

## Cicada fossils (Cicadoidea: Tettigarctidae and Cicadidae) with a review of the named fossilised Cicadidae

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### Abstract

The Cicadoidea comprise two families, the Cicadidae and the Tettigarctidae. This paper evaluates the status and taxonomy of all named Cicadoidea fossils belonging to the Cicadidae. Shcherbakov (2009) has previously revised the Tettigarctidae. Two new genera are described, *Camuracada* **gen. n.** and *Paleopsalta* **gen. n.**, for *Camuracada aichhorni* (Heer, 1853) **comb. n.** and *Paleopsalta ungeri* (Heer, 1853) **comb. n.** A lectotype is designated for *Cicada emathion* Heer, 1853.

*Cicada grandiosa* Scudder, 1892 is transferred to *Hadoa* Moulds, 2015 as *Hadoa grandiosa* **comb. n.**; *Oncotympana lapidescens* J. Zhang, 1989 is transferred to *Hyalessa* China, 1925 as *Hyalessa lapidescens* **comb. n.**; *Meimuna incasa* J. Zhang, Sun & X. Zhang, 1994 and *Meimuna miocenica* J. Zhang & X. Zhang, 1990 are transferred to *Cryptotympana* Stål, 1861 as *Cryptotympana incasa* **comb. n.** and *Cryptotympana miocenica* **comb. n.**; *Tibicen* sp. aff. *japonicus* Kato, 1925 is transferred to *Auritibicen* as *Auritibicen* sp. aff. *japonicus* **comb. n.**, and *Terpnosia* sp. aff. *vacua* Olivier, 1790 is transferred to *Yezoterpnosia* Matsumura, 1917 as *Yezoterpnosia* sp. aff. *vacua* **comb. n.** The generic placement of two other fossils is changed to reflect current classification, those species now being *Auritibicen bihamatus* (Motschulsky, 1861) and *Yezoterpnosia nigricosta* (Motschulsky, 1866).

Two species, *Davisia bearcreekensis* Cooper, 1941 and *Lithocicada perita* Cockerell, 1906, are transferred from the subfamily Cicadinae to the Tibicininae, tribe Tibicinini. *Cicadatra serresi* (Meunier, 1915) is also transferred from the Cicadinae to the Cicadettinae because the Cicadatrini have recently been transferred from the Cicadinae to the Cicadettinae (Marshall *et al.* 2018).

*Miocenoprasia grasseti* Boulard and Riou, 1999 is transferred from the tribe Prasiini to the Lamotialnini. *Tymocicada gorbunovi* Becker-Migdisova, 1954 is transferred from the Dundubiini to the Cryptotympanini; *Paracicadetta oligocenica* Boulard & Nel, 1990 is transferred from the Cicadettini to the Pagiphorini and *Minyscaphus dominicanus* Poinar *et al.*, 2011 is assigned to the Taphurini. Names of species once considered to belong in Cicadidae, but now excluded, are listed with explanation.

**Key words:** Eocene, Cretaceous, Jurassic, Miocene, Oligocene, Paleocene, Quaternary, Pleistocene, Pliocene, Tertiary

### Introduction

The superfamily Cicadoidea comprises two families, Cicadidae Latreille, 1802 and Tettigarctidae Distant, 1905 (Moulds 2005, Wang *et al.* 2013). The Palaeontinidae Handlirsch, 1906 were until recently placed as a family within the Cicadoidea but are now considered to form the superfamily Palaeontinidoidea (Shcherbakov and Popov 2002, Wang *et al.* 2013). The Cicadidae and Tettigarctidae are known from both the fossil record and extant species.

Shcherbakov (2009) reviewed the largely Mesozoic Tettigarctidae in detail and provided an excellent overview of the fauna along with a revised classification and a key to all species. He excluded from the Tettigarctidae *Austroprosbole* Evans, *Austroprosboloides* Reik, *Prosbolomorpha* Reik, *Mesodiphthera* Tillyard, *Shaandongia* Hong, *Leptoprosbole* Reik, *Quadrisbole* Lin, *Lacunisbole* Lin, *Kerjieprosbole* Lin, *Luanpingia* Hong, and *Sinocicadia shandongensis* Hong and Wang (Shcherbakov 1984, 2009). Species added to the Tettigarctidae since Shcherbakov (2009) include *Tianyuprosbole zhengi* Chen *et al.*, 2014, *Paratettigarcta zealandica* Kaulfuss & Moulds, 2015, *Hirtaprosbole erromera* Liu, Yao & Ren, 2016, *Sanmai kongi* Chen, H. Zhang & B. Wang, 2016, *S. mengi* Chen, H. Zhang & B. Wang, 2016, and *S. xuni* Chen, H. Zhang & B. Wang, 2016. The Tettigarctidae are not

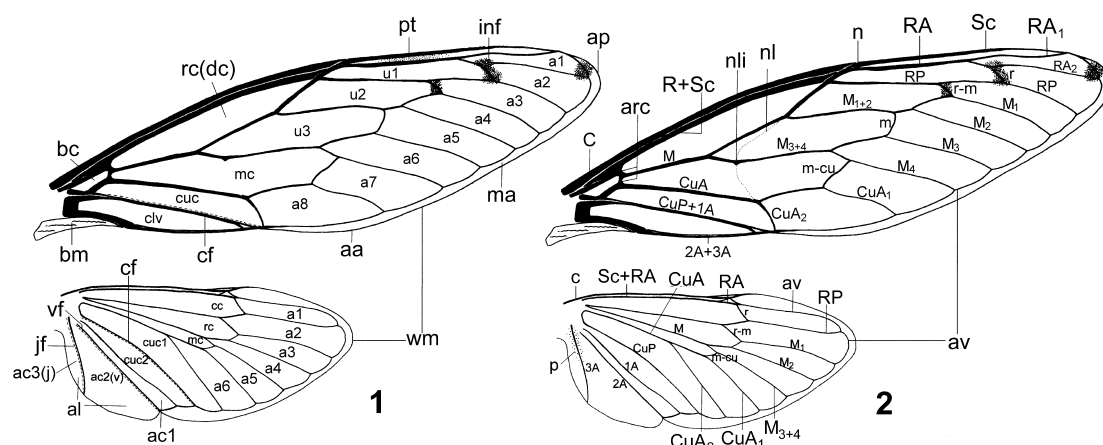
treated further here but Table 1 summarises all named fossils of Tettigarctidae as well as Cicadidae incorporating the changes made herein.

There are 33 recognisable named fossils attributed to the Cicadidae in 23 genera; 10 of those are extinct genera and two are described here as new, *Camuracicada* **gen. n.** and *Paleopsalta* **gen. n.** This paper evaluates the status of all named fossils belonging to the Cicadidae, resulting in the following new combinations: *Camuracicada aichhorni* (Heer, 1853) **comb. n.**, *Paleopsalta ungeri* (Heer, 1853) **comb. n.**, *Hadoa grandiosa* (Scudder, 1892) **comb. n.**, *Hyalessa lapidescens* (J. Zhang, 1989) **comb. n.**, *Cryptotympana incasa* (Zhang *et al.*, 1994) **comb. n.** and *Cryptotympana miocenica* (J. Zhang and X. Zhang, 1990) **comb. n.** Two species, *Davispia bearcreekensis* Cooper, 1941 and *Lithocicada perita* Cockerell, 1906, are transferred from the subfamily Cicadinae to the Tibicininae, tribe Tibicinini. *Miocenoprasia grasseti* Boulard and Riou, 1999 is transferred from the tribe Prasiini to the Lamotialnini; *Tymocicada gorbunovi* Becker-Migdisova, 1954 is transferred from the Dundubiini to the Cryptotympanini; *Paracicadetta oligocenica* Boulard and Nel, 1990 is transferred from the Cicadettini to the Pagiphorini; and *Minyscapheus dominicanus* Poinar *et al.*, 2011 is assigned to the Taphurini. Further, the generic placement of three other fossils is changed to reflect current classification. A lectotype is designated for *Cicada emathion* Heer, 1853.

Most of the Cicadidae fossils are wing fragments (usually only forewings), some have body parts and two are first instar nymphs. They range in age from the Late Cretaceous (99 Ma) to the Late Pleistocene (0.038–0.033 Ma), although as discussed below the oldest record needs to be treated with caution. Certainly the Cicadidae date from at least the Palaeocene (65–55 Ma) with the majority of fossils found in the Miocene (Table 1).

Some fossils, primarily the younger ones, have been identified as extant species by comparison with extant taxa, often in association with biogeographic regions. While such identification has limitations due to the possible presence of taxa now extinct, for the most part these identifications are acceptable. Placement of fossils into tribes and subfamilies identified as extant taxa thus follows the higher classification of those genera. Genera and species known only from fossils have been placed in subfamilies based on similarities with extant genera, mostly of wing venation, following the subfamily characters as defined in Marshall *et al.* (2018).

Ages of fossil sites are given according to Rasnitsyn and Zherikhin (2002) and Fossilworks (2018). Fossil beds not listed by them have been aged from other sources as stated in the text of individual entries or from the original publication, whichever was more recent. Numerical durations of epochs and ages follow the latest version of the International Chronostratigraphic Chart (Cohen *et al.* 2013 v2017/02). Subfamily and tribal classification follows that of Shcherbakov (2009) for the family Tettigarctidae and Marshall *et al.* (2018) for the Cicadidae. Terminology for morphological features follows that of Moulds (2005, 2012). For convenience figures showing terminology for the wings of the family Cicadidae are reproduced here (Figs 1, 2).



**FIGURES 1–2.** Fore- and hindwing notation, *Tamasa tristigma*, Cicadinae. (1) cell notation; (2) vein notation. Adapted from Moulds (2005a). Terminologies in brackets are also in current use. **A** anal vein; **a** apical cell; **aa** anal angle; **ac1** anal cell 1; **ac2(v)** anal cell 2 or vannus; **ac3(j)** anal cell 3 or jugum; **al** anal lobe (= ac2 + ac3); **ap** apex of wing; **arc** arcus; **av** ambient vein; **bc** basal cell; **bm** basal membrane; **C** costal vein; **cc** costal cell; **cf** claval fold; **clv** clavus; **cuc** cubital cell; **CuA** cubitus anterior vein; **CuP** cubitus posterior vein; **inf** infuscation; **jf** jugal fold; **M** median vein; **m** medial crossvein; **ma** marginal area; **mc** medial cell, (also ulnar cell 4 on forewing); **m-cu** mediocubital crossvein; **n** node; **nl** nodal line; **nli** nodal line intersection; **p** plaga; **pt** pterostigma (pigmentation); **R** radius; **r** radial crossvein; **RA** radius anterior; **rc (dc)** radial cell, or discal cell; **r-m** radiomedial crossvein; **RP** radius posterior; **Sc** subcostal vein; **u** ulnar cell; **vf** vannal fold; **wm** wing margin.

