Wilfried Wichard

Overview and descriptions of Trichoptera in Baltic amber

Spicipalpia and Integripalpia

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(1877-1963)

Wilfried Wichard

Overview and Descriptions of Trichoptera in Baltic Amber

Spicipalpia and Integripalpia

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1 Introduction

In 1742 Nathanael Sendel (1686-1757), August Des Starken's medical attendant and physician in Elbing, published his main work "Historia succinorum corpora aliena involventium et naturae opere pictorum et caelatorum ex Augustorum I et II cimeliis Dresdae conditis aeri insculporum", with which he laid the foundation for future paleobiological amber research (Wichard & Wichard 2008). Sendel (1742) was the author of a compendium on fossil inclusions of Baltic amber, which originated from the amber collection of the well-known natural history collection of Dresden, and illustrates, on 12 copper tables, animal and plants encased in amber. On these tables fossil caddisflies were documented for the first time. However, Sendel did not recognise them as caddisflies but categorised the specimens to the butterflies, which are much rarer in Baltic amber (Greven & Wichard 2010).

In the middle of the nineteenth century, trichopteran research, which was yet to develop, already dealt with Baltic amber inclusions. The physician and entomologist Herman August Hagen (1817-1893) and the Swiss zoologists and palaeontologist François Jules Pictet (1809-1872) described 21 caddisfly species from Baltic amber. Hagen and Pictet presented these results in the last part of the monograph "Die im Bernstein befindlichen organischen Reste der Vorwelt", published between 1845 and 1856 (posthumously) by Georg Carl Berendt (1790-1850), amber researcher and physician in Danzig. First evidence on fossil caddisflies in Baltic amber was provided by Ernst Friedrich Germar (1786-1853) in Halle, with his description of *Holocentropus* (*Phryganeolitha*) *vetusta* (Germar, 1813).

The first and decisive scientific breakthrough of trichopteran research was not achieved before 1912, when Georg Ulmer (1877-1963), teacher in Hamburg-Eppendorf, elaborated his monograph on Trichoptera in Baltic amber, including 152 described species of 56 genera (26 of which are extant) and 12 families. This early work has since belonged to the best revisions of insect groups in Baltic amber and contributed to Ulmer's honour title of Doctoris honoris causa, awarded by the University of Basel (Lenz 1964, Weidner 1964). In the beginning of the twentieth century, Ulmer focussed on faunistics and systematics of Trichoptera and contributed essentially to the foundation of qualified, future trichopteran research. His substantial work on amber caddisflies is the basis of current taxonomic and paleobiological research of Trichoptera in Baltic amber.

Many valuable amber collections have been destroyed or disappeared during World War II, like all of the important amber Trichoptera, that were the basis of Ulmer's research. 5060 pieces of amber from 14 collections were used from Ulmer for his studies, two of which were based on the big collection of Klebs, which contained about 1600 pieces and the collection of the University of Königsberg (Geological-Paleontological Institute) with about 2300 pieces with embedded caddisflies. However, not all of these amber inclusions were suitable for description, especially not the "masses of female specimens, which needed to be almost exclusively ignored" (translated from Ulmer 1912, p.6). In his monograph Ulmer labels the described specimens as "types" (holotypes), which are marked by the first figure ("durch die erste Figur") in his species description; all other specimens in the type series of the respective species are paratypes. Most of these holotypes and paratypes are lost and only a few remain as evidence.

Between 1970 and 2010, at least 15 000 fossil caddisflies were examined for the compilation of a new collection of Trichoptera in Baltic amber. Over 1500 taxonomically usable specimens were chosen and contributed, amongst others, to potential new description of overall 32 species, which either belong to Spicipalpia or Integripalpia and are presented in the present work. Furthermore, the selected 1500 pieces of amber are including several but not all of Ulmer's species. Some of these original descriptions are verified and others, if necessary, completed and revised. Almost 90% of the 15 000 examined amber caddisflies belong to the Annulipalpia (especially to the family Polycentropodidae). The remaining 10% of the caddisfly specimens belong to the Spicipalpia or Integripalpia. This explains why many species that were described from Ulmer in 1912 and many of the new species described in this book, are often based on one holotype and only occasionally on a further paratype.

