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# Caddis-flies (Insecta: Trichoptera) from the Insect Limestone (Bembridge Marls, Late Eocene) of the Isle of Wight, UK

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ABSTRACT: The trichopteran assemblage of the Late Eocene Bembridge Marls is revised. six species in five genera and four families are identified, with four species and two genera described as new: (Beraeidae: *Beraeodes vectensis* Cockerell, 1921 and *B. anglicus* Cockerell, 1921; Phryganeidae: *Bembridgea insularia* gen. sp. nov.; Polycentropodidae: ?*Plectrocnemia incompleta* Sukatsheva, sp. nov.; Philopotamidae: *Wormaldia longaeva* Sukatsheva, sp. nov.; incertae familiae: *Paleodicella anomala* Sukatsheva, gen. sp. nov.). The assemblage is unique in being absolutely dominated by the generally uncommon family Beraeidae, and particularly by the single species *Beraeodes vectensis*. Except for a representative of ubiquitous Phryganaeidae, all the caddis-flies recorded apparently had oxy- and psychrophilous larvae confined to springs and cold streams (or else mosses near water), thus indicating the absence of fresh lakes or slow running waters near the depositional water body.

KEY WORDS: Beraeidae, fossil insects, Philopotamidae, Phryganeidae, Polycentropodidae

Caddis-flies are a group of amphibiotic holometabolous insects with aquatic larvae (often living in transportable retreats called caddis cases) and aerial, moth-like adults. Many taxa of caddis-flies are ecologically specific and indicative of (palaeo)environments. The caddis-flies represent a minor component of the insect assemblage of the Bembridge Marls deposits (Isle of Wight, England, which was considered to be early Oligocene in age (Gale *et al*. 2006), but now considered to be latest Eocene (Priabonian) in age (Hooker *et al*. 2007, 2009). However, the composition is unusual compared to other assemblages because of the abundance of Beraeidae.

A total of 71 fossil specimens were studied, mainly as isolated wings, sometimes accompanied with the incomplete body remnants. The majority of them (53 specimens, or 74%) belong to the small and rare family Beraeidae, hitherto unknown as fossils in rocks. Four fossils (6%) represent four other families (Phryganaeidae, Philopotamidae, Polycentropodidae, and incertae familiae), and the remaining 14 (20%) do not permit family identification because of insufficient preservation. All the material comes from the Insect Limestone, Bembridge Marls, at the northwest side of the Isle of Wight, southern England, and is kept at the Natural History Museum, London (NHMUK) as a part of P.B. Brodie, R.W. Hooley and E.J. A'Court Smith Collections.

## 1. Material and methods

The fossils were examined using a Wild (Heerbrugg, Switzerland) microscope with drawing tube, and photographed using Nikon Coolpix 4500 digital camera. Some pictures were taken by photographers at the NHM. Line drawings were hand made, based on photographs and sketches made under the drawing tube.

## 2. Systematic palaeontology

Order Trichoptera Kirby, 1815
Family Beraeidae Wallengren, 1891

**Description.** Wings 3·5–5 mm, rarely 7 mm long, densely pubescent, male fore wing usually with a basal pit furnished with a cover and scaled folds. Venation specialised (reduced and modified) and sexually dimorphic (e.g., fore wing of all males except *Beraeodes minutus* with extra M branch). Sc and R run parallel up to their apices, lacking interconnecting cross-vein. RS is forking somewhat after wing midlength and often accompanied with $rs_{3+4}$-m cross-vein nearby. Discoidal cell (DC, cf. Text-fig. 5) lost. Apical forks $F_2$ and $F_3$ often present. CuA often ends in fork. Hind wings are still more modified, with $F_3$ present only in females.

**Remarks.** Being ecologically indicative and dominant in the assemblage, Beraeidae deserves special discussion. The family comprises seven extant and one extinct genus from the Upper Eocene Baltic amber (Ulmer 1912; Morse 2006; Wichard 2013). Living Beraeidae mainly occur in Europe (*Beraea* Stephens, 1833; *Beraeodes* Eaton, 1867; *Ernodes* Wallengren, 1891; *Beraeamyiia* Mosely, 1930; and *Beraeodina* Mosely, 1931). Other living genera, often of debatable identity (Wiggins 1978), are known from rare records from Tanzania (*Notoernodes* Andersen & Kjaerandsen, 1997) and Japan (*Nipponoberaea* Botosaneanu, Nozaki & Kagaya, 1995). The eleventh, extinct genus is *Pseudoberaeodes* Ulmer, 1912 from Baltic amber. Additionally, a few species of *Beraea* are recorded in North America, Algeria and Central Asia, *Beraeodes* in the Caucasus and *Ernodes* from Turkey, the Caucasus and Japan.