**TABLE 1.** Checklist of species arranged by family, subfamily and age.

Family, subfamily, species	Tribe or subfamily	Ma	Epoch and Locality
<b>Family TETTIGARCTIDAE Distant, 1905</b>			
<b>Subfamily Cicadoprosobolinae Evans, 1956</b>			
<i>'Liassocicada' ignota</i> (Brodie, 1845)	Turutanoviini	209–201	latest Triassic (Rhaetian), England
<i>Diphtheropsis incerta</i> Martynov, 1937	Cicadoprosobolini	201–164	Early/Middle Jurassic, Tadzhikistan
<i>Shuraboprosobole plachutai</i> Becker-Mig., 1949	Turutanoviini	201–164	Early/Middle Jurassic, Tadzhikistan
<i>Cicadoprosobole sogutensis</i> Becker-Mig., 1947	Cicadoprosobolini	199–191	Early Jurassic (Sinemurian), Kyrgyzstan
<i>Diphtheropsis</i> sp. (listed Shcherbakov, 2009)	Cicadoprosobolini	199–191	Early Jurassic (Sinemurian), Kyrgyzstan
<i>Paraprosobole rotruda</i> Whalley, 1985	Turutanoviini	197–191	Early Jurassic (late Sinemurian), Stonebarrow, England
<i>Turutanovia</i> sp. (listed Shcherbakov, 1985)	Turutanoviini	183–174	Early Jurassic (Toarcian), South Siberia, Russia
<i>Shuraboprosobole</i> sp. (listed Shcherbakov, 1985)	Turutanoviini	174–170	Middle Jurassic (Aalenian), South Siberia, Russia
<i>Turutanovia</i> sp. (listed Shcherbakov, 1986)	Turutanoviini	174–164	Middle Jurassic, Central Mongolia
<i>Hirtaprosobole erromera</i> Liu, Yao & Ren, 2016	?Turutanoviini	166–157	Middle/Late Jurassic, Daohugou, Mongolia, NE China
<i>Macrotettigarcta obesa</i> Chen & Wang, 2016	Cicadoprosobolini	166–157	Middle/Late Jurassic, Daohugou, Mongolia, NE China
<i>Maculaprosobole zhengi</i> Zheng, Chen & Wang, 2016	Cicadoprosobolinae	166–157	Middle/Late Jurassic, Daohugou, Mongolia, NE China
<i>Sanmai kongi</i> Chen, Zhang & B. Wang, 2016	?Turutanoviini	166–157	Middle/Late Jurassic, Daohugou, Mongolia, NE China
<i>Sanmai mengi</i> Chen, Zhang & B. Wang, 2016	?Turutanoviini	166–157	Middle/Late Jurassic, Daohugou, Mongolia, NE China
<i>Sanmai xuni</i> Chen, Zhang & B. Wang, 2016	?Turutanoviini	166–157	Middle/Late Jurassic, Daohugou, Mongolia, NE China
<i>Shuraboprosobole daohugouensis</i> W. & Z., 2009	Turutanoviini	166–157	Middle/Late Jurassic, Daohugou, Mongolia, NE China
<i>Shuraboprosobole media</i> B. Wang & Zhang, 2009	Turutanoviini	166–157	Middle/Late Jurassic, Daohugou, Mongolia, NE China
<i>Shuraboprosobole minuta</i> B. Wang & Zhang, 2009	Turutanoviini	166–157	Middle/Late Jurassic, Daohugou, Mongolia, NE China
<i>Tianyuprosobole zhengi</i> Chen <i>et al.</i> , 2014	?Turutanoviini	166–157	Middle/Late Jurassic, Daohugou, Mongolia, NE China
<i>Turutanovia karatavica</i> Becker-Mig., 1949	Turutanoviini	164–152	Late Jurassic, (Oxfordian/Kimmeridgian), Kazakhstan
<i>Elkinda hecatoneura</i> Shcherbakov, 1988	Cicadoprosobolini	140–129	Early Cretaceous (Valanginian/Hauterivian), Undurga Transbaikalia, Russia
<i>Shaanxiarcta perrara</i> (Zhang, 1993) (= <i>Involuta perrara</i> Zhang, 1993)	Cicadoprosobolini	133–129	Early Cretaceous (Hauterivian), Shanxi, N China

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TABLE 1. (Continued)

Family, subfamily, species	Tribe or subfamily	Ma	Epoch and Locality
<i>?Turutanovia</i> sp. (listed Shcherbakov, 1986)	Turutanoviini	133–125	Early Cretaceous (Hauterivian/Barremian), W Mongolia
<i>Hylaeoneura lignei</i> Lameere & Severin, 1897	Cicadoprosoolini	129–125	Early Cretaceous (Barremian), Bernissart, Belgium
<i>Architettix compacta</i> Hamilton, 1990	Architettigini	122–113	Early Cretaceous (late Aptian), NE Brazil
<b>Subfamily Tettigarctinae</b>			
<i>Kisylia psylloides</i> Martynov, 1937	Meunierini	201–174	Early Jurassic, Kyrgyzstan
<i>Liassocicada antedens</i> Brodie, 1953	Protabanini	183–182	Early Jurassic (early Toarcian), Germany
<i>Liassocicada muecke</i> (Nel, 1996)	Protabanini	183–182	Early Jurassic, (early Toarcian), Germany
<i>Protabanus chaoyangensis</i> Hong, 1982	Protabanini	174–164	Middle Jurassic, Liaoning, China
<i>Sunotettigarcta hebeiensis</i> Hong, 1983	Protabanini	174–164	Middle Jurassic, Hebei, China
<i>Sunotettigarcta kudryashevae</i> Shcherbakov, 2009	Protabanini	164–152	Late Jurassic (Oxfordian/Kimmeridgian), Kazakhstan
<i>Magrebarcta africana</i> (Nel <i>et al.</i> , 1998) (= <i>Liassotettigarcta africana</i> )	Protabanini	125–113	Early Cretaceous (Aptian), Tunisia
<i>Tettagalma striata</i> Menon, 2005	Protabanini	122–113	Early Cretaceous (late Aptian), NE Brazil
<i>Meuniera haupti</i> Piton, 1936	Meunierini	59–56	Paleocene (Thanetian), Menat, France
<i>Eotettigarcta scotica</i> Zeuner, 1944	?Protabanini	59–56	Paleocene (Thanetian), Isle of Mull, Scotland
<i>?Tettigarcta</i> sp. (listed Wappler, 2003)	?Tettigarctini	48–41	Middle Eocene (Lutetian), Eckfeld Maar, Germany
<i>Paratettigarcta zealandica</i> Kaulfuss & Moulds, 2015	Tettigarctini	23–16	Early Miocene, Hindon Maar, New Zealand
<b>Family CICADIDAE</b>			
<b>Subfamily Cicadinae</b>			
<i>Burmaticada protera</i> Poinar & Kritsky, 2011	?Cicadinae	98.2–99.4	Earliest Cenomanian, Late Cretaceous, Noije Bum, Myanmar
<i>Hadoa grandiosa</i> (Scudder, 1892) <b>comb. n.</b>	Cryptotympanini	33.9–27.8	Early Oligocene, Florissant, Colorado, USA
<i>Lyristes</i> sp.	Cryptotympanini	30.5–30.2	Early Oligocene, Seifhennersdorf, Germany
<i>Meimuna protopalifera</i> Fujiyama, 1969	Dundubiini	23–16	Early Miocene, Nasu Volcano, Japan
<i>Tymocicada gorbunovi</i> Becker-Mig., 1954	Dundubiini	23–16	Early Miocene, W Siberia, Russia
<i>Dominicicada youngi</i> Poinar & Kritsky, 2011	Cicadinae	20–15	Early/Middle Miocene, Cordillera Septentrional, Dom. Rep.
<i>Cryptotympana incasa</i> (Zhang <i>et al.</i> , 1994) <b>comb. n.</b>	Cryptotympanini	16.0–11.6	Middle Miocene, Shanwang, Shandong, China
<i>Cryptotympana miocenica</i> (Zh. & Zh., 1990) <b>comb. n.</b>	Cryptotympanini	16.0–11.6	Middle Miocene, Shanwang, Shandong, China
<i>Hyalessa lapidescens</i> (Zhang, 1989) <b>comb. n.</b>	Sonatini	16.0–11.6	Middle Miocene, Shanwang, Shandong, China

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TABLE 1. (Continued)

Family, subfamily, species	Tribe or subfamily	Ma	Epoch and Locality
<i>Camuracicada aichhorni</i> (Heer, 1853) <b>comb. n.</b>	Cryptotympanini	13.8–11.6	Middle Miocene, Radoboj, Croatia
<i>Auritibicen</i> sp. aff. <i>japonicus</i> (Kato, 1925) <b>comb. n.</b>	Cryptotympanini	11.6–5.3	Late Miocene, Tottori Pref., Japan
<i>Graptopsaltria inaba</i> Fujiyama, 1982	Polyneurini	11.6–5.3	Late Miocene, Tottori Pref., Japan
<i>Graptopsaltria</i> sp.	Polyneurini	11.6–5.3	Late Miocene, Hyogo Pref., Japan
<i>Yezoterpnosia</i> sp. aff. <i>vacua</i> (Olivier, 1790)	Leptopsaltriini	11.6–5.3	Late Miocene, Tottori Pref., Japan
<b>comb.n.</b>			
<i>Lyristes renei</i> Riou, 1995*	Cryptotympanini	8.5–8.0	Late Miocene, Andance, France
<i>Lyristes?</i> <i>emathion</i> (Heer, 1853)*	Cryptotympanini	7.2–5.3	Late Miocene, Oeningen, Switzerland
<i>Cicada</i> sp. aff. <i>orni</i> Linnaeus, 1758	Cicadini	3.6–2.6	Late Pliocene, Willershausen, Germany
<i>Meimuna</i> sp.	Dundubiini	3.6–2.6	Late Pliocene, Hyôgo Pref., Japan
<i>Tanna?</i> sp.	Leptopsaltriini	1.7–1.5	Early Pleistocene, Kashiya, Japan
<i>Graptopsaltria</i> aff. <i>nigrofuscata</i> (Motsch., 1866)	Polyneurini	1.1–0.5	Middle Pleistocene, Kagoshima Pref., Japan
<i>Auritibicen bihamatus</i> (Motschulsky, 1861)	Cryptotympanini	0.038– 0.033	Late Pleistocene, Shiobara, Tochigi Pref., Japan
<i>Yezoterpnosia nigricosta</i> (Motschulsky, 1866)	Leptopsaltriini	0.038– 0.033	Late Pleistocene, Shiobara, Tochigi Pref., Japan
<b>Subfamily Tibicininae**</b>			
<i>Davispia bearcreekensis</i> Cooper, 1941	Tibicinini	59.2–56.0	Late Paleocene, Bear Creek, Montana, USA
<i>Lithocicada perita</i> Cockerell, 1906	Tibicinini	33.9–27.8	Early Oligocene, Florissant, Colorado, USA
<i>Platypedia primigenia</i> Cockerell, 1908	Platypediini	33.9–27.8	Early Oligocene, Florissant, Colorado, USA
<i>Tibicina sakalai</i> Prokop & Boulard, 2000	Tibicinini	17.9–17.8	Early Miocene, Bilina, Czech Rep.
<i>Tibicina gigantea</i> Boulard & Riou, 1988	Tibicinini	8.5–8.0	Late Miocene, Andance, France
<i>Tibicina haematodes</i> (Scopoli, 1763)	Tibicinini	3.6–2.6	Late Pliocene, Willershausen, Germany
<b>Subfamily Cicadettinae</b>			
<i>Paracicadetta oligocenica</i> Boulard & Nel, 1990	Pagiphorini	33.9–27.8	Early Oligocene, Céreste, France
<i>Cicadatra?</i> <i>serresi</i> (Meunier, 1915)	?Cicadatrini	27.8–26.0	Late Oligocene, Aix-en-provence, France
<i>Paleopsalta ungeri</i> (Heer, 1853) <b>comb. n.</b>	Cicadettini	20.4–16.0	Early Miocene, Radoboj, Croatia
<i>Minyscapheus dominicanus</i> Poinar <i>et al.</i> , 2011	Taphurini	20–15	Early/Middle Miocene, La Búcara, Dominican Republic
<i>Miocenoprasia grasseti</i> Boulard & Riou, 1999	Lamotialnini	8.5–8.0	Late Miocene, Andance, France

\* The status of the generic name *Lyristes* is in dispute and an application is currently before the ICZN to retain it (Marshall 2015, Puissant *et al.* 2015).

