
A new chironomid (Insecta: Diptera) from Wealden amber (Lower Cretaceous) of the Isle of Wight (UK)

E. A. JARZEMBOWSKI¹ | D. AZAR² | and A. NEL³ |

¹ | Maidstone Museum and Bentsliff Art Gallery, St Faith's St, Maidstone
Kent, ME14 1LH and SHES, The University, Reading, UK. E-mail: edjarzembowski@maidstone.gov.uk

² | Lebanese University, Faculty of Sciences II, Department of Biology, Fanar Matn
P. O. box 26110217, LEBANON. E-mail: azar@mnhn.fr

³ | CNRS UMR 5202, Muséum National d'Histoire Naturelle
CP 50, Entomologie, 45 Rue Buffon, F-75005 Paris, FRANCE. E-mail: anel@mnhn.fr

ABSTRACT

The first insect from the Wealden amber of the Isle of Wight (early Barremian) is formally described. *Dungeyella gavini* n. gen., n. sp. (Diptera: Chironomidae) is a tiny buchomyiine/podonomian with specialised wing venation and probably lived in an araucarian riparian woodland with seasonal resin production. It is in one of the oldest-known ambers with insect inclusions.

KEYWORDS | Insecta. Diptera. Chironomidae. Barremian. United Kingdom.

INTRODUCTION

Amber is fossilised tree resin and may be found at several levels in the Lower Cretaceous (Valanginian-Aptian) of southern England (Jarzembowski, 1999). Only one of these levels, however, in the Wessex Formation of the Isle of Wight (IoW) has produced insect inclusions so far (Jarzembowski, 1995a; Figs. 1 and 2). The initial chance finds included non-biting midges (Insecta: Diptera: Chironomidae) which was unexpected in view of the general low frequency of culicomorphs (midges and mosquitoes) as rock fossils in Wealden insect assemblages (Jarzembowski, 1995b). A week-long investigation of the amber-bearing strata on

the south-west coast of the IoW was undertaken in June, 2001, during BBC 2's 'Dinosaur Island' programme. This confirmed that non-biting midges comprise the majority (44%) of the insect inclusions found in Wealden amber; this compares with less than 0.1% in the background (rock) fauna (*loc. cit.*; Lukashevich et al., 2001) pointing to selective preservation. No chironomids have been formally described previously from the Wealden. Numerous other chironomids have been described from the early Lower Cretaceous amber of Lebanon but these are Gondwanian (Brundin, 1976; Veltz et al., 2007). *Dungeyella gavini* n. gen., n. sp. is thus the first Laurasian and one of the earliest amberised chironomids to be described to date.