All Beraeidae are small insects with densely pubescent wings only 3·5–5 mm, rarely 7 mm long. Wing venation is much reduced, modified and sexually dimorphic. Beraeidae are poor fliers and often abundant locally near their eclosion sites but never in other circumstances (V.D. Ivanov, pers. comm. 2006). Larval Beraeidae populate springs and streams with clear, cold water and feed on dead plant matter. They build small sandy tubes as caddis cases. Several European *Beraea* and *Ernodes* are known to develop out of water among mosses or larger plant fragments near stream or spring.

Beraeidae fossils from the Bembridge Marls all belong to the genus *Beraeodes*, which is otherwise known from the

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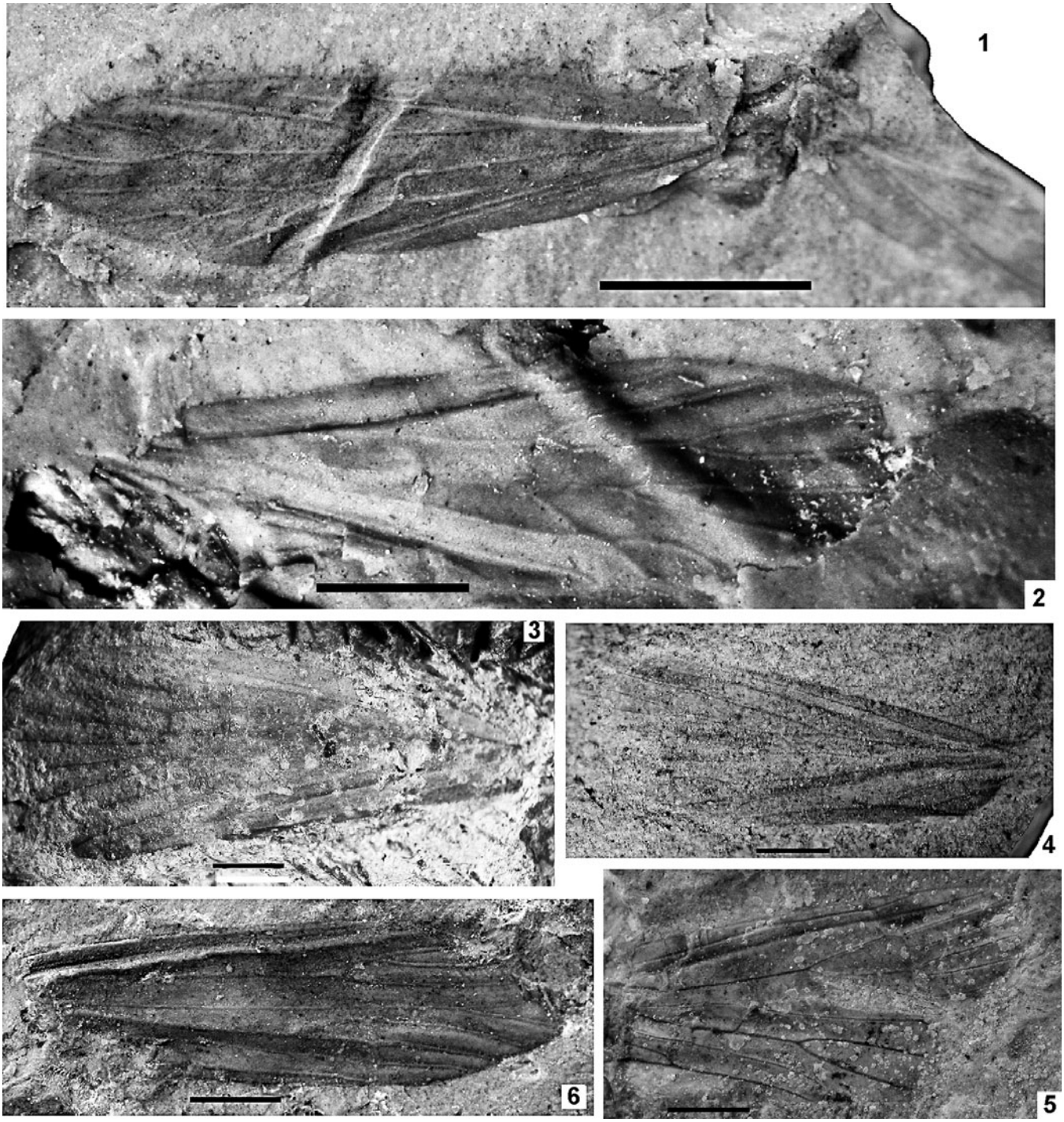