\*\* *Sensu* Moulds (2005).

## REVIEW OF SPECIES

### FAMILY CICADIDAE

#### *Auritibicen bihamatus* (Motschulsky, 1861)

*Tibicen bihamatus* (Motschulsky): Fujiyama, 1979: 145–146.

*Auritibicen bihamatus* (Motschulsky): Lee, 2015: 242, 243.

**Age and origin:** 0.038–0.033 Ma. Late Pleistocene, Quaternary, Cenozoic. Naka-Shiobara, Tochigi Prefecture, Japan (the age of the site is discussed in Fujiyama, 1979: 142).

**Status:** Cicadinae, Cryptotympanini. Nearly complete right forewing underside, lacking only parts of base and hind margin, 39 mm long x 11.7 mm wide (Pl. 3, fig. 3). Placed in the genus *Tibicen* by Fujiyama (1979) but Lee (2015) transferred *bihamatus* (and some other South-East Asian species) to his new genus *Auritibicen*. Fujiyama (1979) gave a detailed explanation why this fossil can be matched closely with extant *A. bihamatus*. He discussed the variable nature of the forewing venation in extant *A. bihamatus* and his conclusion that the fossil is this species seems reasonable considering its young age, although the costal margin appears slightly less bowed in the fossil and the basal branching of vein M is unusually close to the basal cell.

***Auritibicen* sp. aff. *japonicus* (Kato, 1925) comb. n.**

*Tibicen* sp. aff. *japonicus* (Kato): Kinugasa & Miyatake, 1976: 6–10, pls 1 and 2.

**Age and origin:** 11.6–5.3 Ma. Late Miocene/Early Pliocene, Neogene, Cenozoic. Tatsumi-tôge, Tottori Prefecture, Japan.

**Status:** Cicadinae, Cryptotympanini. An anterior half of hindwing, partly obscured, 32.9 mm long (Figs 6a, 6b; Pl. 2, fig. 2). Kinugasa & Miyatake (1976) gave a detailed analysis for the identity of this specimen and if it is to be associated with an extant Oriental species then their determination is acceptable. Placed in the genus *Tibicen* by Kinugasa & Miyatake but Lee (2015) transferred *japonicus* (and some other South-East Asian species) to his new genus *Auritibicen*. Kinugasa & Miyatake (1979) give a detailed analysis for the identity of this species.

***Burmacicada protera* Poinar and Kritsky, 2011**

*Burmacicada protera* Poinar & Kritsky, 2011: 2–3.

*Novicicada burmanica* Poinar, Kritsky & Brown, 2011: 4. *Nomen nudum*.

**Age and origin:** 98.2–99.4 Ma. Early Cenomanian, Late Cretaceous, Mesozoic. Noiye Bum 2001 summit site, 26°20'N 96°36'E, Hukawng Valley, south-west of Maingkhwan, Kachin State, Myanmar (Burma). The age of the site has been determined by Shi *et al.* (2012).

**Status:** Cicadoidea, ?Cicadidae. First instar nymph in amber, holotype (Pl. 3, fig. 8). *Burmacicada protera*, at 99 Ma is some 40 Ma older than the next oldest confirmed Cicadidae fossil, *Davisipia bearcreekensis*. Poinar and Kritsky placed *Burmacicada protera* in the family Cicadidae because this hatchling nymph was similar to a first instar nymph of *Magicicada septendecim*, differing in having eight antennal segments instead of seven, the terminal antennomere with a forked process, the inner surface of protibia with a tooth adjacent to a setal spine instead of a single spine, and the upper protrusion on the inner edge of the profemur cylindrical rather than spine-like. While *Burmacicada protera* may belong to the Cicadidae some caution should be exercised. Poinar and Kritsky did not consider the possibility that *Burmacicada protera* may belong to the family Tettigarctidae, a much older lineage also known from Asia in the late Cretaceous. First instar nymphs are unknown for either extant or fossil Tettigarctidae and although there are differences in the last instar nymphs between the two families (Moulds 2005), first instars may not be that much different from each other because hatchlings of extant Cicadidae show minimal morphological variation. This fossil is important because it bears on the question of whether modern cicadas (family Cicadidae) originated before or after the Cretaceous-Tertiary boundary.

***Camuracicada* gen. n.**

**Type species:** *Cicada aichhorni* Heer, 1853; Miocene, Neogene, Cenozoic.

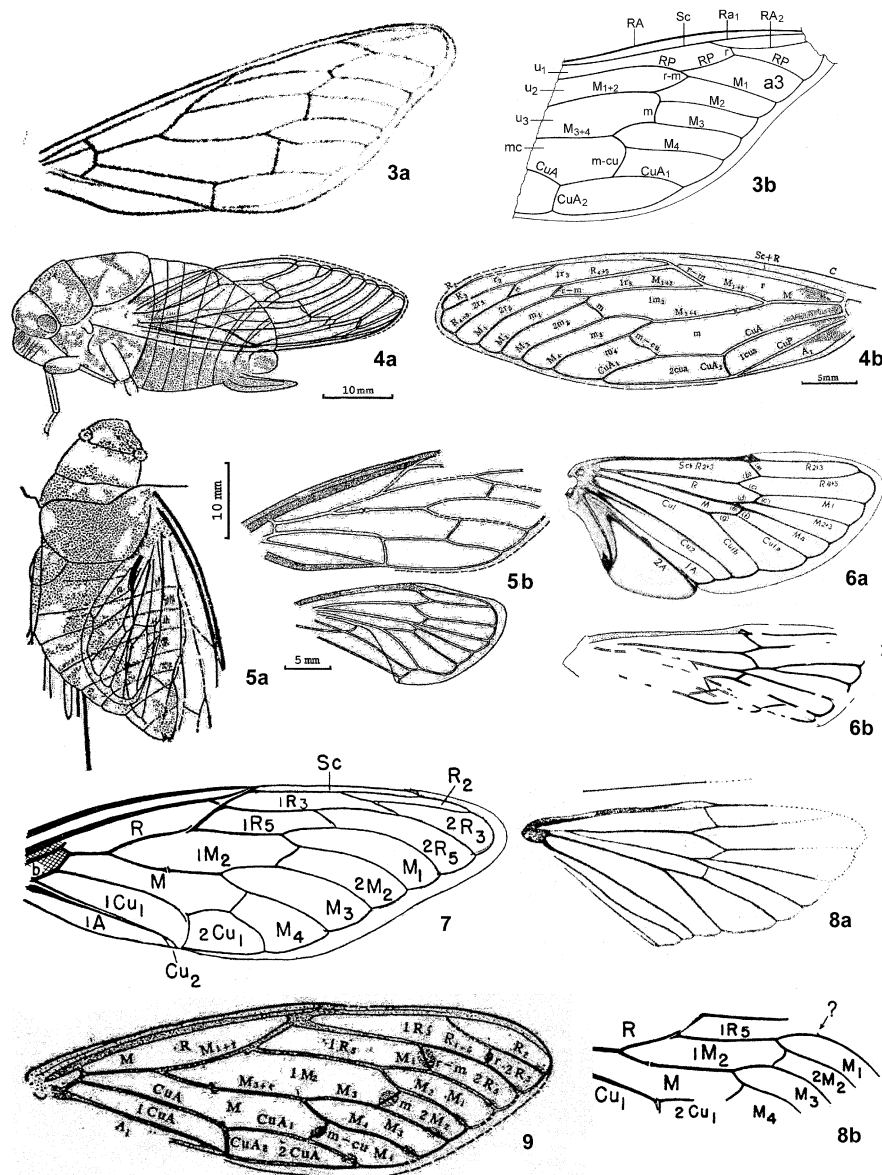
**Included species:** *Camuracicada aichhorni* (Heer, 1853), **comb. n.**

**Etymology:** From the Latin *camura* meaning curved, bent, or crooked, and referring to forewing vein RP that is distinctly recurved prior to the crossvein. Feminine.

**Diagnosis:** Forewing (Figs 3a, 3b; Pl. 1, fig. 1) with anal angle well developed so that outer margin and inner margin are opposed at about 135 degrees; with 8 apical cells; apical cells a little shorter than ulnar cells; apical cell 3 considerably larger in area than all others except last; ulnar cell 1 very narrow, its narrowest width not much greater than between Sc and Ra, but its width considerably expanded at its distal end; ulnar cell 2 about twice the width of ulnar cell 1; ulnar cell 3 and medial cell very wide; vein RP before cross vein strongly curved backwards in a sweeping arc; cross veins r and r-m both very short; vein CuA<sub>1</sub> divided by crossvein so that proximal portion shortest.

**Distinguishing features:** Differs from all other cicada genera in having, in combination, crossveins r and rm very short, and forewing vein RP curved backwards in a sweeping arc prior to the cross vein and by so doing producing a greatly expanded distal end to ulnar cell 1.

**Phylogenetic relationships:** Subfamily Cicadinae, tribe Cryptotympanini. *Camuracicada* appears closest to genera such as *Lyristes*, *Chremistica* and *Cryptotympana*, all of which have narrow ulnar cells 1 and 2 and a broad ulnar cell 3 and medial cell.