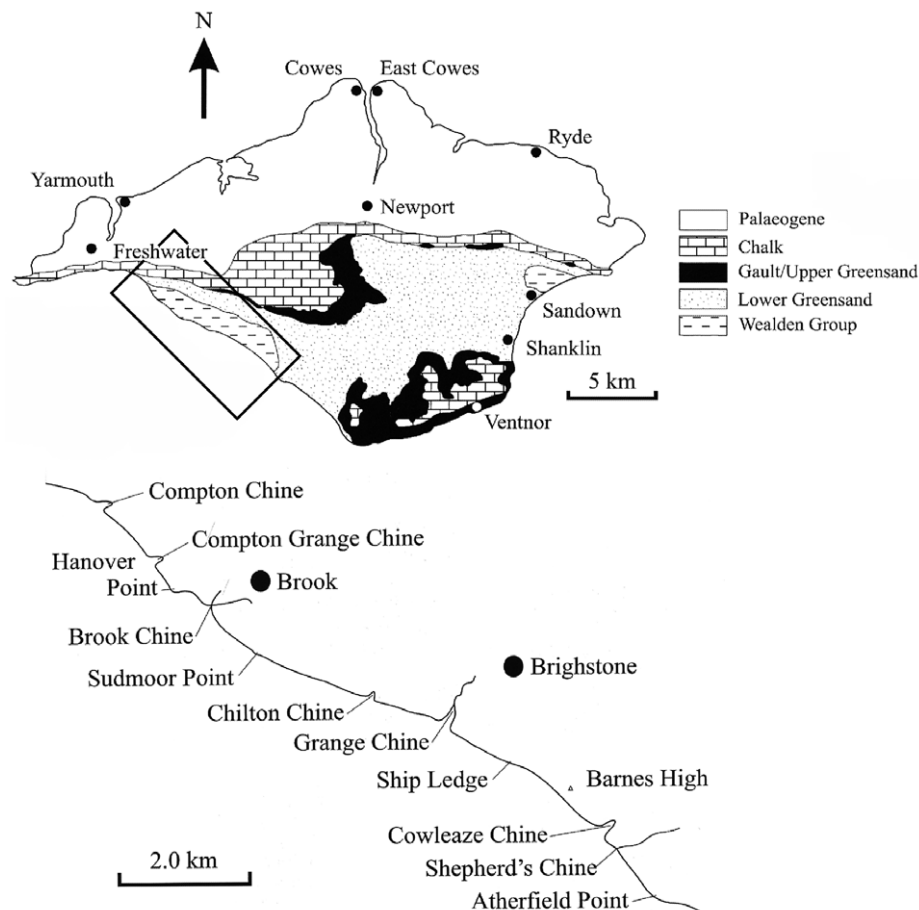


FIGURE 1 | The Isle of Wight showing the location of the Wealden (above) and Chilton Chine (below). From Martill and Naish, 2001, with author's permission.

GEOLOGICAL OCCURRENCE

Context

Amber was reported from several Wealden horizons prior to the discovery of insect inclusions. The main outcrop near Chilton Chine (Fig. 1) in the Isle of Wight was described by Nicholas et al. (1993) and interpreted as a fluvial channel lag deposit. The amber pieces are uncommon and usually brown coloured, brittle and frequently pyritous, i.e. of low gem quality. The Chilton outcrop yielded the first Wealden arthropod inclusions in 1994 comprising chironomids, a wasp (Hymenoptera) and a spider (Araneae) (Jarzembowski, 1995a). Sustained collecting by Simpson (in Jarzembowski, 1999) showed that the amber occurred in four lignitic mudstone horizons of a plant debris bed. The 2001 investigation (see Introduction) yielded additional chironomids and other Diptera, more Hymenoptera, and also a cockroach (Blattodea) and beetle (Coleoptera) plus a piece of old spider's web. No further specimens were found, however, of the chironomid described herein, which is one of the initial finds.

Palaeoecology

The insectiferous Wealden amber is from one of the plant debris beds in the Wessex Fm. and was evidently deposited in a flood plain pool as a result of flood or debris flow (Insole et al., 1998). A primitive gymnosperm (araucarian) origin of the resin is suggested by the biserrate tracheid pitting (ca. 6 pits) in wood extracted from the amber by one of us (D. Azar); well-preserved *Pagiophyllum* macrofossils in the same bed (probably a new species: Dr J. Watson -Manchester University-, Dr J. Francis -Leeds University- pers. com.); and infrared spectra of the amber (Dr E. Ragazzi -Padova University-, written comm.). The amber-bearing tree may be the same as the conifer which produced *Masculostrobus* cones and *Araucariacites* pollen in the local Wealden (Alvin et al., 1994).

A high percentage of chironomids (up to 10% of the whole insect fauna) has been observed in the Earliest Eocene amber of France (Doitseau and Nel, 2007); up to 41% has been reported in Middle to Late Eocene Baltic