100 years after Ulmer's commendable amber work (1912), the research on Eocene Trichoptera is currently steadily expanding. Evolutionary biology creates the framework for new insights into the systematics and taxonomy, paleobiogeography and paleoecology of Trichoptera. "Over the years, the family Sericostomatidae has been used as a "dumping ground" for genera unable to be placed with confidence in other families" (Holzenthal et al. 2007). In the meantime, some subfamilies once included in Sericostomatidae and found in Baltic amber (Ulmer 1912) have been upgraded to discrete families. Furthermore, new findings provided evidence about further families that were not yet included in Ulmer's amber material (1912). All of these families are represented with extant species. One exception is the family Ogomymidae, whose species are apparently extinct. Overall, caddisflies of Baltic amber are distributed into 26 families (Tab 2.)

In 1912 Georg Ulmer listed 9 Spicipalpia and 48 Integripalpia species in his summarizing revision. During the last 100 years Ulmer's species list was extended by the addition of only 4 Spicipalpia and 6 Integripalpia species. The revision of the Trichoptera in Baltic amber presented in this publication deals with the suborders Spicipalpia and Integripalpia and increases the overall species number to currently 99. The following results are presented: the family Ogmomyidae and eight genera are newly established. Descriptions of 13 new Spicipalpia and 19 new Integripalpia species are provided. The now known 26 Spicipalpia species are distributed into 5 families and 8 genera, the 73 Integripalpia species into 14 families and 36 genera. Two species could not be classified and remain unplaced (incertae sedis).

In contrast to the many other fossil Trichoptera, which are mostly imprints and incompletely preserved, showing only fragments of wings and wing venation, which results often in a dubious taxonomic identification, the Trichoptera of Baltic amber are often three dimensionally preserved. The specimens show mostly the necessary characteristics, as for example tibial spurs, ocelli and maxillary palps, which allow a clear determination of family and genus (Tab. 3). Nevertheless, the fossil Trichoptera from Eocene Baltic amber are hardly qualified for a phylogenetic analysis with fossil and recent taxa together. Many characteristic features that are used for a phylogenetic analysis of recent taxa, are not available in fossil taxa. Especially the description of the genital fine structure is sometimes very limited. Some fossil species on the other hand are endowed with characteristic features that challenge a combined and simultaneous phylogenetic analysis of fossil and extant taxa. The described holotypes and neotypes are deposited in different collections (Tab. 1), in particular in the Museum für Naturkunde der Humboldt Universität Berlin. In this review some neotypes are designated to stabilise the taxonomy of the genus and of the missing species.

This revision of Trichoptera would not have been possible without the contribution of some museums and private collections, which unfortunately contained only very rarely old amber stocks or were only established in recent years. These collections provided a valuable addition to my private collection of Trichoptera in amber, which I have been building up in the past 40 years for this revision. I cordially thank everybody who enabled access to her or his collection and kindly allowed me to examine the fossil caddisflies for this revision. I especially thank Wolfram Mey and Christian Neumann (Museum für Naturkunde, Humboldt Universität, Berlin), Claudia Franz and Wolfgang Tobias (Senckenberg Forschungsinstitut and Museum, Frankfurt), Mike Reich and Hans Jahnke (Geowissenschaftliches Museum, Universität Göttingen, amber collection of the "Stiftung Preußischer Kulturbesitz"), Wolfgang Weitschat and Ulrich Kotthoff (Geologisch-Paläontologisches Museum, Universität Hamburg), R. Förster (Bayerische Staatssammlung für Paläontologie und historische Geologie München, amber collection Bachofen-Echt), Niels Peder Kristensen (Zoological Museum, University of Copenhagen), Andrew Ross and Claire Mellish (Natural History Museum London, Dept of Earth Sciences), Barbara Kosmowska-Ceranowicz (Museum Ziemi, Polska Akademia Nauk, Warsaw) and Irina Sukatcheva (Paleontological Institute RAS, Moscow). I'm equally indebted to the private collectors Alexander von dem Busche, Hamburg, Friedhelm Eichmann, Hannover, Carsten Gröhn, Glinde, I. & A. Herrling, Bramsche, Heiner Graben-horst, Wienhausen, Christel & Hans Werner Hoffeins, Hamburg, Bernd Vahldiek, Böhme, Franziska & Günter Witsch, Köln and Jörg Wunderlich, Hirschberg.