**Plate 1** (1) *Beraeodes vectensis* Cockerell, 1921, NHMUK In.43473, holotype; (2) *Beraeodes anglicus* Cockerell, 1921, NHMUK I.10240, holotype; (3) *Bembridgea insularia* sp. nov., NHMUK I.8668, holotype; (4) ?*Plectrocnemia incompleta* sp. nov., NHMUK In.24595, holotype; (5) *Wormaldia longaeva* sp. nov., NHMUK I.9718, holotype; (6) *Paleodicella anomala* sp. nov., NHMUK In.24630, holotype. Scale bars = 1 mm.

unique living species *B. minutus* (Linnaeus, 1761) and *B. pectinatus* Ulmer, 1912 from the Baltic amber. The Bembridge material under revision includes holotypes of two more extinct species, *B. anglicus* Cockerell, 1921 and *B. vectensis* Cockerell, 1921. Additional specimens of both species (18 of *B. vectensis* and two of *B. anglicus*), and 32 specimens of insufficient preservation state, are referred to as *Beraeodes* indet.

Apparently, *Beraeodes* represents a strikingly relict genus, with the majority of known species being extinct before the mid-Tertiary. The venational similarity and, possibly, close relationship between *Beraeodes* and *Pseudoberaeodes* known solely from Baltic amber, also suggests a long history for *Beraeodes*.

## Genus *Beraeodes* Eaton, 1867

1867 *Bereodes* Eaton, p. 400.
1879 *Beraeodes* McLachlan, p. 499 (emendation justified under ICZN 1999, # 33.2.3.1).

**Type species.** *Phryganea minuta* Linnaeus, 1761 (by monotypy), from Europe.

### *Beraeodes vectensis* Cockerell, 1921
Plate 1, fig. 1; Text-fig. 1

1921 *Beraeodes vectensis* Cockerell, p. 479, fig. 48.

**Holotype.** NHMUK I.9134/In.43473, Brodie/Hooley Collections (part and counterpart), female fore and hind wings

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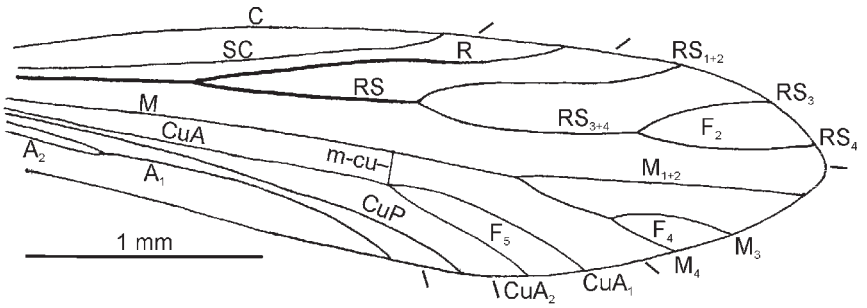
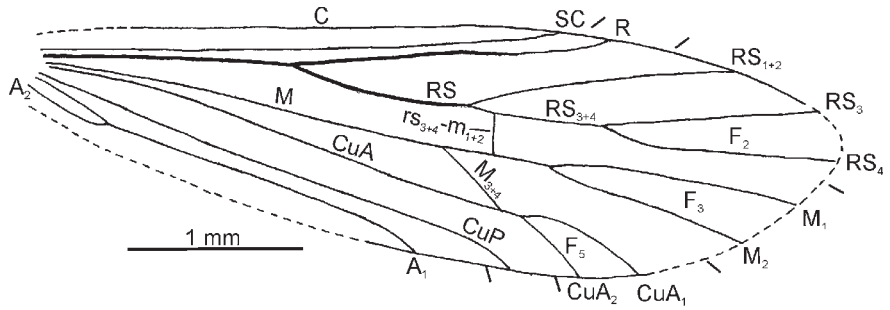



**Text-figure 1** *Beraeodes vectensis* Cockerell, 1921, holotype, NHMUK I.9134, late Eocene, Bembridge Marls, Isle of Wight, England. Abbreviations: $F_1$–$F_5$ = apical forks; other venational symbols are standard.




**Text-figure 2** *Beraeodes anglicus* Cockerell, 1921, holotype, NHMUK I.10240, late Eocene, Bembridge Marls, Isle of Wight, England. Abbreviations: $F_1$–$F_5$ = apical forks; other venational symbols are standard.

with thoracic fragments. Insect Limestone, Bembridge Marls, Isle of Wight, England.