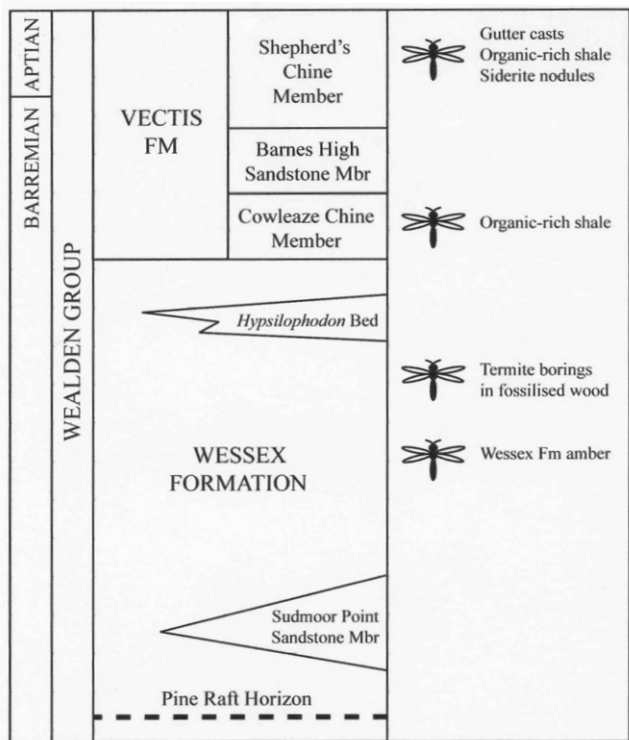


FIGURE 2 | General stratigraphy of the Wealden on the Isle of Wight showing the distribution and lithology of insect-bearing horizons (from Heads, in press, by permission).

amber (Perkovsky et al., 2003, 2007; Sontag, 2003). This is attributed to the mating swarms during resin flow in the European spring and early summer (Larsson, 1978). The Wealden palaeoclimate is considered to have been Mediterranean-like with wet winters and dry summers (Allen, 1998) and the disproportionate number of chironomids in the Wealden amber probably has a similar seasonal correlation. This is supported by the frequency of bubbles in the Wealden amber which is suggestive of originally moist resin, and only a single piece has been found with evidence of charring (wildfire).

Chironomid adults are common insects today being found especially near water and subsisting on plant exudates; they are mainly crepuscular or nocturnal, often swarming at sundown (Colless and McAlpine, 1991, p. 744). Chironomid larvae are aquatic or moisture-loving and play an important role in fresh water ecosystems by recycling nutrients and providing prey for other animals. Buchonomyiinae prefer lower montane or warm lowland rivers (Mrs A. Self -Natural History Museum- pers. comm.) whereas Podonominae are associated with cold streams and brooks (loc. cit.: 746). Some chironomid species show salinity tolerance and the occasional chironomid adults and pupae found as rock fossils in the earliest Cretaceous Purbeck beds of Wessex suggest a brackish water association (Coram and Jarzembowski,

1998). From the above discussion, a riparian association is more likely in the Wessex Formation, supported by the geological setting of a coastal flood plain bordering a conifer-clad Jurassic upland (Martill and Naish, 2001, fig. 2.11).

Taphonomy

The insect's legs are mostly embedded in the convex surface of an earlier flow prior to the entombing one suggesting that the resin was extruded externally as a stalactite or drip. Other inclusions in the amber are tiny air bubbles with organic matter.

SYSTEMATIC PALAEOLOGY

The study of the unique type was initially hampered by the traditional preparation of the specimen involving tumbling and hand polishing. More appropriate techniques for preparing early amber have since been applied (Azar, 2000). The drawings were prepared using a CK40 OLYMPUS inverted compound microscope and a SZX OLYMPUS binocular microscope, both with a *camera lucida* attachment. Photography was done using a digital compact camera CAMEDIA C-5060 OLYMPUS.

Class: Insecta LINNAEUS, 1758

Order: Diptera LINNAEUS, 1758

Family: Chironomidae NEWMAN, 1834

Subfamily: Buchonomyiinae BRUNDIN and SÆTHER, 1978 or Podonominae THIENEMANN, 1937

Genus *Dungeyella* n. gen.

Type species: *Dungeyella gavini* n. sp.

Diagnosis: Maxillary palps short, palpal segments sub-cylindrical with segment 4 longer than the other segments. Flagellum beaded with enlarged, spindle-shaped terminal flagellomere (female). R_{2+3} absent; R_{4+5} short; distal portions of median and anterior cubital veins relatively desclerotised; a strong angle on M_{3+4} at the end of m-cu; five short and one long setae on brachiolum; numerous setae on wing membrane between R_{4+5} and M_{1+2} ; one long and four or five short setae on first axillary sclerite; no anal lobe; hind tibial comb present, in one row.

Included species. Type species.

Dungeyella gavini n. sp.

Figures 3-5

1995a female chironomid midge: Jarzembowski, pp. 41-42, cover illustrations.