**FIGURES 3–9.** (3a) *Camuracicada aichhorni* gen. n., comb. n., Heer's interpretation of the fossil, his fig. 2b. (3b) *Camuracicada aichhorni* gen. n., comb. n., interpretation with veins and cells labelled. (4a) *Cryptotympana incasa* comb. n., interpretation of the fossil from Zhang & Zhang (1994). (4b) *Cryptotympana incasa* comb. n., Zhang & Zhang's interpretation of the left forewing with notation. (5a) *Cryptotympana miocenica* comb. n., interpretation of the fossil, from Zhang & Zhang (1994). (5b) *Cryptotympana miocenica* comb. n., Zhang & Zhang's interpretation of the right forewing and hindwing. (6a) *Auritibicen japonicus*, hindwing, extant, from Kinugasa & Miyatake (1976). (6b) *Auritibicen* sp. aff. *japonicus* comb. n., Kinugasa & Miyatake's interpretation of the fossil hindwing. (7) *Davispsia bearcreekensis* forewing interpretation from Cooper (1941). (8a) *Hadoa grandiosa* comb. n., hindwing interpretation from Scudder (1892). (8b) presumed *Hadoa grandiosa* comb. n. forewing part, interpretation from Cooper (1941). (9) *Hyalessa lapidescens* comb. n., forewing interpretation from Zhang (1989).

***Camuracicada aichhorni* (Heer, 1853) comb. n.**

*Cicada aichhorni* Heer, 1853: 89, pl. XI, figs 2, 2b.

**Age and origin:** 13.8–11.6 Ma. Middle Miocene (Serravallian), Neogene, Cenozoic. Radoboj, Croatia. Sarmatian lagoonal/restricted shallow subtidal limestone.

**Status:** Cicadinae, Cryptotympanini. Forewing fragment from near nodal line almost to wing tip, approximately 40 x 14 mm (Figs 3a, 3b; Pl. 1 fig. 1). As noted by Cooper (1941), Heer's line drawing and photo of the specimen are not in agreement. The forewing size, shape and venation is typical of species of the subfamily Cicadinae. Heer (1853) placed *aichhorni* in the genus *Cicada* because that genus had a much broader concept at the time incorporating most known cicadas. However, there are some features of the venation that preclude it from *Cicada* (and other extant and fossil genera), in particular the very narrow first ulnar cell that is expanded distally because vein RP has a distinct backward curve, a feature unique in the Cicadoidea. Other notable features include apical cell 3 considerably larger in area than all others except last, ulnar cells 1 and 2 narrow but ulnar cell 3 and medial cell very wide, cross veins r and r-m both very short. For these reasons *aichhorni* is here placed in the new genus *Camuracicada* (see above).

***Chremistica? beauchampi* (Piton, 1940).** *Nomen dubium*. Subfamily ?Cicadinae; specimen in Muséum National d'Histoire Naturelle, Paris, F.R07036 (Pl. 4, fig. 7). Described from a fragmented specimen from the Palaeocene (59–56 Ma) from Menat, France. Although originally placed in the extant genus *Rihana* (a junior synonym of *Chremistica*) (family Cicadidae) by Piton the specimen does not show enough detail for generic placement. Carpenter (1992) corrected the generic name from *Rihana* to *Chremistica*, and stated that the fossil does not show enough structural detail for family assignment. It follows that there is also not enough detail for generic assignment. Because the status of this specimen cannot be verified it is here regarded as a *nomen dubium*.

***Cicada aichhorni* Heer, 1853.** See *Camuracicada aichhorni* above.

***Cicada bifasciata* Heer, 1853.** *Nomen dubium*. Subfamily ?Cicadinae. The specimen was described by Heer from a Miocene (Serravallian) fossil (13.8–11.6 Ma) from Radoboj, Croatia, comprising an extended ventral abdomen lacking the basal segments (Pl. 1, fig. 2). Heer placed *bifasciata* in the genus *Cicada* because that genus had a much broader concept at the time incorporating most known cicadas. However, the limited nature of the specimen precludes placement at generic level in a modern classification, and to some extent placement in Cicadoidea is doubtful. If the specimen is considered to belong to the Cicadoidea then it probably falls within the subfamily Cicadinae, based on size (as extrapolated by Cooper 1941) and the shape of the terminal abdominal segment but this may not be true. Unless another specimen is found with wings and matching abdomen its identity remains in question and is therefore considered here a *nomen dubium*.

***Cicada emathion* Heer, 1853.** See *Lyristes emathion* below.

***Cicada forsythii* Buckton, 1891.** Not Cicadoidea. Handlirsch (1908: 1140) assigned the specimen to family Jassidae (now Cicadellidae, Membracoidea).

***Cicada gigantea* Weyenbergh, 1874.** Not Cicadoidea. Treated as *Cicadites gigantea* by Haase (1890). Treated as *Beloptesis gigantea* by Handlirsch (1906) and placed in the family Palaeontinidae which he erroneously believed belong to the order Lepidoptera. Now considered to be a junior synonym of *Prolystra lithographica*, family Palaeontinidae of the Cicadomorpha (Wang *et al.* 2010).

***Cicada grandiosa* Scudder, 1892.** See *Hadoa grandiosa* below.

***Cicada lowei* Ethridge and Olliff, 1890.** See *Griphologus lowei* below.

***Cicada murchisoni* Brodie, 1845.** Family Tettigarctidae. Dismissed by Handlirsch (1908: 504) as a cicada and doubtful even Hemiptera. Placed as a junior synonym of *Liassocicada ignota* (Brodie) by Whalley (1983) who incorrectly spelt the species name as *ignotat(us)*. Shcherbakov (2009) discusses that status of *ignota* concluding that it does not belong to *Liassocicada* but to an undescribed genus and places it in family Tettigarctidae, subfamily Cicadoprosbolinae.



***Cicada* sp. aff. *orni* Linnaeus, 1758**

*Cicada orni* Linnaeus, 1758: Wagner, 1967: 92, 93.

**Age and origin:** 3.6–2.6 Ma. Pliocene (Piacenzian), Neogene, Cenozoic. Willershausen clay pits, Germany. Meischner (2000) gave a detailed account of the geology of these fossil beds.

**Status:** Cicadinae, Cicadini. Two specimens from the clay pit at Willershausen, Allemagne, were attributed to the extant species *Cicada orni* by Wagner (1967) (Pl. 1 fig. 3) and the association of these fossils with the Holarctic *C. orni* is reasonable considering the young age of the fossils. But it is difficult to say if this is true *C. orni* or one of the other species within the *orni* complex described in more recent years. The wing infuscations are a close match for *C. orni* (and allied species) falling within the variation within these species, while the apparent elongation of the ulnar and apical cells is probably caused by transverse compression of the fossil rather than being a natural elongation.

***Cicada plebeja* Scopoli, 1763.** Serres (1829: 228) applied the name to an Oligocene fossil from Provence, France. Handlirsch (1907: 1077) recognised Serres's determination and it was listed by Metcalf & Wade (1966), but the record has not appeared in the literature since. The location of the specimen is unknown and in the absence of a description, image or other identity Serres's identification is here disregarded.

***Cicada prisca* Weyenbergh, 1874.** Not Cicadoidea. A *nomen dubium*, error for *Cercopis prisca*. Superfamily Cercopoidea, family Cercopidae.

***Cicada psocus* (Westwood, 1854).** Not Cicadoidea. Equals *Cicadellium psocus* Westwood, 1854; erroneously placed in *Cicada* by Giebel (1856). Shcherbakov (2012) places *psocus* in superfamily Membracoidea, family Archijassidae as *Purbecellus psocus* (Westwood, 1854).

***Cicada punctata* Brodie, 1845.** Not Cicadoidea. Equals *Jassites punctatus* (Brodie, 1845). Family Cicadellidae (Handlirsch 1907).

***Cicada serresi* Meunier, 1915.** See *Cicadatra serresi* below.

***Cicada ungeri* Heer, 1853.** See *Paleopsalta ungeri* below.

***Cicada violacea* Scopoli, 1763.** *Nomen dubium*. Serres (1829: 228) applied the name to an Oligocene fossil from Provence, France. Handlirsch (1907: 1077) recognised Serres's determination and it was listed by Metcalf & Wade (1966), but the record has not appeared in the literature since. The location of the specimen is unknown and Serres's identification is here disregarded in the absence of a description, image or other identity. Further, the name is a junior homonym of *Cicada violacea* Linnaeus, 1758, thus making it unavailable.

***Cicadatra? serresi* (Meunier, 1915)**

*Cicada serresi* Meunier, 1915: 9, Pl. 2, fig. 8.

*Cicadatra serresi* (Meunier): Théobald, 1937: 367–368, Pl. 27, fig. 13.

**Age and origin:** 27.8–26.0 Ma. Earliest Late Oligocene (Chattian), Paleogene, Cenozoic. Aix-en-Provence, France. Location of specimen unknown, presumed lost.

**Status:** Cicadettinae, ?Cicadatrini. Nearly entire specimen (Fig. 15, Pl. 1 fig. 4); length of body according to Meunier (1915) 20 mm, forewing according to Cooper (1941) 24 x 8.2 mm and estimated hindwing 13.4 x 6.1 mm. Théobald (1937: 367) indicates that the specimen initially belonged to the Geological Institut of Lyon but that Meunier subsequently lost track of it. Enquires to Dr Olivier Béthoux, Curator at the Muséum National d'Histoire Naturelle, Paris, confirmed that the specimen was not traceable there, so it seems to have been lost. The photograph of the specimen published by Meunier (1915) is of poor quality. Théobald (1937) provided a drawing of the forewing that must have been taken from Meunier's photograph as Théobald was unable to trace the specimen, and if one is to compare Théobald's drawing with extant Holarctic species then there certainly is a similarity to *Cicadatra* in the broad rounded wing, small apical cell 1, distally wide apical cell 2 and long apical cell 8. However, Cooper (1941: 301) questioned Théobald's placement of *serresi* in the genus *Cicadatra* concluding that Meunier's photograph could not allow the wing reconstruction Théobald presented, especially in the vicinity of the

basal cell. Therefore, one must agree with Cooper's conclusion that placement in *Cicadatra* is questionable and *serresi* may not belong to the tribe Cicadatrini. Until recently the tribe Cicadatrini was in the subfamily Cicadinae (Sanborn 2014). However, a DNA study by Marshall *et al.* (2018) has shown that extant *Cicadatra* should belong to the subfamily Cicadettinae, not Cicadinae, and is more closely allied to tribes such as Taphurini. So if accepting *serresi* as belonging to *Cicadatra* then *serresi* should be placed in the tribe Cicadatrini, subfamily Cicadettinae.

***Cicadetta montana* (Scopoli, 1772).** Straus (1952: 74) associated this species with Pliocene plant fossils from the clay pits of Willershausen, Germany, age 3.6–2.6 Ma. However, he did not specifically mention a fossil specimen of *C. montana* or provide other evidence for this association. Wagner (1967) considered the record as a misidentification. Because there is no specimen the record is here disregarded.

***Cryptotympana incasa* (J. Zhang, Sun & X. Zhang, 1994) comb. n.**

*Meimuna incasa* J. Zhang, Sun & X. Zhang, 1994: 56–57, pl. 4.