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Tab. 1 List and Acronyms of Depositories

BMNH	British Natural History Museum London
BSP	Bayerischen Staatssammlung für Paläontologie München
GPIMH	Geol.-Paläontol. Institute and Museum, University Hamburg
GZG	Geowissenschaftliches Zentrum der Universität Göttingen
MNHU	Museum für Naturkunde der Humboldt Universität Berlin
SMF	Naturmuseum Senckenberg Frankfurt
SMNS	Staatliches Museum für Naturkunde Stuttgart
ZMC	Zoological Museum, University of Copenhagen

Tab. 2: Systematic and classification

Extant families of the order Trichoptera and their records in Baltic amber (dark lettering), including the extinct family Ogmomyidae n.fam.

Spicipalpia

Glossosomatidae
Hydrobiosidae
Hydroptilidae
Ptilocolepidae
Rhyacophilidae

Integripalpia, Brevitentoria

Atriplectididae
Anomalopsychidae
Antipodoeciidae
Barbarochthonidae
Beraeidae
Calamoceratidae
Calocidae
Chathamiidae
Conoesucidae
Helicophidae
Helicopsychidae
Hydrosalpingidae
Leptoceridae
Limnocentropodidae
Molannidae
Odontoceridae
+Ogmomyidae n.fam.
Petrothrincidae
Philorheithridae
Sericostomatidae
Tasimiidae

Integripalpia, Plenitentoria

Apataniidae
Brachycentridae
Goeridae
Kokiriidae
Lepidostomatidae
Limnephilidae
Oeconesidae
Phryganeidae
Phryganopsychidae
Pisuliidae
Plectrotarsidae
Rossianidae
Uenoidae

Annulipalpia

Dipseudopsidae
Ecnomidae
Hydropsychidae
Philopotamidae
Polycentropodidae
Psychomyiidae
Stenopsychidae
Xiphocentronidae

Tab. 3: Genus key to Spicipalpia and Integripalpia in Baltic amber

TS	**OC**	**MXP**	
0/2/2	–	5	*Setodes*
0/3/4	+	5	*Agraylea, Allotrichia, Electrotrichia*
0/4/3	–	2	*Aulacomyia*
0/4/4	+	5	*Isochorema, Meyochorema*
1/2/2	–	1	*Stenoptilomyia*
1/2/2	–	5	*Electroadicella, Electrotriaenodes, Erotesis, Triaenodes*
1/2/4	+	3	*Electrocryptochia*
1/3/4	+	3	*Electroapatania*
1/3/4	+	5	*Allotrichia*
1/4/4	–	3	*Lithax*
2/2/2	–	5	*Perissomyia, Triplectides*
2/2/4	–	2	*Electrohelicopsyche, Helicopsyche, Palaeohelicopsyche*
2/2/4	+	5	*Beraeodes*
2/2/4	–	5	*Electroleptorussa, Fusuna*
2/3/3	–	3	*Brachycentrus*
2/4/4	–	1	*Archaeocrunoecia, Electrocrunoecia, Lepidostoma, Maniconeurodes*
2/4/4	–	3	*Goera, Lithax, Silo, Pseudoberaeodes, Sphaleropalpus,*
2/4/4	+	4	*Phryganea*
2/4/4	+	5	*Electragapetus, Palaeagapetus*
2/4/4	–	5	*Electrocerum, Electropsilotes, Marilia, Molanna, Molannodes, Ogmomyia, Electroganonema, Georgium, Ganonema*
3/4/4	+	5	*Rhyacophila*

(**TS** - tibial spurs, **OC** - ocelli, **MXP** - ♂ maxillary palps)

2 Suborder SPICIPALPIA - Cocoon-Making Caddisflies

Family key to the suborder Spicipalpia in Baltic amber
(based on described amber fossil species and considered features usually visible in amber: antennae, maxillary palps, tibial spurs, thoracal nota and wing venations)

1 Fossil forewings <2 mm, narrow, slender, often pointed apically
Hydroptilidae
(*Agraylea*)
(*Allotrichia*)
(*Electrotrichia*)