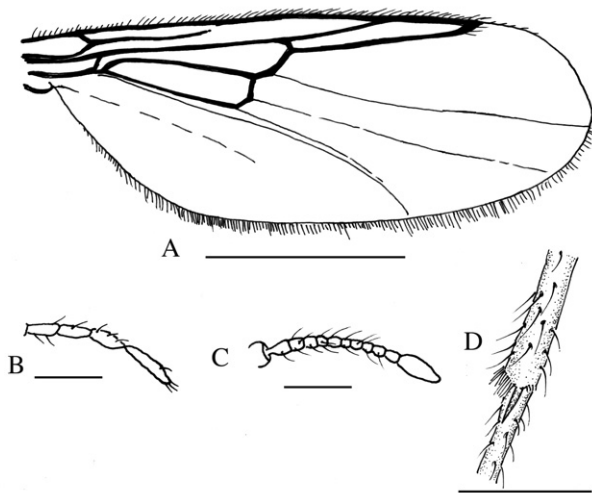


FIGURE 3 | *Dungeyella gavini* n. gen., n. sp. A) forewing venation (scale bar represents 0.3 mm). B) maxillary palp (scale bar represents 0.2 mm). C) antenna (scale bar represents 0.1 mm). D) tibial spur on hind leg (scale bar represents 0.1 mm).

- 1995c midge: Jarzembowski, p. 10.
 1995 wasp [sic]: Young, p. 24.
 1996 female chironomid midge: Palmer, p. 13.

Derivation of name: After Farmer James Dungey for his invaluable support and Mr. Gavin Leng, finder of the specimen.

Holotype: IWCMS 1994.99 (Isle of Wight County Museum Service); Wealden amber, plant debris bed above Chilton Chine sandstone (Martill and Naish, 2001: fig. 2.8), Wessex Formation, SW coast of IoW (Figs. 1 and 2; Jarzembowski, 1995a); early Barremian (ca. 130 Ma); collected by Mr. G. Leng.

A male midge in the Leng collection (Jarzembowski, 1995a) with plumose antennae is not related to the above female. This insect (IWCMS 1994.100) is a tanypodian larger than *D. gavini* n. gen., n. sp. with a wingspan of nearly 3 mm (almost twice that of the latter).

Diagnosis: a small Cretaceous species of Chironomidae with wing length of 0.62 mm, width 0.25 mm, otherwise characters that of genus.

Description: head: maxillary palps short, palpomeres only slightly inflated, the fourth being slightly narrower than the third. Antennae simple, with 11 flagellomeres, distal flagellomeres beaded except for large swollen terminal segment (female dimorphism).

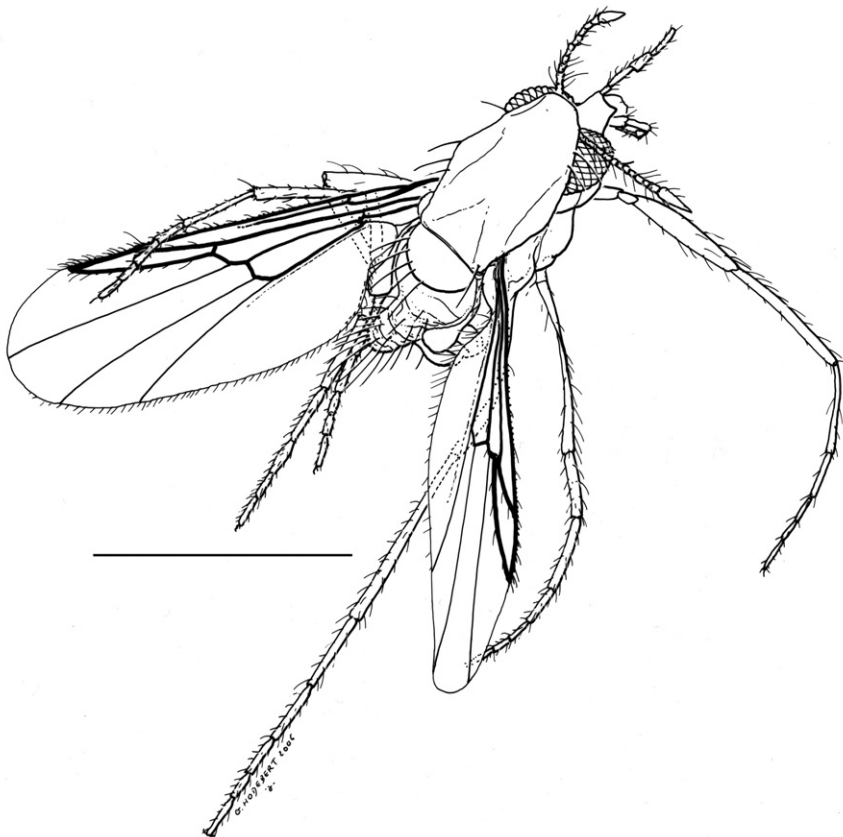


FIGURE 4 | *Dungeyella gavini* n. gen., n. sp. Whole insect in dorsal view (scale bar represents 0.5 mm).