**Age and origin:** 16.0–11.6 Ma. Middle Miocene, Neogene, Cenozoic. Shanwang Village, Shandong, China (dates for the Shandong fossil beds are discussed by Qiu *et al.* 2013). In Shandong Geological Museum, China.

**Status:** Cicadinae, Cryptotympanini. A large cicada in lateral aspect, forewing 40 mm long (Figs 4a, 4b). Zhang, Sun & Zhang (1994) placed this species in *Meimuna* but it cannot belong there because female *Meimuna* have a very long ovipositor. Further, assuming Zhang, Sun and Zhang interpreted the base of the forewing correctly where veins M and CuA meet the basal cell wide apart on a rounded basal cell, those veins in *Meimuna* are much closer together and on a long and narrow basal cell. The fossil forewing has several telling features; the basal stem of M is long, ulnar cells 1 and 2 are narrow compared to cell 3, the stem of RA<sub>2</sub> is long, and the extremities of veins M<sub>1</sub>–M<sub>4</sub> are noticeably curved basad. The body also appears deep-set although there could be some distortion here from squashing of the specimen. Among Oriental extant cicadas all these features are best found in some species of *Cryptotympana*, e.g. *C. takasagona*. If *M. incasa* is to be placed in an extant genus then *Cryptotympana* would seem the most appropriate.

Zhang, Sun and Zhang compare their *Cryptotympana incasa* (then *Meimuna incasa*) with *M. miocenica* Zhang & Zhang, 1990 (Figs 5a, 5b) and conclude that *C. incasa* is a different species. But there appears to be no difference of any consequence between the two species and they are probably synonymous. The size of the two specimens is similar, the venation of the forewing is the same in all those important diagnostic features as mentioned above, and the proportions of the body are similar. The difference in the size of the eyes in the two figures is considered misleading and the larger eye of *C. incasa* is probably due to misinterpretation from an ill-preserved specimen and excessive flattening of the specimen. The eyes of extant *Cryptotympana* are small and wide apart as in the specimen of *C. miocenica*.

***Cryptotympana miocenica* (J. Zhang and X. Zhang, 1990) comb. n.**

*Meimuna miocenica* J. Zhang & X. Zhang, 1990: 338–339 (Chinese), 346 (English), pl. 1.

**Age and origin:** 16.0–11.6 Ma. Middle Miocene, Neogene, Cenozoic. Shanwang Village, Shandong, China (dates for the Shandong fossil beds are discussed by Qiu *et al.* 2013).

**Status:** Cicadinae, Cryptotympanini. A dorso-lateral body with a little more than the basal half of the right forewing and most of the hindwing folded at the anal lobe, forewing 34.7 mm (Figs 5a, 5b). Zhang & Zhang (1990) placed this species in *Meimuna* but the wing venation shows that it cannot belong there. In particular forewing veins M and CuA meet the basal cell wide apart whereas those veins in *Meimuna* are much closer together on a long and narrow basal cell. Further, the eyes are small and wide apart and barely project wider than the pronotum whereas in *Meimuna* they are much larger and project much wider than the anterior pronotum. Among Oriental extant cicadas these features are best found in species of *Cryptotympana* and if *M. miocenica* is to be placed in an extant genus then *Cryptotympana* would seem the most appropriate.

As discussed above under *Cryptotympana incasa* it would appear that *C. miocenica* is synonymous with *Cryptotympana incasa*.

***Davispia bearcreekensis* Cooper, 1941**

*Davispia bearcreekensis* Cooper, 1941: 289–292; Fig. 1; Plate 1, figs 1–2.

**Age and origin:** 59.2–56.0 Ma. Late Paleocene (Thanetian), Paleogene, Cenozoic. One mile south of Bear Creek, Montana, USA.

**Status:** Tibicininae (*sensu* Moulds 2005), Tibicinini. Complete forewing with counterpart, 52 mm long by 18.4 mm

wide (Fig. 7; Pl. 4, fig. 6), in Peabody Museum of Natural History, Yale University, YPM IP 223394. Cooper (1941) noted the similarity of the forewing to that of *Tibicen cultriformis* (now *Neotibicen cultriformis*) and highlighted similarities and differences between other North American species of *Diceroprocta*, *Cacama* and *Okanagana* and concluded that *Davispia* probably belongs to the subfamily Cicadinae (then Platyleurinae) because of its similarity to *Tibicen*. However, *Davispia* is far more similar to *Okanagana* in the following significant attributes: the nodal line intersection passes through vein  $M_{3+4}$  at about mid length which is an unusual feature in cicadas but is found in most *Okanagana*, the mid section of the basal cell (arculus) is almost aligned with the basal section (the stem of CuA), and apical cell 8 is large. *Okanagana* is the only extant genus possessing all these features and as it falls within the tribe Tibicinini (not to be confused with the Tibicenini) of the subfamily Tibicininae. Because of this close similarity with *Okanagana*, *Davispia* is also now considered to belong to the subfamily Tibicininae, tribe Tibicinini, rather than the subfamily Cicadinae as concluded by Cooper by erroneously associating *Okanagana* with *Tibicen*.

#### ***Dominicicada youngi* Poinar & Kritsky, 2011**

*Dominicicada youngi* Poinar & Kritsky, 2011: 3–5.

**Age and origin:** 20–15 Ma. Early/Middle Miocene, Neogene. Cordillera Septentrional, Dominican Republic.

**Status:** Cicadidae. A hatchling nymph preserved in amber (Pl. 3, fig. 7). Poinar & Kritsky (2011) concluded that this nymph belongs to the Cicadidae by comparison with a hatchling nymph of *Magicicada septendecim*. Both nymphs are similar with the most significant difference being the number of antennal segments, eight in *Dominicicada youngi* but seven in *Magicicada septendecim*. A far older hatchling amber fossil believed by its authors to belong to the Cicadidae (although questionable), *Burmasicada protera* Poinar & Kritsky (99 Ma), also has eight antennal segments. This assignment (*Burmasicada protera*) is important because it bears on the question of whether modern cicadas (family Cicadidae) originated before or after the Cretaceous-Tertiary boundary (see also discussion under *Burmasicada protera*).

***Feoichnus challa* Krause, Bown, Bellosi & Genise, 2008.** Krause *et al.* (2008) described this ichnotaxon from trace fossils of cicada nymph burrows (feeding chambers) from the Eocene/Miocene of Central Patagonia. They reported the same ichnospecies from the latest Cretaceous (Maastrichtian) to Pliocene of the USA, the Oligocene of Ethiopia, and the Miocene of the United Arab Emirates and Kenya. It does not mean that the chamber-makers were conspecific; nymphs of all cicada species do this and it is impossible to associate these structures with particular species. *Feoichnus challa* is just a 'label' for fossilised feeding chambers of nymphal Cicadidae. It remains unconfirmed if the nymphs of modern *Tettigarcta* species make such chambers, and in this regard the absence of *F. challa* from the strata older than end-Cretaceous can be indicative.

#### ***Graptopsaltria inaba* Fujiyama, 1982**

*Graptopsaltria inaba* Fujiyama, 1982: 181–184.

**Age and origin:** 11.6–5.3 Ma. Tochiwara Formation, Misasa Group, Late Miocene, Neogene, Cenozoic. Tatsumi-tôgê, Tottori Prefecture, Japan.

**Status:** Cicadinae, Polyneurini. A left forewing lacking the basal part, and a part of the right forewing in grey mudstone (Pl. 1, fig. 5). There is no reason to question the identity of this specimen. Fujiyama (1982) clearly shows the similarity of *G. inaba* to extant *Graptopsaltria* species.

#### ***Graptopsaltria* aff. *nigrofuscata* (Motschulsky, 1866)**

*Graptopsaltria* aff. *nigrofuscata* (Motschulsky): Fujiyama, 1979: 142–145.

**Age and origin:** 1.1–0.5 Ma. Middle Pleistocene, Quaternary, Cenozoic. Kuwanomaru, Yoshida-machi, Kagoshima Prefecture, Japan (the age of the site is discussed in Fujiyama, 1979: 140–142).

**Status:** Cicadinae, Polyneurini. An almost complete left forewing showing underside in whitish diatomaceous mudstone, 45 mm long x 14.1 mm wide (Pl. 3, fig. 1). Fujiyama's (1979) placement of this species in *Graptopsaltria* is a logical conclusion considering its age, geographic location and wing venation. Fujiyama points out that there is a close correlation between this fossil and extant *G. nigrofuscata* although the ratio of the length to width is a little different. However, such a difference could be caused by distortion in the fossil bed.

### *Graptopsaltria* sp.

*Graptopsaltria* sp. Fujiyama, 1982: 184.

**Age and origin:** 11.6–5.3 Ma. Late Miocene or Early Pliocene, Neogene, Cenozoic. Hyogo Prefecture, Japan.

**Status:** Cicadinae, Polyneurini. An incomplete forewing lacking the distal one third and basal one fifth sections. There is no reason to not accept Fujiyama's identification. As Fujiyama points out the specimen appears closer to *G. nigrofusca* than to *G. inaba*.

***Griphologus lowei* (Etheridge & Olliff, 1890).** Not Cicadoidea. Etheridge & Olliff (1890) described this species from a Late Jurassic (164–145 Ma) fossil from the Talbragar fish bed, New South Wales, Australia, calling it *Cicada? lowei* in the family Cicadidae (Pl. 4, fig. 5). However, it is not of the genus *Cicada*, or even a cicada in the broader sense (superfamily Cicadoidea). At best it can be only doubtfully be assigned to the infraorder Cicadomorpha (an infraorder encompassing the Cicadoidea, Cercopoidea and the synonymous Membracoidea/Cicadelloidea). Reik (1970) questioned its identification and considered it not to be a cicada but gave no indication as to what it could be.

The impression is poorly defined; there is no evidence of a rostrum, eyes, ocelli or timbals, and the wing venation on the basal half in particular is indecipherable. Etheridge and Olliff placed *lowei* in the genus *Cicada* solely because 'its general form and the plan of the venation of its fore-wings, as far as can be judged from the limited material at our disposal, seem to forbid its inclusion in any other family.' No author has since dealt with the species apart from a brief summary by Jell (2004) who also figured the specimen. However, a second specimen has now been found (Beattie & Avery 2012) that is purported to be a Palaeontinidae and which is currently under further study.

### *Hadoa grandiosa* (Scudder, 1892) comb. n.

*Cicada grandiosa* Scudder, 1892: 15, Pl. 1, fig. 3.