– Forewings usually >2 mm, broad and apically rounded ... 2

2 Hindwing discoidal cell closed, tibial spurs: 2/4/4 ... 3

– Hindwing discoidal cell open, tibial spurs: 0/4/4 or 3/4/4 ... 4

3 Second segment of maxillary palps slightly cylindrical, not globose, posterior setose head warts large and oval, almost touching in centre, mesoscutal setose warts without a dark subtriangular hair tail
Ptilocolepidae
(*Palaeagapetus*)

– Second segment of maxillary palps with a globular mesolateral projection, oval posterior setose head warts with a row of dark hairs along distal margin, mesoscutal setose warts with a dark subtriangular hair tail
Glossosomatidae
(*Electragapetus*)

4 Forewing anal cell short, fore- and hindwings discoidal cell open, tibial spurs: 3/4/4
Rhyacophilidae
(*Rhyacophila*)

– Forewing anal cell long, discoidal cell usually closed, hindwings discoidal cell open, tibial spurs: 0/4/4
Hydrobiosidae
(*Meyochorema* n.gen)
(*Isochorema* n.gen.)

Family GLOSSOSOMATIDAE Wallengren, 1891

Type genus: *Glossosoma* Curtis, 1834

Diagnosis. – Head with compound eyes, ocelli present, and filamentous antennae, shorter than forewings. Maxillary palps 5-segmented in both sexes, first two segments short, second segment globular with lateral projection, third segment at least as long as terminal segment or longer; labial palps 3-segmented; terminal segments of maxillary and labial palps pointed. Hindwing with closed discoidal cell. Tibial spurs: 0-2/4/4. Male genitalia with one-segmented inferior appendages (claspers).

Remarks. – The oldest fossils are known from Low Cretaceous: *Dajella tenera* Sukatcheva, 1990 within the subfamily +Dajellinae (Ivanov & Melnitsky 2006). From Miocene five fossil glossosomatids are known, four in Dominican (*Cubanoptila*: Wichard 2007) and one species in Mexican amber (*Culoptila*: Wichard et al. 2006).

Electragapetus Ulmer, 1912

Type species: *Electragapetus scitulus* Ulmer, 1912

Diagnosis. – Head with 5-segmented maxillary palps, segments one and two short, segment three little longer than terminal segment, weakly pointed. Head capsule with an unpaired frontal setose wart and three pairs of setose warts: antennal sw., postgenal (ocellar) sw., and occipital (posterior) sw. In the described fossil species from Baltic amber the occipital setose warts bear a obtrusive close row of dark brown hairs at distal wart margin. The pair of mesoscutal setose warts forms anteromesally a dark subtriangular tail probably consisting of a carpet of fine hairs (Fig. 5 b, c). The distal, salient angle of the long carpet rounded and overlaps little the anterior mesoscutellum. Bilaterally the furry subtriangular tail is accompanied by long hairs rooted in the tegulae. Wing venation complete, in forewing with forks I to V present (but in fossil *E. novus* n.sp. fork IV absent); in hindwing forks I, II, III, and V present; forks I and II petiolate; fork I near wing margin, fork II beyond cross-vein s; cross-veins r and r-m usually not directly connected to cross-vein s; closed discoidal cell very small and pentagonal. Abdominal segment VI with a ventral process, broad at base and rounded at apex forming a semicircular lobe. Tibial spurs: 2/4/4. Male genitalia with one-segmented inferior appendages, often longer than wide, sligthly holed, distally with a dark tooth inside the concave surface. Superior appendage basally broad in extant species and in Baltic amber fossil species formed like an inwardly bent spike. Tenth tergite divided into two lateral lobes. The aedeagus is bilaterally accompanied each with a long rod.

Fig. 2: *Electragapetus intectus* n.sp. in Baltic amber, in ventral view

Remarks. - The archaic genus *Electragapetus* belonging to the subfamily Agapetinae is consisting of two subgenera: *Eoagapetus* MARTYNOV, 1934 and *Electragapetus* ULMER, 1912. Now, four Baltic amber fossils (of subgenus *Electragapetus*) are accompanied by six extant species (probably all of the subgenus *Eoagapetus*), which are found in Russian Far East and Japan (VSHIVKOVA & AREFINA 1996, MORSE 2013). Extant species lack the dark, subtriangular hair tail on mesoscutum known from the Baltic amber fossils (Fig. 5 b, c). Probably this conspicuous feature distinguishs the fossil subgenera *Electragapetus* s.str..