Wing: twice longer than broad (beyond arculus); numerous setae on wing membrane between R_{4+5} and M_{1+2} ; five short and one long setae on brachiolum; one long and four or five short setae on first axillary sclerite; squama with numerous setae; C thickened anterolaterally, ending at apex of R_{4+5} ; short Sc present, thin beyond humeral vein (h); R_{2+3} absent; Rs separating in distal half of wing, base subperpendicular; R_1 half length of R_{4+5} ; R_{4+5} shortened, reaching wing margin well basal of its apex; median vein with two branches M_{1+2} and M_{3+4} ; distal portions of median branches weakly sclerotized (spectral). Cu1 curved; anal area broad with oblique desclerotised anal (A) vein(s).

Tibial spur simple, spur formula 1,1,1; hind tibial comb present, in one row; tarsomere 4 cylindrical, shorter than tarsomere 5.

Abdomen broad; female genital appendages only partly visible.

Remarks: according to the key to dipteran families of McAlpine (1981), this fossil falls in the family Chironomidae because of the following characters: anal vein An2 absent; radius with only two branches R_1 and R_{4+5} , costa ending at apex of last branch of radius; ocelli absent; antennae much longer than head and distinctly hairy;

wings narrow; only M_{1+2} and M_{3+4} present. The presence of a postnotal longitudinal groove cannot be established with certainty.

Following the key to Holarctic subfamilies of Oliver and Dillon (1989), *Dungeyella* n. gen. could fall in the Podonominae Thienemann and Edwards in Thienemann, 1937 or in the Buchonomyiinae Brundin and Sæther, 1978 because of the presence of m-cu and absence of R_{2+3} . It can be excluded from the Early Mesozoic subfamily Aenneinae Ansoerge, 1999 because of the short basal part of Rs (Ansoerge, 1999; Krzemiński and Jarzembowski, 1999). Among the Recent non-Holarctic subfamilies, the Aphroteniinae Brundin, 1966 and Usambaromyiinae Andersen and Sæther, 1994 can be also excluded because *Dungeyella* n. gen. retains m-cu (Brundin 1966, 1976; Andersen and Sæther, 1994). The Chilenomyiinae Brundin, 1983 have m-cu in a basal situation and no R_{2+3} , but their wings are densely hairy all over, their brachiolum is bare, and they have no anal lobe- unlike *Dungeyella* n. gen. (Brundin, 1983).

The presence of five short and one long setae on the brachiolum, several setae on the wing membrane between R_{4+5} and M_{1+2} , and of one long and four or five short setae on the first axillary sclerite would support affinities with the Buchonomyiinae. Nevertheless, *Dungeyella* n.