**Other material.** 18 fossils, all NHMUK: three males (I.9256, I.9356(1), Brodie Collection, body and wings; In.26041, Hooley Collection, fore wing) and 15 females: wings with incomplete body (I.9288, I.9770, I.9863, Brodie Collection; In.17397, Smith Collection) and isolated fore wings (I.8964, I.9716, I.10038, Brodie Collection; In.17290, In.17351, In.17393, In.17499, Smith Collection; In.24633, In. 25382, In.25409, Hooley Collection; PI II.2823, part and counterpart, north end Thorness Bay, Collected 22.05.05, A.J. Ross).

**Diagnosis.** Sc short, reaching 0·5 of wing length. RS base at 0·25 wing length, $RS_{3+4}$ forking slightly basad of $RS_{1+2}$ apex, with stalk 1·2 times as long as $RS_4$. Cross-vein m–cu vertical.

**Description.** Fore wing lanceolate, acuminate apically, with fore and hind margins straight. Costal area widened subbasally, subcostal area narrow. Sc and R short, reaching respectively 0·5 and 0·7 of wing length, R straight. RS base at 0·25 wing length, RS stalk subequal to $RS_{1+2}$, forking near wing midlength. $RS_{3+4}$ forking slightly basad of $RS_{1+2}$ apex, with stalk 1·2 times as long as $RS_4$. Cross-vein rs-m absent. M forking at 0·65 wing length, with no $F_3$. $F_{1+2}$ straight. $M_{3+4}$ stalk subequal to $M_4$. Cross-vein m–cu vertical, placed at wing midlength at base of long $F_5$. CuP simple, long, meeting wing hind margin just anterior of $A_1$. $A_1$ meeting wing hind margin at level of RS fork. Hind wing narrower than fore wing, with no venation preserved. Fore wing length 3·0–6·5 mm (holotype: length 3·5 mm; width 0·9 mm; hind wing length 2·8 mm, width 0·7 mm).

**Comparison.** The present species is very similar to *B. minutus*, but differs in having short Sc, and in distal position of bases of RS and $RS_4$. Differs from another similar species *B. pectinata* from the Eocene Baltic amber in having cross-vein m–cu vertical and not oblique.

**Remarks.** *B. vectensis* is venationally similar also to *Ernodes*, which differs in shorter RS stalk and longer M branches, as well as in vertical m–cu. The high morphological stability of *Beraeodes* (except *B. anglicus*, see below) and related genera known almost exclusively from Europe may indicate their slow evolution within this territory only.

Wing length range of the species (3–6·5 mm) is unusually wide. However, no venational differences correlated with the wing size is observed, and distribution is not distinctly bimodal. One specimen with a wing length of 3·0 mm has been recorded (I.9256); eight with a wing length of 3·5 mm (I.9134 (= In.43473), I.9288, I.9770, I.10038, In.17290, In.17351, In.24633, In.25409); two with a wing length of 4·0 mm (I.8964, I.9356(1)); two with a wing length of 4·5 mm (In.25382, In.26041); one with a wing length of 5·0 mm (In.17393); one with a wing length of 6·0 mm (In.17499); and one with a wing length of 6·5 mm (In.17397). Excluding male wings (I.9256, I.9356(1), In.26041) makes the pattern slightly more bimodal: the progression 1:8:2:2:1:0:1:1:1 turns into 8:2:1:0:0:1:1:1. This might indicate the male In.26041 and females In.17393, In.17499, In.17397, with wing lengths of 4·5 mm and 5·0–6·5 mm respectively, as belonging to a distinct species with identical venation. However, with the limited information available, formal description of this species looks premature.

*Beraeodes anglicus* Cockerell, 1921
Plate 1, fig. 2; Text-fig. 2

1921 *Beraeodes anglica* Cockerell, p. 479, fig. 49.

**Holotype.** NHMUK I.10240, isolated female fore wing; Brodie Collection; Insect Limestone, Bembridge Marls; 'Gurnard Bay', Isle of Wight, England.