Key to species of Glossosomatidae (*Electragapetus*) in Baltic amber

1 In ventral view basal part of claspers broad	*E. scitulus*
– In ventral view basal part of claspers as small as apical part	2
2 Phallic apparatus short, not overtopping the claspers	*E. elegans* n.sp.
– Phallic apparatus long, overtopping the claspers	3
3 Forewing apical fork IV present	*E. intectus* n.sp.
– Forewing apical fork IV absent	*E. novus* n.sp.

Electragapetus scitulus Ulmer, 1912

Figs.: 3, 4

Type: Male holotype in Baltic amber ex coll. Hermenau (H 91) and further two syntypes ex coll. Klebs (x3298, a383) are missing. A neotype is designated and deposited in the amber collection of MNHU (ex coll.Wichard).

Diagnosis. – Length of forewing 3.8 mm.
Ocelli present. Antennae filamentous, shorter than forewings. Maxillary palps 5-segmented, segments one and two short, second segment globular with lateral projection, segment three little longer than terminal segment, weakly pointed. Labial palps 3-segmented, terminal segment weakly pointed. Forewing venation complete; hindwing apical forks I, II, III, V present, discoidal cell and thyridium cell in both wings closed, in hindwing discoidal cell small. Tibial spurs: 2/4/4.

The description from Ulmer (1912) can be completed by further characters:
1. the occipital setose warts bear a row of dark brown hairs along distal margin,
2. the mesoscutum is anteriomesally covered by a dark, furry, subtriangle overlay.
3. the inferior appendages bear a dark strong tooth inside the apical concave surface.
Electragapetus scitulus differs from all other fossil species by the broad basal shape of the one-segmented inferior appendages accentuated by a tooth in the middle of the inner margin.