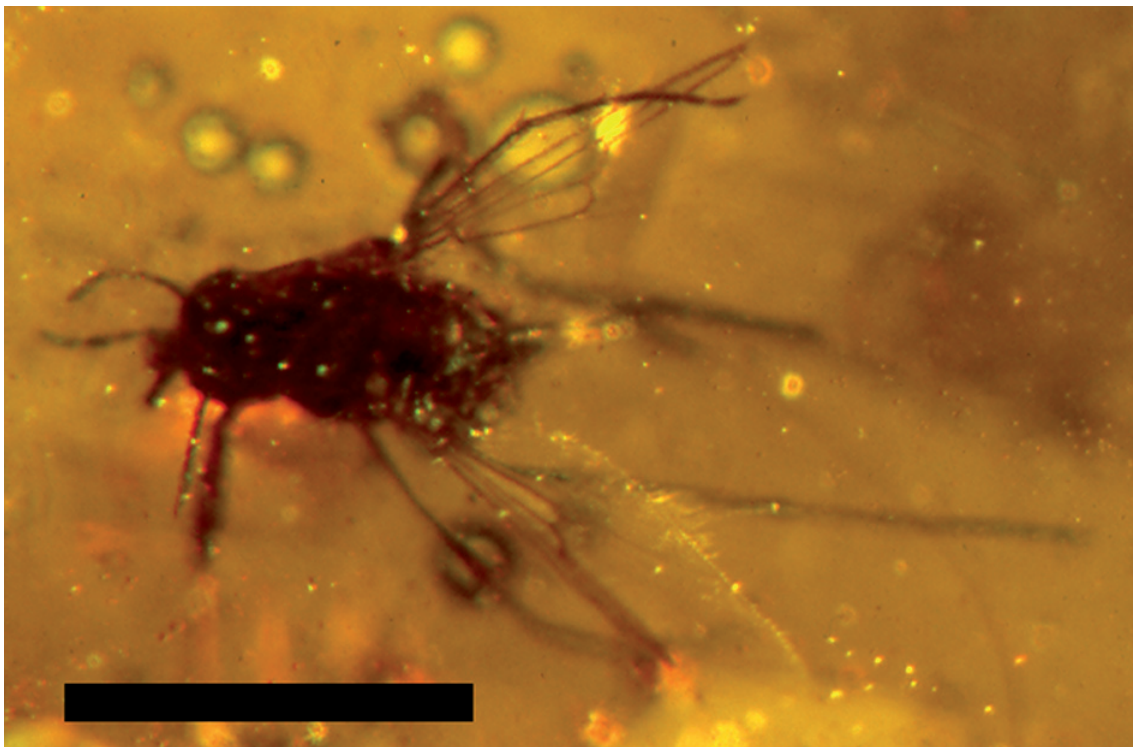


FIGURE 5 | *Dungeyella gavini* n. gen., n. sp. Photograph in ventral aspect. Scale bar represents 0.5 mm.

gen. strongly differs from the Recent and Baltic amber genus *Buchonomyia* Fittkau, 1955 in its flagellum being composed of 11 flagellomeres instead of 14, only the ultimate flagellomere is elongated, distinctly shorter R_{4+5} , a strong angle on M_{3+4} at the end of m-cu, M_{1+2} and M_{3+4} are weakly sclerotized, and m-cu is not as close to the wing base. On the other hand, *Dungeyella* n. gen. shares with the Podonominae an elongated terminal flagellomere and the number of flagellomeres is reduced to 11 as in the females of the extant genus *Parochlus* Enderlein, 1912. The wing venation of *Dungeyella* n. gen. is rather similar to that of *Libanochlites* Brundin, 1976 from the Lower Cretaceous amber of Lebanon (Veltz et al., 2007) except that vein R_{4+5} is shorter. *Libanochlites* was originally included in the Podonominae (Brundin, 1976), but Azar et al. (in press) demonstrated that it actually belongs to the Tanypodinae. *Dungeyella* g. nov. also has one long and four or five short setae on the first axillary sclerite, a character absent in Podonominae although a hind tibial comb is present (plesiomorphy), and m-cu is very variable among Podonominae, with some taxa having the crossvein in a more basal position than in *Buchonomyia*, and others with it in nearly the same position as in the new genus (Sæther, 1989, 2000; Seredusz and Wichard, 2003). Unfortunately, none of the characters that would characterize the Chironominae group of subfamilies to which the Buchomyiinae currently belongs (following Sæther's (2000) phylogenetic analysis of the chironomid subfamilies) is available.

The subfamily affinities of *Dungeyella* n. gen. therefore remain uncertain although they are of interest because Buchomyiinae are not recorded from the Mesozoic and Mesozoic 'Podonominae' are either family incertae sedis or belong to other subfamilies of Chironomidae (Veltz et al., 2007; Azar et al., in press). Sæther (2000) considered the Buchomyiinae to be the sister group of the clade (Diamesinae + Prodiamesinae + Orthoclaadiinae + Chironominae). The discovery of an Early Cretaceous buchomyiine would not be surprising as the Prodiamesinae and Orthoclaadiinae are present in Early Cretaceous Lebanese amber (Veltz et al., 2007). The discovery of Cretaceous Podonominae would also not be surprising because the related Tanypodinae were already very diverse during this period and represented in Wealden amber (see Holotype above). Further search for small chironomid midges in Wealden amber may well resolve the issue and help elucidate the history of this ecologically significant aquatic family.