**Age and origin:** 33.9–27.8 Ma. Early Oligocene (Rupelian), Paleogene, Cenozoic. Florissant, Colorado, USA.

**Status:** Cicadinae, Cryptotympanini. Hindwing, complete except for about apical fifth and anal lobe; Scudder's estimated total length of the wing, 26.5 mm (Figs 8a, 8b). Cockerell (1911) reasonably concluded that two fragments of a forewing also found at Florissant also represent this species (in University of Colorado Museum). Cooper (1941) described the forewing fragments mentioned by Cockerell and reviewed the dimensions of Scudder's hindwing and concurred with Cockerell (1911) that *grandiosa* most likely belongs to the genus *Tibicen*. Assuming *grandiosa* belongs to an extant genus (which may not be necessarily so), especially one from North America, then its wing venation matches *Tibicen* well, but only *T. parallelus* and those other *Tibicen* species found in the western United States as well as some Asian *Tibicen*. These species, plus *grandiosa*, all have an unusual feature, the hindwing second cubital cell width at its distal end is less than that of the first anal cell, a feature found in few other genera providing the ambient vein does not turn at rightangles between these cells. The genus *Tibicen* in North America has been recently reviewed (Hill *et al.* 2015) and is now replaced by three new genera, *Hadoa* Moulds, *Megatibicen* Sanborn and Heath, and *Neotibicen* Hill and Moulds. *Tibicen parallelus* and those other western *Tibicen* species fall under *Hadoa* and *grandiosa* is also best included there. From North and South America the only other genera known to possess this attribute are *Cacama* and *Cornuplura*. *Cacama* can be dismissed on account of its very broad wing margin while *Cornuplura* cannot be entirely dismissed but is less likely because of the much larger size of *Cornuplura* species.

### *Hyalessa lapidescens* (J. Zhang, 1989) comb. n.

*Oncotympana lapidescens* J. Zhang, 1989: 59–60, 386, pl. 10.

**Age and origin:** 16–11.6 Ma. Early to Middle Miocene, Neogene, Cenozoic. Shanwang Village, Shandong, China (dates for the Shandong fossil beds are discussed by Qiu *et al.* 2013).

**Status:** Cicadinae, Sonatini. Zhang (1989) compared the well preserved right forewing (Fig. 9; Pl. 1, fig. 8) with that of *O. melanoptera* Distant (now *Hyalessa melanoptera*) and his association of this fossil with *Hyalessa* seems a reasonable conclusion. The venation closely matches that of *Hyalessa* except for the more distal placement of crossvein r. The forewing also carries the typical infuscations of *Hyalessa* species.

***Hylaeoneura lignei* Lameere & Severin, 1897.** Described from a fragment from apical half of a wing. Originally described as a Cretaceous sialid but considered to be that of a cicada by Handlirsch (1908, 1925). Cooper (1941)

gives a detailed account of the specimen and concludes it is unlikely to be a cicada. Now placed in Tettigarctidae, subfamily Cicadoprosobolinae, tribe Cicadoprosobolini (Shcherbakov 2009).

***Liassocicada antecedens* Bode, 1953.** Not Cicadidae. Originally placed in Cicadidae by Bode (1953: 201) but later transferred to Tettigarctidae by Hamilton (1992) and Shcherbakov (1996). Now placed in Tettigarctidae, subfamily Tettigarctinae, tribe Protabanini (Shcherbakov 2009).

**'*Liassocicada* ignota (Brodie, 1845).** Not Cicadidae. Brodie described *ignota* as a dipteran. Whalley (1983) recognised the species as a cicada and placed it as *Liassocicada ignotatus* (an incorrect subsequent spelling) in the family Cicadidae. According to Shcherbakov (2009), it belongs to an undescribed genus of Tettigarctidae, subfamily Cicadoprosobolinae, tribe Cicadoprosobolini.

#### ***Lithocicada perita* Cockerell, 1906**

*Lithocicada perita* Cockerell, 1906: 457–458.

**Age and origin:** 33.9–27.8 Ma. Early Oligocene (Rupelian), Paleogene, Cenozoic. Florissant, Colorado, USA.

**Status:** Tibicininae (*sensu* Moulds, 2005), Tibicinini. Nearly complete forewing, approximate dimensions according to Cooper (1941) 22mm x 9.6 mm. Cockerell (1906) states that the type is in the American Museum of Natural History (Pl. 1, fig. 9) with 'reverse' in University of Colorado (Pl. 1, fig. 10). However, while the venation of the specimen located in UC closely corresponds with the type in AMNH (AMNH-FI 18915), its wing shape is noticeably different and it cannot be the counterpart. The counterpart is in the Natural History Museum, London (NHMUK PI I 8414). Previously placed in Cicadinae because that was the accepted classification for all cicadas at the time. *Lithocicada* is here placed in the subfamily Tibicininae, tribe Tibicinini. Among extant cicadas the wing venation is close to some species of *Okanagana* Distant and some of *Clidophleps* Van Duzee (both genera in Tibicinini) because veins M and CuA are widely separated on meeting an elongated basal cell, the apical cells are long, the outer margin is broad, the costal vein is thickened to the node, and the costal margin is strongly curved, all features of these two genera. It is possible that the distal portion of the wing has been partially distorted in preservation exaggerating the curvature but some curvature is typical of some Tibicinini. Crossvein m-cu seems unusually short in this fossil.

#### ***Lyristes? emathion* (Heer, 1853)**

*Cicada emathion* Heer, 1853: 88, Pl. 11, fig. 3.

*Lyristes emathion* (Heer): Riou, 1995: 76 (by inference).

**Age and origin:** 7.2–5.3 Ma. Messinian, Late Miocene, Neogene, Cenozoic. Oeningen, Switzerland (the location of the site is described by Cockerell 1915).

**Status:** Cicadinae, Cryptotympanini. A whole specimen in dorsal aspect but with wing venation visible only on basal two-thirds of left forewing (Pl. 1, fig. 7). Riou (1995) gives the wingspan as 83 mm. Heer (1853) placed *emathion* in the genus *Cicada* (and therefore family Cicadidae), an appropriate decision at the time when *Cicada* was a much broader concept. Cooper (1941) doubtfully attributed *emathion* to the subfamily Cicadinae. Riou (1995) suggested *emathion* was better placed in the genus *Lyristes*, which concurs with Cooper's tentative subfamily designation.

*Lyristes emathion* has some distinctive features relevant to generic placement. The pronotal collar is broad both dorsally and laterally, the eyes are large and close to the postclypeus, the apical cells of the forewing appear to be only a little shorter than the ulnar cells, and the abdomen tends to be parallel-sided. These attributes alone make it difficult to determine generic placement in a modern classification. However, while the broad pronotal collar and large eyes are not entirely compatible with extant *Lyristes*, if *emathion* is to be placed in an extant genus then *Lyristes* seems as appropriate as any other.

**Lectotype designation.** Heer (1853) attributed two specimens to this species, one a near complete specimen that he figured, the other a poorer specimen but with a well defined body. Cooper (1941) concluded that Heer's two specimens were unlikely to be the same species based on extrapolated measurements. To clarify the identity of *Cicada emathion*, the specimen illustrated by Heer (1853) as fig. 1 on plate XI is here designated as lectotype.

### ***Lyristes renei* Riou, 1995**

*Lyristes renei* Riou, 1995: 74–75.

**Age and origin:** 8.5–8.0 Ma. Late Miocene, Neogene, Cenozoic. Andance, France.

**Status:** Cicadinae, Cryptotympanini. Holotype, a large cicada with wings spread, comprising body almost complete but mostly poorly preserved, the forewing 45 mm long, hindwing 27 mm long, wingspan 104 mm (Pl. 2, fig. 1). Based on the forewing venation, body shape and locality, Riou (1995) concluded this fossil was allied to extant species of *Lyristes* and there is no reason to question this determination.

### ***Lyristes* sp.**

*Tibicina haematodes* (Scopoli): Tietz, Berner & Mattig, 1998: 142, 145, 149, 151.

**Age and origin:** 30.5–30.2 Ma. Early Oligocene, Paleogene, Cenozoic. Seifhennersdorf, Germany. For discussion on the age of the deposit see Walther & Kvaček (2007).

**Status:** Cicadinae, Cryptotympanini. Basal half of forewing from the diatomite slate deposit of Seifhennersdorf, 20 mm long x 13 mm wide (Pl. 4, fig. 3). Tietz, Berner & Mattig (1998) identified this fossil as being *Tibicina haematodes* (Scopoli, 1763). Prokop & Fikáček (2007) re-examined it as part of a study of Seifhennersdorf insect fossils and concluded the specimen was unidentifiable. The specimen is fragmentary but does have some features indicative of generic placement, although not those of *Tibicina*. The forewing veins M and CuA meet a rounded basal cell wide apart, the nodal intersection is close to  $M_{3+4}$ , the proximal two sections of the discal cell are long and much longer than the distal one, the distal portion of the discal cell is very sharply angled, and the costal margin is moderately ampliate. If this fossil is to be placed in an extant genus, then among Palearctic cicadas these features are found only in *Lyristes* Horváth and *Auritibicen* Lee. These two genera differ in the shape of the medial cell and the fossil matches that of *Lyristes*.

***Meimuna incasa* J. Zhang, Sun and X. Zhang, 1994.** See *Cryptotympana incasa* comb. n.

***Meimuna miocenica* J. Zhang and X. Zhang, 1990.** See *Cryptotympana miocenica* comb. n.

### ***Meimuna protopalifera* Fujiyama, 1969**

*Meimuna protopalifera* Fujiyama, 1969: 864–867.

**Age and origin:** 23–16 Ma. Early Miocene, Neogene, Cenozoic. Nasu Volcano, Tochigi Prefecture, Japan.

**Status:** Cicadinae, Dundubiini, Aolina. Female showing upper surface except for part of head where part of under surface appears, and interrupted fore- and hindwings (Figs 10a, 10b); length of body including ovipositor 29 mm; forewing length to apex estimated at 32.5 mm, width 8.8 mm. Fujiyama (1969) provides convincing evidence for the placement of this species in *Meimuna*, comparing it with extant *M. opalifera*, the wings of both being closely similar. In particular, forewing veins M and CuA meet the basal cell close together on a long and narrow basal cell, the discal cell is very narrow and distally acutely pointed, ulnar cells 1 and 2 are narrower than ulnar cell 3 and the apical cells are clearly shorter than the ulnar cells. However, the closely allied genus *Haphsa* Distant also has these attributes and is distinguishable only by features of the male genitalia (Lee 2009). Thus, it is impossible to say if *protopalifera* belongs to *Meimuna* or *Haphsa*. I leave it in *Meimuna* as the most likely of the two because it is the most abundant and the only one extant in Japan. There are two other allied genera described in more recent years, *Sinotympana* Lee, 2009 and *Kaphsa* Lee, 2012 that also need consideration, both of which are monotypic. However, both these genera can be dismissed by the development of forewing vein  $RA_2$ . This vein in *Meimuna* (and *Haphsa*) has a characteristic bow where it meets crossvein r, and it joins the ambient not at the ambient vein's most apical part. In *Kaphsa*  $RA_2$  is not bowed and in *Sinotympana*  $RA_2$  joins the ambient vein at its most distal part.