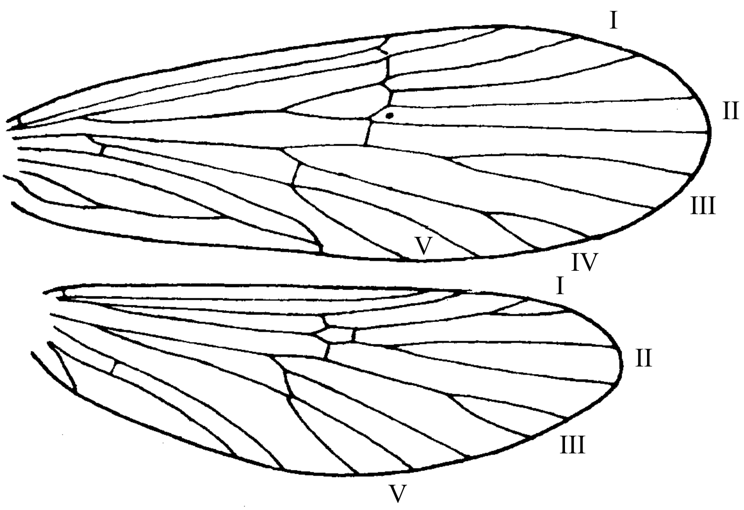
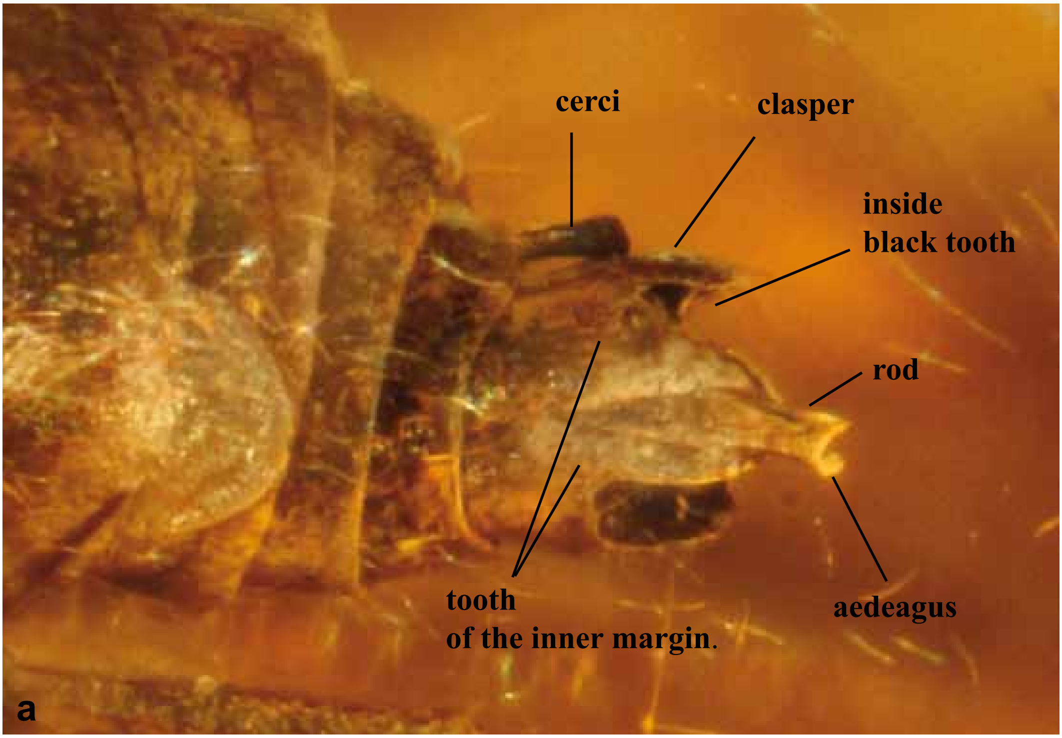
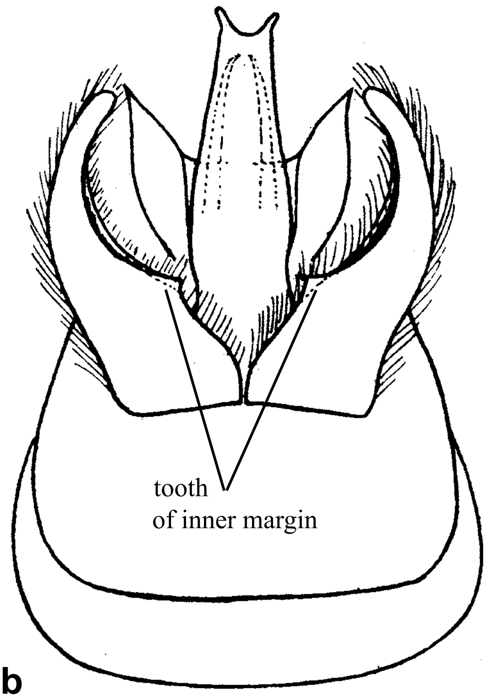


Fig. 3: *Electragapetus scitulus* Ulmer, 1912, wings, adopted from Ulmer (1912)





b

Fig. 4:
Electragapetus scitulus ULMER, 1912,
male genitalia in ventral view
a - detail screen from neotype
(with a dark tooth inside of the concave surfaces of the inferrior appendages, aedeagus with a pair of long rods, covered dorsolaterally by two X tergite lobes, dark, spike-shaped cercus)
b - adopted from ULMER (1912)
(dark tooth inside the concave surfaces of the inferior appendages not depicted)

Electragapetus elegans n.sp.

