sex-dependent and typical for all members of *Eatoniana* having the plume-like setae on legs IV.

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