**Other material.** In addition to the holotype, two isolated fore wings I.9175 and I.9215 from the same collection.

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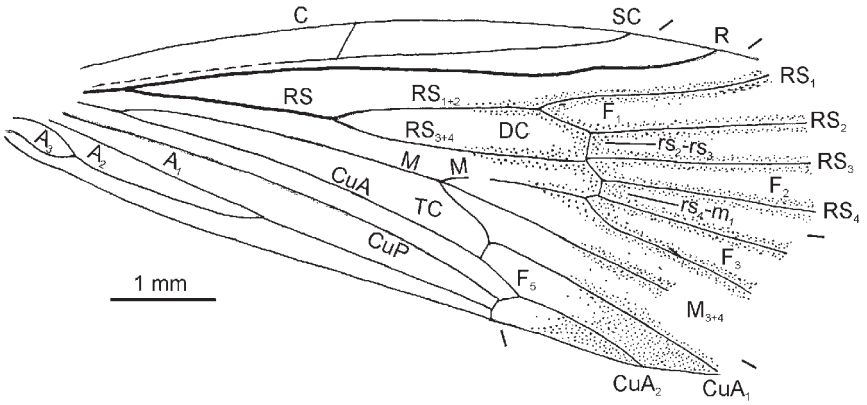


**Text-figure 3** *Bembridgea insularia* Sukatsheva, sp. nov., holotype, NHMUK I.8668, late Eocene, Bembridge Marls, Isle of Wight, England. Abbreviations: DC = discoidal cell; $F_1$–$F_5$ = apical forks; TC = thyridial cell; other venational symbols are standard.

**Diagnosis.** $F_4$ and $F_5$ fused traceless. Cross-vein m–cua placed on M at long distance from both $F_3$ and base of $M_{4+5}$

**Description.** Fore wing lanceolate, not coloured, with fore margin straight, slightly convex only basal of its junction with Sc and R. Costal and subcostal spaces narrow. Sc meeting wing fore margin at *c.* 5/8, R at *c.* 3/4 of wing length. RS leaving R at *c.* 3/8 of wing length and branching beyond wing midlength, slightly distal of branching of M. RS and M reduced in branching: apparently $F_1$ is lost and $F_4$ and $F_5$ are fused traceless. RS stalk 0·75 as long as $RS_{1+2}$. $F_2$ base at level of R apex, shorter that $F_3$. Cross-vein rs–m single, subvertical, slightly beyond RS fork. Apparent m–cua cross-vein long, oblique, evidently represent stalk of $F_4$ fused with $F_5$. $F_{4+5}$ short, forking slightly distal of m-cua. CuP simple, long. $A_1$ long, meeting wing hind margin at wing midlength at a distance from CuP apex. $A_2$ very short. Forewing length 4·5 mm, width 1·1 mm.

**Comparison.** Differs from all congeners in complete fusion of $F_4$ and $F_5$, and also in m-cua placed on M at long distance from both $F_3$ and base of $M_{4+5}$ ("oblique m-cu cross-vein").

Family Phryganeidae Leach, 1815
Genus *Bembridgea* Sukatsheva, gen. nov.

**Derivation of name.** After the source stratum name Bembridge Marls.

**Type species.** *Bembridgea insularia* sp. nov., from Bembridge Marls, Isle of Wight, England.

**Diagnosis.** Fore wing wide in apical half, strongly narrowing basally, roughly 2·5 times as long as wide. Costal area very wide, crossed with strong, weakly oblique cross-vein at level of RS fork. Subcostal area abruptly narrowed in basal half. $F_1$ starting moderately within DC. DC long and wide, 1·3 times as long as RS stalk. Cross-vein m–cu of moderate length, S-like bent. $F_4$ lost. $A_2$ comparatively long (0·55 times as long as $A_1$).

**Comparison.** The new genus is similar to a group of venationally uniform genera, including *Trichostegia* Kolenati, 1848, *Oligotricha* Rambur, 1842, *Hagenella* Martynov, 1924 and *Semblis* Fabricius, 1775, in having $F_4$ lost and m–cua S-like bent. It differs from these, as well as from all other Phryganeidae, in having c–sc cross-vein displaced distally, DC cell longer, sc–r crossvein lost, costal space wider, and $F_1$ in more distal position.

*Bembridgea insularia* Sukatsheva, sp. nov.
Plate 1, fig. 3; Text-fig. 3

**Derivation of name.** From *insula*, the Latin for island.

**Holotype.** NHMUK I.8668, isolated fore wing, probably male; P.B. Brodie Collection; Insect Limestone, Bembridge Marls; Isle of Wight, England.

**Diagnosis.** As for genus.

**Description.** Wing fore margin slightly convex. Sc straight, long, reaching level of rs–m. Subcostal area narrow basally, wide apically. R long, straight, slightly waved subapically. RS and M bases leveled. $F_1$, $F_2$, $F_3$ long, straight. Cross-veins $rs_2$–$rs_3$ and $rs_4$-$m_1$ straight and strong. M forking at wing midlength, slightly before midlength of DC. Bases of $F_2$ and $F_3$ levelled slightly distal of $F_1$ base. MC cell lost. Sinuate m–cu connecting the very point of M, forking with right-angled basal corner of $F_5$ placed basal of level of $F_1$ base. $CuA_2$ slightly arching inside $F_5$ after receiving arching $cua_2$–cup cross-vein. CuP bending at right angle at $cua_2$–cup to reach wing hind margin vertically, thus forming, jointly with $cua_2$–cup and apical section of $CuA_2$, smooth low curve delimiting narrow cell characteristic of Phryganeidae. $A_1$ ending at vertical section of CuP. Wing length 12·5 mm as preserved, wing width 5 mm.