ACKNOWLEDGEMENTS

In addition to the above mentioned colleagues, we are indebted to Prof. R. Szadziewski (Gdańsk, Poland), Prof. P.

Cranston (Davis, California) and Dr A. Borkent (Enderby, British Columbia) for discussion of this species; also, to the Museum of Isle of Wight Geology for generous loan of material and Prof. D.J. Batten (Manchester, UK) and Mr P. Austen (Seaford, UK) for palaeobotanical references. We also thank Gilbert Hodebert for the drawings of the type specimen and Prof. Szadziewski (Poland) and Herr M. Grund (Germany) for their helpful review of this paper. This paper was partially funded by the generosity of the Spanish Amber Project and the Royal Entomological Society.

REFERENCES

- Allen, P., 1998. Purbeck-Wealden (Early Cretaceous) climates. *Proceedings of the Geologists' Association*, 109(3), 197-236.
- Alvin, K.L., Watson, J., Spicer, R.A., 1994. A new coniferous male cone from the English Wealden and a discussion of pollination in the Cheirolepidiaceae. *Palaeontology*, 37(1), 173-180, 1 pl.
- Andersen, T., Sæther, O.A., 1994. *Usambaromyia nigrata* gen. n., sp. n., and Usambaromyiinae, a new subfamily among the Chironomidae (Diptera). *Aquatic Insects*, 16(1), 21-29.
- Ansorge, J., 1999. *Aenne liasina* gen. et sp. n. – the most primitive non-biting midge (Diptera: Chironomidae: Aenninae subfam. n.) – from the Lower Jurassic of Germany. *Polskie Pismo Entomologiczne*, 68, 431-443.
- Azar, D., 2000. Les ambres mésozoïques du Liban. Doctoral thesis. Université de Paris-Sud, 164 [+145] pp. (Unpublished)
- Azar, D., Veltz, I., Nel, A., in press. Blood feeding chironomids: primitive or derived? (Diptera: Chironomidae). *Systematic Entomology*.
- Brundin, L., 1966. Transantarctic relationships and their significance, as evidenced by chironomid midges with a monograph of the subfamilies Podonominae and Aphroteniinae and the austral Heptagylae. *Kungliga Svenska Vetenskapsakademiens Handlingar*, 11, 1-472.
- Brundin, L., 1976. A Neocomian chironomid and Podonominae-Aphroteniinae (Diptera) in the light of phylogenetics and biogeography. *Zoologica Scripta*, 5, 139-160.
- Brundin, L., 1983. *Chilenomyia paradoxa* gen. n., sp. n. and Chilenomyiinae, a new subfamily among the Chironomidae (Diptera). *Entomologica Scandinavica*, 14(1), 33-45.
- Brundin, L., Sæther, O.A., 1978. *Buchonomyia burmanica* sp. n., and Buchomyiinae, a new subfamily among the Chironomidae (Diptera). *Zoologica Scripta*, 7(4), 269-275.
- Colless, D.H., McAlpine, D.K., 1991. Diptera (flies). In: Naumann, I.D. (ed.). *The insects of Australia*. 2nd ed., Carlton, Melbourne University Press, C.S.I.R.O., 2, 717-786.
- Coram, R., Jarzembowski, E.A., 1998. Insect-bearing horizons in the type Purbeck and new Purbeck/Wealden flies (Diptera). *Proceedings of the Dorset Natural History and Archaeological Society*, 119, 135-140.