### ***Meimuna* sp.**

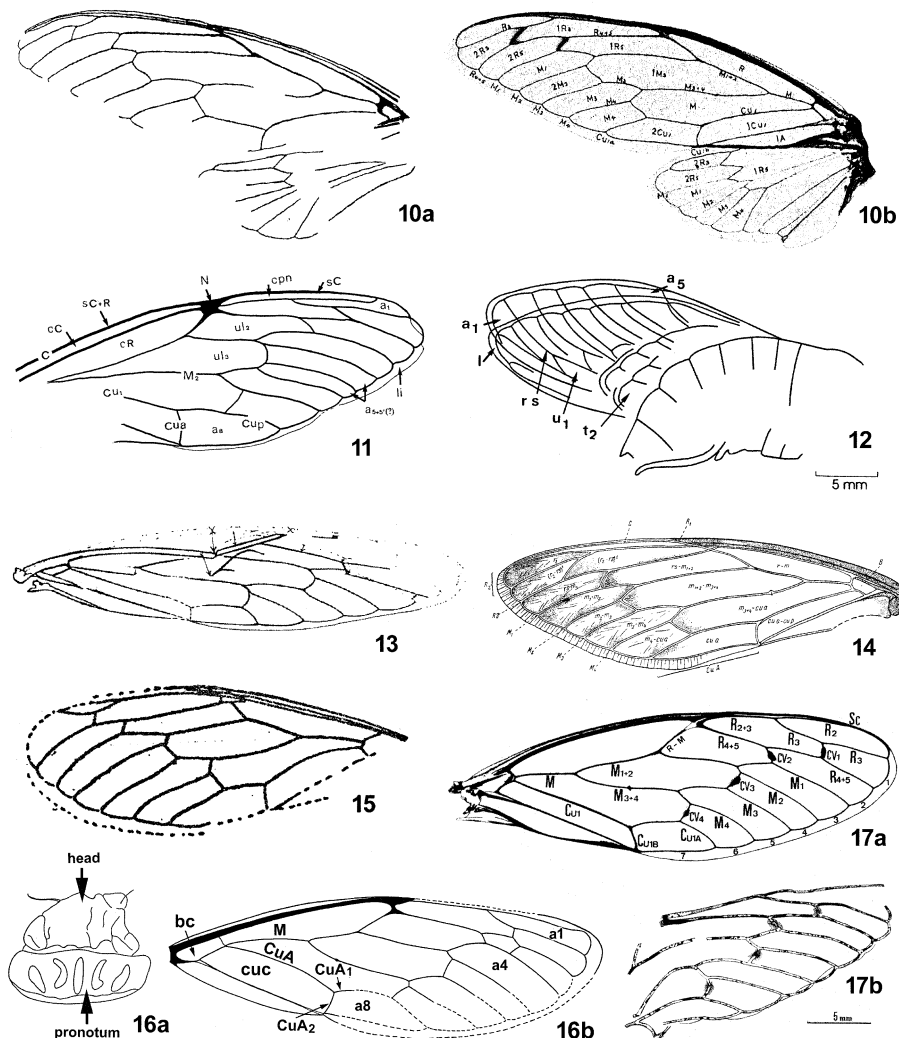
*Meimuna* sp. Fujiyama, 1982: 184–185.

**Age and origin:** 3.6–2.6 Ma. Haruki Formation, Teragi Group, Late Pliocene, Neogene, Cenozoic. Umigami, Hyōgo Prefecture, Japan.

**Status:** Cicadinae, Dundubiini, Aolina. A left(?) forewing lacking basal third and a small part of apex, the remaining part 32.5 mm long x 13.2 mm wide. Fujiyama (1982) provides convincing evidence for the placement of this species in *Meimuna*. In particular, he mentions how vein  $RA_2$  terminates near the wing apex, unlike in

*Terpnosia*, *Oncotympana* and *Tibicen*, and how the first crossvein slants outwards but is curved in *Tanna*. Although *Meimuna* is very similar to *Haphsa* and some other allied genera it is retained here in *Meimuna* for the reason discussed under *M. protopalifera* above.

***Meuniera haupti* Piton, 1936.** Not Cicadidae. Originally placed in Cicadae by Piton but later transferred to Tettigarctidae by Cooper (1941: 301). Redescribed by Boulard and Nel (1990) and now placed as Tettigarctidae, subfamily Tettigarctinae, tribe Meunierini (Boulard and Nel 1990, Shcherbakov 2009).



**FIGURES 10–17.** (10a) *Meimuna protopalifera* fore and hindwing, interpretation of the venation, from Fujiyama (1969). (10b) Recent *Meimuna opalifera*, fore and hindwing with labelled venation, from Fujiyama (1969). (11) *Miocenoprasia grasseti* forewing, interpretation of venation, from Boulard & Riou (1999). (12) *Tibicina sakalai*, interpretation of the fossil, from Prokop & Boulard (2000). (13) *Yezoterpnosia nigricosta*, forewing interpretation from Fujiyama (1979). (14) *Tymocicada gorbunovi* forewing, interpretation from Becker-Migdisova (1954). (15) *Cicadatra? serresi* forewing interpretation, from Théobald (1937). (16a) *Paracicadetta oligocenica* head and pronotum, from Boulard & Nel (1990). (16b) *Paracicadetta oligocenica* left wing with revised notation, from Boulard & Nel (1990). (17a) *Yezoterpnosia vacua*, extant, from Kinugasa & Miyatake (1979). (17b) *Yezoterpnosia* sp. aff. *vacua* comb. n., forewing fossil, interpretation, from Kinugasa & Miyatake (1979).

### ***Minyscapheus dominicanus* Poinar, Kritsky & Brown, 2011**

*Minyscapheus dominicanus* Poinar, Kritsky & Brown, 2011: 2–4.

**Age and origin:** 20–15 Ma. Early/Middle Miocene, Cenozoic. La Búcara amber mine, Cordillera Septentrional, Dominican Republic.

**Status:** Cicadinae, Taphurini. Nearly whole specimen (female) in amber, body length approximately 11.1 mm,

forewing length 16.2 mm (Pl. 3, fig. 4). Poinar, Kritsky & Brown (2011) mention the similarity of this fossil to extant species in the genus *Uhleroides* Distant, also found in the West Indies. In particular, they mention (apart from things that differentiate *Minyscapheus* from *Uhleroides*) the dilated rounded sides to the pronotal collar that are so characteristic of *Uhleroides* and other Zammarini. However, they also point out the protruding lateral angles of the pronotal collar that are clearly visible in the fossil. These two features are incompatible because the lateral angles cannot protrude if the lateral margins of the pronotal collar are dilated and it would appear the fossil does not have dilated lateral margins. This would mean *Minyscapheus* is not allied to *Uhleroides* or the Zammarini.

Poinar *et al.* compared *Minyscapheus* with extant genera found in the West Indies, but going further afield to mainland South America there are other genera that appear to be more closely allied to *Minyscapheus*. Two genera in the Taphurini in particular appear closest, *Taphura* Stål and the recently described *Malloryalna susanae* Sanborn. Notable features of *Taphura*, that are shared with *Minyscapheus* for example, include the large eyes that have angular inner margins, the similar positions of the ocelli, a pronotum with deep paramedian and lateral fissures and a pale midline, a pronotal collar with pointed lateral angles and reduced lateral margins, a mesonotum with short submedian sigillae and weak paramedial and lateral sutures, a forewing costal margin swollen basally and towards the node, forewing cross veins r and r-m close together, and a hindwing with the distal end of the 2nd cubital cell wider than that of the 1st anal cell so that the ambient vein is not sharply angled at this point. Notable features of *Minyscapheus* that differ from *Taphura* include its more slender cruciform elevation, longer forewing ulnar cells, straight distal end of vein Ra<sub>2</sub> (although apical cell 2 does widen distally as in most cicadas), closer association of veins M and CuA at the basal cell, longer hindwing apical cells and longer vein 3A. *Malloryalna susanae* not only has features similar to *Taphura* but wings that are even more similar to those of *Minyscapheus* differing primarily only in having the forewing costal margin thicker on its the basal half, hindwing vein 3A shorter and cross vein r sloping rather than near perpendicular to RP. This close similarity of *Taphura* and *Malloryalna* (both tribe Taphurini) to *Minyscapheus* suggests *Minyscapheus* is best placed in the Taphurini.

#### ***Miocenoprasia grasseti* Boulard and Riou, 1999**

*Miocenoprasia grasseti* Boulard & Riou, 1999: 136–138.

**Age and origin:** 8.5–8.0 Ma. Late Miocene, Neogene, Cenozoic. Andance, France.

**Status:** Cicadettinae, Lamotialnini. Male in ventral view with wings in resting position, the left forewing fully visible except for basal part excluded by body, right forewing slightly crumpled, hindwings minimal, abdomen apparently missing, total length 56 mm, length of forewings 46 mm (Fig. 11; Pl. 3, fig. 5). Boulard & Riou (1999) placed this fossil in the tribe Prasiini because the specimen had features resembling some extant *Prasia* and *Lembeja*. In particular, they noted the narrow head with its large eyes, and the abdomen that they believed had its distal two thirds telescoped within its proximal third, the latter feature found only in some Prasiini. However, there are features suggesting that *Miocenoprasia grasseti* would be more appropriately placed in the Lamotialnini. Many of the species in this tribe have characteristic attributes found in the fossil including a very narrow apical cell 1, a triangular apical cell 8, ulnar cell 3 narrowly pointed basad, a developed but narrow wing margin, large male opercula (arrowed), large eyes, and a head tending narrow although not as narrow as that of the fossil. Attributes of the fossil that exclude it from the Prasiini are the developed forewing margin (absent or underdeveloped in the Prasiini) and the large male opercula (Prasiini males have very small opercula). Further, the fossil most likely has its abdomen missing rather than telescoped within whereby some evidence of its existence would be visible distal of the opercula. Some genera in the Lamotialnini with species possessing features of *Miocenoprasia grasseti* include *Abroma*, *Trismarcha* and *Monomatapa* (all African), and *Abrieta* (from Mauritius). For the preceding reasons the fossil is here placed in the Lamotialnini.

***Oncotympana lapidescens* J. Zhang, 1989.** See *Hyalessa lapidescens* comb. n.

#### ***Paleopsalta* gen. n.**

**Type species:** *Cicada ungeri* Heer, 1853; Miocene, Neogene, Cenozoic.

**Included species:** *Paleopsalta ungeri* (Heer, 1853), comb. n.

**Etymology:** From the Greek *paleo* meaning ancient, old, and referring to the fossil status of the specimen and from *psalta*, a traditional ending for cicada generic names which probably originates from the Latin *psaltria* meaning a female harpist. Feminine.



**Diagnosis:** Forewing (Pl. 1, fig. 6) with anal angle well developed so that outer margin and inner margin are opposed at about 135 degrees; marginal area broad so that ambient vein is distinct from wing margin; with 8 apical cells; apical cells a little shorter than ulnar cells except apical cell 4 that is similar in length to ulnar cell 3; ulnar cells and medial cell more or less similar in size; radial cell exceptionally wide, far wider than any other forewing cell; veins M and CuA completely fused as one before the basal cell; vein CuA<sub>1</sub> divided by crossvein so that proximal portion shortest.