**Remark.** Ecology unknown: extant phryganeids are diverse bionomically and give no clue to way of life of the new species.

Family Polycentropodidae Ulmer, 1906
Genus *Plectrocnemia* Stephens, 1836

**Type species.** *Plectrocnemia senex* Stephens, 1836 (nec Pictet, 1834), =*Plectrocnemia geniculata* McLachlan, 1871 (monobasic); contemporary Europe.

?*Plectrocnemia incompleta* Sukatsheva, sp. nov.
Plate 1, fig. 4; Text-fig. 4

**Derivation of name.** From *incompletus*, the Latin for incomplete.

**Holotype.** NHMUK In.24595, incomplete fore wing; R.W. Hooley Collection, Natural History Museum, London; Insect Limestone, Bembridge Marls, late Eocene; 'Gurnard Bay', Isle of Wight, England.

**Diagnosis.** Costal space with single oblique cross-vein at level of RS fork. $F_1$ present, long. DC closed, long and wide.

**Description.** Fore wing comparatively narrow, with fore and hind margins straight. Costal space narrow, slightly widening basally, with single oblique cross-vein at level of RS fork. Subcostal space ribbon-like narrow. DC closed with straight cross-vein $rs_{1+2}$–$rs_{3+4}$, 1·3 times as long as RS stalk. $F_1$ and $F_2$ long, sessile. RS and M bases levelled. M forking far distal of RS. $F_3$ short or lost. $F_4$ long, levelled with $F_2$ basally. Weak

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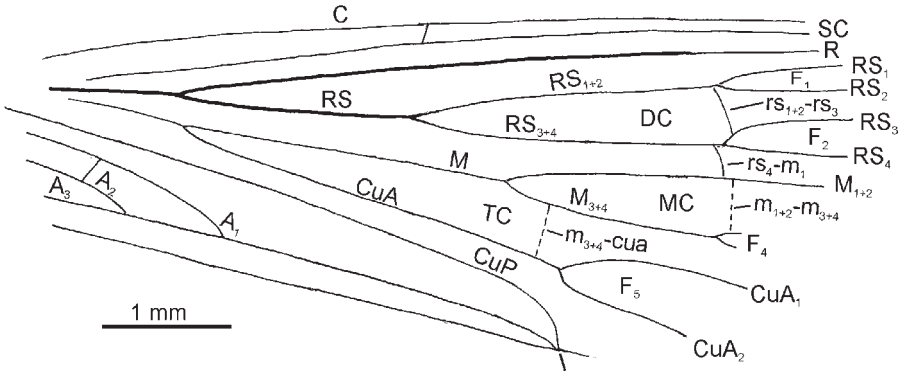
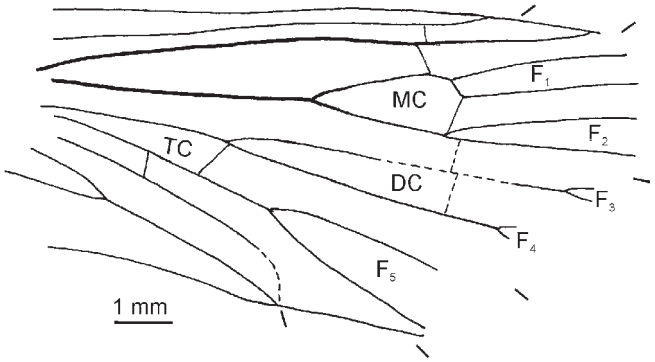



**Text-figure 4** *Plectrocnemia incompleta* Sukatsheva, sp. nov., holotype, NHMUK In.24595, late Eocene, Bembridge Marls, Isle of Wight, England. Abbreviations: DC = discoidal cell; $F_1$–$F_5$ = apical forks; MC = median cell; TC = thyridial cell; other venational symbols are standard.