- Doitteau, G., Nel, A., 2007. Chironomid midges from early Eocene amber of France (Diptera: Chironomidae). *Zootaxa*, 1404, 1-66.
- Hedges, S. W., in press. A new species of *Yuripopovia* from the Early Cretaceous of the Isle of Wight (Coleorrhyncha: Progonocimicidae). *British Journal of Entomology and Natural History*.
- Insole, A., Daley, B., Gale, A., 1998. The Isle of Wight. Geologists' Association Guide, 60, v + 132 pp.
- Jarzewski, E.A., 1995a. The first insects in Cretaceous (Wealden) amber from the UK. *Geology Today*, 11(2), 41-42 + cover illustrations.
- Jarzewski, E.A., 1995b. Early Cretaceous insect faunas and palaeoenvironment. *Cretaceous Research*, 16(6), 681-693.
- Jarzewski, E.A., 1995c. The first insects in Cretaceous (Wealden) amber from the UK. *Down to Earth*, 13, p. 10.
- Jarzewski, E.A., 1999. British amber: a little-known resource. *Proceedings of the World Congress on Amber Inclusions, Vitoria-Gasteiz, 1998. Estudios del Museo de Ciencias Naturales de Alava*, 14 (Número especial 2), 133-140.
- Krzemiński, W., Jarzewski, E.A., 1999. *Aenne triassica* sp. n., the oldest representative of the family Chironomidae (Insecta: Diptera). *Polish Journal of Entomology*, 68, 445-449.
- Larsson, S.G., 1978. Baltic amber – a palaeobiological study. *Entomograph*, 1, 1-192.
- Linnaeus, C., 1758. *Systema naturae per regna tria naturae secundum classes, ordines, genera, species cum characteribus, differentiis, synonymis, locis. Ed. decima reformata. Holmiae, Laur. Salvii*, 1, 1-823.
- Lukashevich, E.D., Coram, R.A., Jarzewski, E.A., 2001. New true flies (Insecta: Diptera) from the Lower Cretaceous of southern England. *Cretaceous Research*, 22, 451-460.
- Martill, D.M., Naish, D., 2001. The geology of the Isle of Wight. In: *Dinosaurs of the Isle of Wight. Palaeontological Association Field Guide to Fossils*, 10, 25-43.
- McAlpine, J.F., 1981. Key to families- adult. pp. 89-124. In: *McAlpine, J.F., Peterson, B.V., Shewell, G.E., Teskey, H.J., Vockeroth, J.R., Wood, D.M. (coord.). Manual of Nearctic Diptera*, 1, Research Branch, Agriculture Canada Monograph, Ottawa, Ontario, 27, 674 pp.
- Newman, E., 1834. Attempted division of British insects into natural orders. *Entomological Magazine*, 2, 379-431.
- Nicholas, C.J., Henwood, A.A., Simpson, M., 1993. A new discovery of early Cretaceous (Wealden) amber from the Isle of Wight. *Geological Magazine*, 130(6), 847-850.
- Oliver, D.R., Dillon, M.E., 1989. The adult males of Chironomidae (Diptera) of the Holarctic region – key to subfamilies. *Entomologica Scandinavica, Supplement* 34, 11-15.
- Palmer, D., 1996. *Fossils*. London, Dorling Kindersley, 160 pp.
- Perkovsky, E.E., Zosimovich, V.Yu., Vlaskin, A.Yu., 2003. Rovno amber fauna: a preliminary report. *Acta Zoologica Cracoviensia*, 46(suppl. – Fossil Insects), 423-430.
- Perkovsky, E.E., Rasnitsyn, A.P., Vlaskin, A.P., Taraschuk, M.V. 2007. A comparative analysis of the Baltic and Rovno amber arthropod faunas: representative samples. *African Invertebrates* 48(1), 229-245.
- Sæther, O.A., 1989. The adult males of Prodiamesinae (Diptera: Chironomidae) of the Holarctic region- keys and diagnoses. *Entomologica Scandinavica, Suppl.*, 34, 155-163.
- Sæther, O.A., 2000. Phylogeny of the subfamilies of Chironomidae (Diptera). *Systematic Entomology*, 25(3), 393-403.
- Seredszus, F., Wichard, W., 2003. Buchonomyinae (Diptera, Chironomidae) im Baltischen Bernstein. *Studia Dipterologica*, 9(2), 393-402.
- Sontag, E., 2003. Animal inclusions in a sample of unselected Baltic amber. *Acta Zoologica Cracoviensia*, 46(suppl. – Fossil Insects), 431-440.
- Thienemann, A., 1937. Podonominae, eine neue Unterfamilie der Chironomiden (Chironomiden aus Lappland I). *Internationale Revue der Gesamten Hydrobiologie und Hydrographie*, 35, 65-99.
- Veltz, I., Azar, D., Nel, A., 2007. New chironomid flies in the Early Cretaceous Lebanese amber (Diptera: Chironomidae). *African Invertebrates*, 48(1), 169-191.
- Young, S., 1995. Amber dexterity. *BBC Wildlife [Magazine]*, July 1995, p. 24.

Manuscript received November 2007;
 revision accepted May 2008;
 published Online July 2008.