Fig. 5

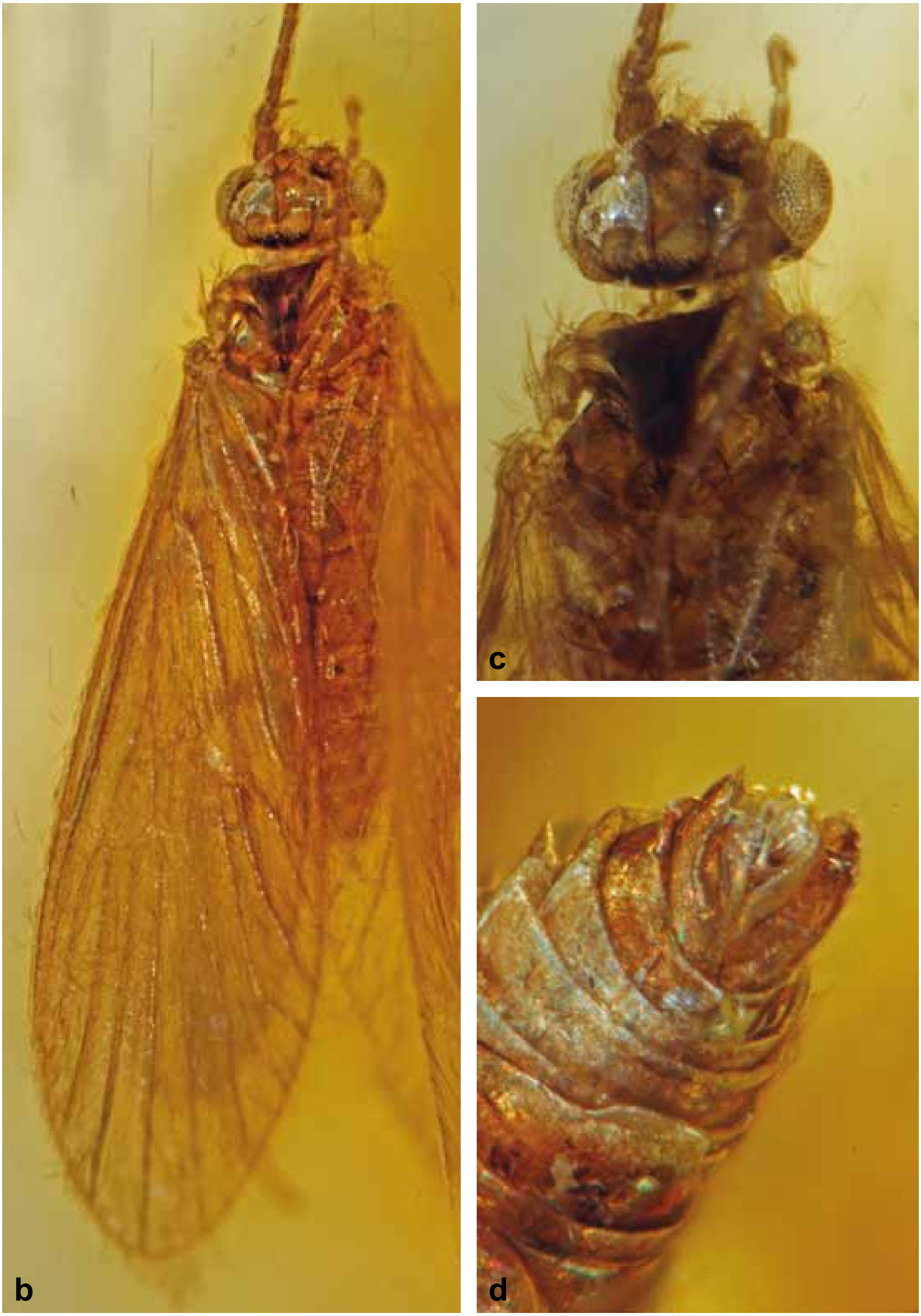
Type: Male holotype embedded in Baltic amber, kept in the amber collection of MNHU (ex coll. WICHARD).
Etymology: New species is a nice (= elegans, Latin), elegant fossil caddisfly.

Diagnosis. – Length of forewing 2.5 mm.
Electragapetus elegans n.sp. is characterised by the elongate and holed inferior appendages which do not possess a thooth in the middle of the inner margin as described of *Electragapetus scitulus*; the compact phallic apparatus does not project the distal level of the inferior appendages as occurring in all other species of *Electragapetus* from Baltic amber.

Description. – Head with 5-segmented maxillary palps, segment one and two short, segment two globose. Head capsule with one unpaired frontal setose wart and three paired compact setose warts. The occipital setose warts bear a continuous row of dark brown hairs - like brows - at distal wart margin. Mesoscutum anteromesally covered by a dark brown subtriangular tail, a clearly visible trait of the holotype of *Electragapetus elegans* n.sp. and very probably of all fossil species of *Electragapetus*. The dark triangular tail consisting probably of a carpet of fine hairs. The distal salient angle of the carpet is rounded and overlaps the anterior scutellum. Wing venation complete, in forewing with forks I toV, in hindwing fork I, II, III, and V present; fork I and II petiolate; cross-veins r and r-m mostly not directly connected to cross-vein s; closed discoidal cell very small and pentagonal.
Male genitalia with 1-segmented inferior appendages, longer than wide, sligthly holed, distally rounded, a dark tooth inside the apical concave surface. Superior appendage spike-like. In ventral view, tergite X divided into two pointed lobes behind the phallic apparatus.