**Text-figure 5** *Wormaldia longaeva* Sukatsheva, sp. nov., holotype, NHMUK I.9718, late Eocene, Bembridge Marls, Isle of Wight, England. Abbreviations: DC = discoidal cell; $F_1$–$F_5$ = apical forks; MC = median cell; TC = thyridial cell; other venational symbols are standard.

cross-veins $m_{1+2}$–$m_3$ and $m_{3+4}$–cua may exist. $F_5$ wide. CuP and $A_1$ coinciding at wing hind margin. $A_2$ and $A_3$ short. Strong interanal cross-vein present. Postanal space narrow. Fore wing more than 7 mm long, 2·5 mm wide.

**Remarks.** Taxonomy of Polycentropodidae is based on body structures, and particularly male genitalia, which are not available for the present fossil. Based on the fore wing fragment at hand, the new species is attributed tentatively to *Plectrocnemia*, based mainly on presence of $F_1$, on long, wide, and closed DC, and on presence of c–sc cross-vein which is placed somewhat distal of RS fork. On the other hand, long $F_1$ is unknown in extant and Eocene (Baltic amber) *Plectrocnemia* and characteristic rather of *Neuroclipsis* McLachlan, 1864, which has no cross-vein midlength in the costal space. This justifies description of the new species based on the insufficient material.

Contemporary *Plectrocnemia* are most abundant in Europe, but known also in North America and, rarely, in Australia, with larvae frequenting streams and springs.

Family Philopotamidae Stephens, 1829
Genus *Wormaldia* McLachlan, 1865.

**Type species.** *Hydropsyche occipitalis* Pictet, 1834 (selected by Ross 1949); contemporary Europe.

*Wormaldia longaeva* Sukatsheva, sp. nov.
Plate 1, fig. 5; Text-fig. 5

**Derivation of name.** From *longaevus*, the Latin for long living.

**Holotype.** NHMUK I.9718, I.9866(1), incomplete fore wing (part and counterpart); P.B. Brodie Collection; Insect Limestone, Bembridge Marls; Gurnard Bay, Isle of Wight, England.

**Diagnosis.** $F_1$ base wide, $F_2$ sessile, $F_4$ present, long-stalked. Cross-vein $rs_2$–$rs_{3+4}$ long, meeting very base of $F_2$.

**Description.** Wing fore margin straight. Costal space narrow, slightly widening basally, lacking cross-veins. Subcostal space narrow except for basally and apical, with short vertical cross-vein basal of Sc apex. R long, simple. DC short, wide, subtriangular, about half as long as RS stalk. All five apical forks present, $F_1$ and $F_2$ long, straight, $F_1$ with wide straight base, $F_2$ sessile. Cross-vein r–$rs_{1+2}$ strong, oblique, placed at widest place of DC, just before sc–r and base of $F_1$. $F_3$ stalk 1·3 times as long as $F_4$ stalk. $F_5$ long and wide. TC short, closed with strong, slightly oblique $m_{3+4}$–cua placed at M fork. Cross-vein cua–cup oblique, placed slightly distal of junction of $A_1$ and CuP and $A_2$. $A_1$ short, apparently co-incident at wing hind margin. $A_2$ short. Postcostal area very wide. Wing fragment 5·9 mm long and 3 mm wide as preserved.

**Comparison.** Differs from the type species in having $F_1$ base wide, $F_4$ present, and $rs_2$–$rs_{3+4}$ long and meeting very base of $F_2$. Differs from other extinct (Upper Cretaceous and Eocene) species as follows: long stalk of $F_4$ differentiates it from *W. angularia* Mey, 1986, *W. contigua* Mey, 1986 and *W. media* Ulmer, 1912; presence of $F_4$ differentiates it from *W. advenaria* Mey, 1988; wide base of $F_1$ differentiates it from *W. phaeromonia* Ivanov & Melnitsky, 2005, *W. sukatshevae* Ivanov & Melnitsky, 2005, *W. vlipla* Ivanov & Melnitsky, 2005, *W. myanmari* Wichard & Poinar, 2005, *W. praecursor* Botosaneanu, 1995 and *W. praemissa* (Cockerell 1916); and sessile base of $F_2$ differentiates it from *W. aequalis* (Hagen 1856)

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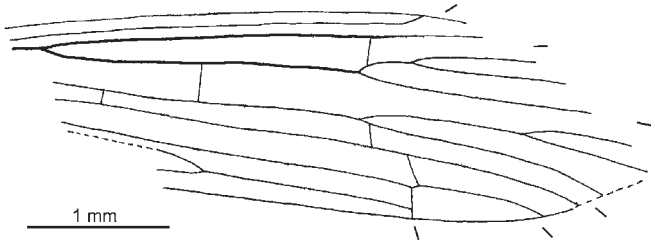


**Text-figure 6** *Paleodicella anomala* Sukatsheva, sp. nov., holotype NHMUK In.24630; late Eocene, Bembridge Marls; Isle of Wight, England.

and *W. congenera* (Ulmer 1912). Presence of $F_4$ may indicate position of the new species within the *W. copiosa* (McLachlan 1868) species group as defined by Malicky (1983).