Fig. 5: *Electragapetus elegans* n.sp.
a - male genitalia in ventral view
b - male in Baltic amber,
left wing in dorsal view
c - male head and thorax
with dark brown subtriangular furry trail
on mesoscutum
d - male genitalia in ventro-lateral view

a


b
c
d

Electragapetus intectus n.sp.
Figs. 2, 6

Type: Male holotype embedded in Baltic amber, kept in the amber collection of MNHU (ex coll. WICHARD)

Etymology: The amber inclusion is uncovered (= intectus, Latin) and well visible in ventral view.

Diagnosis. – Length of forewing 4 mm.
Electragapetus intectus n.sp. is characterised by following festures:
1. In ventral view, the inferior appendages are slightly holed; basally not as broad as in *Electragapetus scitulus,* basal part about as narrow as apical part.
2. Inferior appendage does not possess a thooth in the middle of the inner margin as in *Electragapetus scitulus* but bears a dark tooth inside the apical concave surface as in all amber fossil *Electragapetus.*
3. Aedeagus projects over the distal part of the inferior appendages as in most species of *Electragapetus*, except *Electragapetus elegans* n.sp.

Description. – Ocelli present, antennae filamentous, maxillary palps 5-segmented, segments one and two short, segment three slightly longer than terminal segment. Head capsule with an unpaired, frontal setose wart and three pairs of compact setose warts: antennal, postgenal, and occipital; the occipital setose warts bear a conspicious continuous row of dark brown hairs at distal wart margin. A pair of mesoscutal setose warts forms anteromesally a dark furry, subtriangular tail. Bilaterally the salient subtriangular tail is distad accompanied by long hairs coming from the tegulae. Wing venation complete, in forewing with forks I toV and in hindwing forks I, II, III, and V present; forks I and II petiolate; fork I near wing margin, fork II beyond cross-vein s; cross-veins r and r-m mostly not directly connected to cross-vein s; discoidal cell closed, small and pentagonal; fore- and hindwing venations very similar to *Electragapetus scitulus.* Abdomen with a ventral, semicircular process on segment VI.

In male genitalia:
1. inferior appendages elongate, slightly holed, dark teeth inside the apical concave surfaces
2. aedaeagus basally coated, on both sides accompanied by long rods
3. tergite X bifurcated, with two lateral lobes
4. cerci spike-shaped

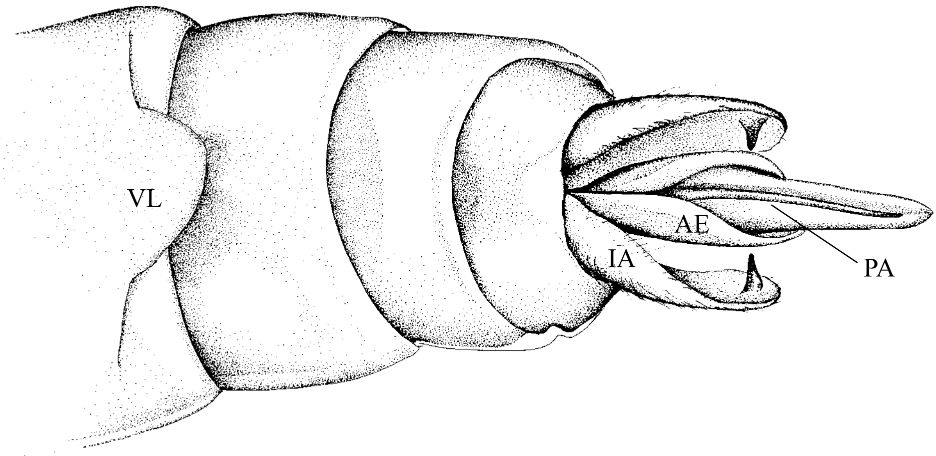


Fig. 6: *Electragapetus intectus* n.sp. - male genitalia in ventral view,

VL - ventral lobe of abdominal sternite VI
IA - hairy inferior appendages (clasper) with apical dark tooth on concave inside
AE - aedeagus coated by pale lobes, probably of abdominal segment X
PA - ight aedeagus accompanied by long rods (only one of two? visible)