**Remarks.** Taxonomy of *Wormaldia* is based mainly on the body morphology, including structure of male genitalia which are not available for the new species. The wing venation of Philopotamidae is known to vary even between left and right wing of one and the same specimen: this makes attribution and comparison of *W. longaeva* tentative.

Ivanov & Melnitsky (2005) conclude that based on genital and sternal structures, the Baltic amber *Wormaldia* (*W. aequalis, W. congenera, W. media, W. phaerimonia, W. sukatshevae*, *W. vlipla*) are related to the extant North Pacific and not to European species. It is not clear if this holds true with the present species.

Larval *Wormaldia* develop in cold, often mountain streams.

Familia *incertae sedis*
Genus *Paleodicella* Sukatsheva, gen. nov.

**Derivation of name.** From *palaios*, the Greek for old, and the leptocerid genus *Adicella*.

**Type species.** *Paleodicella anomala* sp. nov., by monotypy and present designation; late Eocene of Bembridge Marls, England.

**Diagnosis.** Fore wing long and narrow (length more than three times width). Costal and subcostal areas narrow. Cell DC very short, open. $F_1$ long, $F_2$ and $F_4$ absent. Cell TC very long. Cell enclosed by $CuA_2$, vertical CuP apex, and wing hind margin, long and wide. Hind wing narrow, with $F_1$ present.

**Comparison.** Similar to some Leptoceridae (*Adicella* McLachlan, 1877, *Erotesis* McLachlan, 1877, and several other genera) in having DC short. However, venation of the new genus is otherwise so unusual that does not permit attribution to a family with any certainty.

**Species included.** Type only.

*Paleodicella anomala* Sukatsheva, sp. nov.
Plate 1, fig. 6; Text-fig. 6

**Derivation of name.** From *anomalos*, the Greek for illegal.

**Holotype.** NHMUK In.24630, incomplete fore and hind wings; R.W. Hooley Colllection, Natural History Museum, London; Insect Limestone, Bembridge Marls; Gurnard Bay, Isle of Wight, England.

**Diagnosis.** As for genus.

**Description.** Fore wing with fore margin straight. SC long, straight, reaching level of $F_1$ base, R long, straight, lacking apical bend. $F_1$ long, petiolate, three times as long as its stalk. $F_3$ 0·9 times as long as its stalk. Cross-vein $r–rs_{1+2}$ strong, strictly vertical unlike slightly oblique $m_{3+4}$–cua and $cua_1–cua_2$. Cell TC long, starting more close to RS base than to rs–m cross-vein. $F_5$ wide, its fore branch $CuA_1$, its hind branch $CuA_2$ slightly arching, running backward almost vertically in a characteristic manner of Leptoceridae. CuP and $A_1$ long, jointly forming vertical section at level of $F_1$ base. $A_2$ of moderate length. Hind wing with forks $F_1$ and $F_3$ present, DC open, otherwise venation is not clear enough. Fore wing length 6·4 mm, width 3.2 mm.

## 3. Conclusion

The caddis-fly assemblage of the Bembridge Marls is composed of abundant Beraeidae with one dominant and another far subordinate species, and three other families (Phryganeidae, Philopotamidae and Polycentropodidae). All families recorded are also known in the Baltic amber assemblage, which is rather similar to the Bembridge Marls one both in time (Late Eocene; Hooker *et al.* 2007, 2009; Perkovsky *et al.* 2007) and space, but differs much in taphonomy (rock fossils *vs.* amber inclusions). The present assemblage agrees with at least some others of comparable age in having two of its five genera extinct and three other extant; assemblages of the Baltic amber and Florissant shales also have some half of their constituent genera extinct (respectively, 26:30 and 8:8; Ulmer 1912; Meyer 2003). In spite of all of this, composition of the Bembridge Marls Trichoptera is strictly unique in being dominated by Beraeidae. As it was explained in the beginning of the present paper, Beraeidae is a small, uncommon family rarely recorded as fossils and in no other case found abundant there.

Another unexpected but equally unmistakable feature of the assemblage is its ecological appearance. With the exception of the sole specimen of eurybiotic Phryganeidae, all identifiable caddis-flies belong to groups with psychro- and oxyphilous larvae restricted to springs, or at most to cold streams. This indicates an abundance of cold water and the absence of fresh lakes and slow, warm, running waters in the vicinity of the Insect Limestone mother water body.

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