**Distinguishing features:** Differs from all other cicada genera in having the forewing radial cell very broad proximally, far broader than any other forewing cell. The other notable feature is the complete fusion of veins M and CuA before the basal cell, an attribute restricted to the Cicadettini.

**Phylogenetic relationships:** Subfamily Cicadettinae, tribe Cicadettini. *Paleopsalta* appears closest to some extant genera from the Holarctic such as *Melampsalta* and *Tettigetia*, and several Australian genera such as *Auscala*, *Birrima*, *Pauropsalta* and *Yoyetta*, all of which have forewing veins M and CuA completely fused as one before the basal cell. It is difficult to say if *Paleopsalta* is closer to the Holarctic genera (type species from Croatia) rather than elsewhere and it may be a common ancestor of all.

***Paleopsalta ungeri* (Heer, 1853) comb. n.**

*Cicada ungeri* Heer, 1853: 89, pl. XI.

**Age and origin:** 13.8–11.6 Ma. Middle Miocene (Serravallian), Neogene, Cenozoic. Radoboj, Croatia.

**Status:** Cicadettinae, Cicadettini. Forewing virtually entire, approximately 26 x 8.5 mm (Pl. 1, fig. 6). Cooper (1941) extrapolated the body size to be approximately 20 mm and the hindwing 14.4 x 6.6 mm. Heer (1853) placed *ungeri* in the genus *Cicada* because that genus had a much broader concept at the time incorporating most known cicadas. However, there is one feature of the venation that precludes it from *Cicada* (and other extant and fossil genera), specifically the very wide radial cell that is far wider than any other forewing cell. Another notable feature is the complete fusion of veins M and CuA before the basal cell, an attribute confined to the tribe Cicadettini. For these reasons *ungeri* is here placed in the new genus *Paleopsalta* (see above).

***Paracicadetta oligocenica* Boulard and Nel, 1990**

*Paracicadetta oligocenica* Boulard & Nel, 1990: 37–38, 39.

**Age and origin:** 33.9–27.8 Ma. Rupelian (=Stampien), Early Oligocene, Paleogene, Cenozoic. Céreste, France.

**Status:** Cicadettinae, Pagiphorini. Nearly complete dorso-lateral body with superimposed wings (Figs 16a, 16b; Pl. 2, fig. 3). Boulard & Nel (1990) placed this fossil as very close to the extant genus *Cicadetta* (tribe Cicadettini), distinguishing their new genus *Paracicadetta* from *Cicadetta* by the obtusely angled CuA<sub>1</sub> to CuA<sub>2</sub> (rather than acute), the broad cubital cell (narrow in *Cicadetta*), and the larger and differently shaped apical cell 8 (Fig. 16b). While there certainly are similarities between *Paracicadetta* and *Cicadetta* (such as the meeting of veins M and CuA at the basal cell), among the extant cicadas from the Palaearctic region *Paracicadetta* appears closer to the genus *Pagiphora* Horvath (tribe Pagiphorini). Apart from having the three features mentioned above, apical cell 1 in *Pagiphora* is unusually large and distally extended a little beyond the apical extremity of cell 2 so that it is the most distal part of the forewing venation. Besides *Pagiphora*, this feature is found in the genus *Cicada* (tribe Cicadini) and a few other genera from outside the Palaearctic region including some species of *Purana*, *Haphsa* and *Terpnosia* that are mainly from the Indo-Australian region, but all these differ from *Paracicadetta* in lacking the distinct separation of vein RA<sub>1</sub> from Sc.

The other unusual feature of this fossil, the meeting of veins M and CuA at the basal cell, is not quite emulated in *Pagiphora* although these veins do reach the basal cell very close together. There are extant species of Cicadettini with M and CuA touching at the basal cell, often in species of the genus *Cicadetta* as mentioned above, and in some individuals of *Physeema convergens*, *Noongara issoides*, *Gelidea torrida*, *Kobonga umbrimargo* and *K. froggatti* (Moulds 2012: 15). Beyond the Cicadettini this feature is rare in cicadas occurring in species such as *Cystosoma saundersii* (tribe Chlorocystini) and in some species of *Odopoea*, *Zammara* and allied genera (tribe Zammarini) and *Karenia* (tribe Sinosenini) but *Paracicadetta* differs from all these including *Cicadetta*, in its large apical cell 1 and distinct separation of vein RA<sub>1</sub> from Sc, features however present in *Pagiphora*. *Pagiphora* differs from *Paracicadetta* in its much broader forewing, smaller eyes and parallel-sided abdomen.

If *Paracicadetta* is more closely related to *Pagiphora* rather than *Cicadetta*, then its placement in the tribe Cicadettini becomes questionable. *Pagiphora* is now in the tribe Pagiphorini following a comprehensive molecular

study of the Cicadidae by Marshall *et al.* (2018) and considering the similarities of *Paracicadetta* with *Pagiphora*, *Paracicadetta* is here included in the Pagiphorini Moulds & Marshall, 2018.

***Platypedia primigenia* Cockerell, 1908**

*Platypedia primigenia* Cockerell, 1908: 52.

**Age and origin:** 33.9–27.8 Ma. Early Oligocene (Rupelian), Paleogene, Cenozoic. Florissant, Colorado, USA.

**Status:** Tibicininae (*sensu* Moulds, 2005), Platypediini. Nearly whole specimen with wings superimposed over ventro-lateral body, with part and counterpart, in Peabody Museum of Natural History, Yale University; YPM IP 026165. Body 24 mm long, forewing estimated at 24 mm long (Cooper 1941). There is another specimen in similar lateral profile determined as this species in Colorado University Museum of Natural History; UCM 29658 (Pl. 2, fig. 4), and another figured by Grimaldi & Engel (2005: 310) in the Natural History Museum, London: NHMUK PI In 19232. Cockerell (1908) compared this fossil with extant *Platypedia putnami* and because of the close similarity placed it in *Platypedia* which is a reasonable conclusion. Particularly noted by Cockerell was the large triangular ulnar cell 2 characteristic of *Platypedia*. The larger body and downwardly directed head that differ from *Platypedia* are probably due to distortion of the fossil from compression.

***Prosholecicada gondwanica* Pinto, 1987.** Not Cicadoidea. See Shcherbakov (2000). Family Prosbolidae, superfamily Prosboloidea.

***Rihana beauchampi* Piton, 1940.** See *Chremistica beauchampi* above.

***Tanna?* sp.**

*Tanna?* sp.: Fujiyama 1979: 148–151.

**Age and origin:** 1.7–1.5 Ma. Early Pleistocene, Quaternary, Cenozoic. Ōya Formation, Kashiyama, Kazusa-muchi, Minami-takaki-gun, Nagasaki Pref., Japan (the age of the site is discussed in Fujiyama, 1979: 139–140).

**Status:** Cicadinae, Leptopsaltriini, Leptopsaltriina. An incomplete hindwing lacking its base, apex and anal area, 32 mm maximum length (Pl. 3, fig. 2). Fujiyama (1979) gives a very detailed account of why this fossil seems best placed in the genus *Tanna*. Among extant species from South-East Asia, Fujiyama concludes that it is closest to *Tanna japonensis* Distant, 1892, although its much larger size means it cannot be that species. The limited nature of the specimen does not allow a better determination. There are other allied genera that this fossil may belong to, but this is a young fossil and *Tanna* is the only extant genus in Japan matching its features and placing it there is a reasonable conclusion.

***Terpnosia nigracosta* now *Yezoterpnosia nigracosta*, q.v.**

***Terpnosia* sp. aff. *vacua* now *Yezoterpnosia* sp. aff. *vacua*, q.v.**

***Tibicen bihamatus* now *Auritibicen bihamatus*, q.v.**

***Tibicen grandiosa* now *Hadoa grandiosa*, q.v.**

***Tibicen* sp. aff. *japonicus* now *Auritibicen* sp. aff. *japonicus*, q.v.**

***Tibicina gigantea* Boulard & Riou, 1989**

*Tibicina gigantea* Boulard & Riou, 1989: 349–351.

**Age and origin:** 8.5–8.0 Ma. Late Miocene, Neogene, Cenozoic. Andance, France.

**Status:** Tibicininae (*sensu* Moulds, 2005), Tibicinini. Holotype male, a whole specimen in dorsal aspect with body and wings intact, total length 60 mm (further measurements in original description) (Pl. 2, figs 5a, 5b). Boulard & Riou (1989) highlight the close similarity of this specimen with the smaller extant *Tibicina haematodes* and there is no reason to question the identity of this fossil.

***Tibicina haematodes* (Scopoli, 1763)**

*Tibicina haematodes* (Scopoli): Wagner, 1967: 91–92, 93, 94.

**Age and origin:** 3.6–2.6 Ma. Pliocene, Neogene, Cenozoic. Willershausen, Germany. Meischner (2000) gives a detailed account of the geology of these fossil beds.

**Status:** Tibicininae (*sensu* Moulds, 2005), Tibicinini. Forewing missing apical portion from the clay pit at Willershausen (Pl. 2, fig. 6). Thirteen specimens in all from Willershausen are attributed to this species by Wagner (1967) but only the status of his figured specimen is reviewed here. Wagner compared his specimens with extant *Tibicina haematodes* and the specimen figured shows a number of *T. haematodes* attributes. In particular forewing veins M and CuA meet an elongated basal cell wide apart, the proximal and distal sections of the inner margin of the discal cell are just a little shorter than the mid section, ulnar cells 1 and 2 are only slightly smaller than ulnar cell 3, the wing is broad with the anal angle well formed, and the costal margin is moderately ampliate. Among extant Holarctic cicadas these features are found only in some species of *Tibicina* and if this fossil is to be placed anywhere then taking into account its size *Tibicina haematodes* would be appropriate.

***Tibicina haematodes* (Scopoli, 1763).** A specimen identified by this name by Tietz, Berner and Mattig (1998) from the diatomite slate deposit of Seifhennersdorf is now identified as *Lyristes* sp., *q.v.*

#### ***Tibicina sakalai* Prokop & Boulard, 2000**

*Tibicina sakalai* Prokop & Boulard, 2000: 128–130.

**Age and origin:** 17.9–17.8 Ma. Early Miocene (Eggenburgian/Ottnangian boundary), Neogene, Cenozoic. Bílina Mine, Czech Republic.

**Status:** Tibicininae (*sensu* Moulds, 2005), Tibicinini. Holotype female, a whole specimen in lateral profile with body and wings intact, both imprint and counter-imprint, total length 37 mm, in National Museum, Prague (further measurements in original description) (Fig. 12; Pl. 2, fig. 7; Pl. 4, fig. 4). Prokop & Boulard (2000) concluded that this species belonged to the genus *Tibicina* based on the forewing venation, general body shape, and development of the female's ovipositor, and while details of these associations were not specified their conclusion seems a reasonable one.

***Tibicina wagneri* Boulard & Riou, 1989.** *Nomen nudum*. Boulard & Riou (1989: 44) inadvertently included this name in their Table 1 and the name should be ignored. The record intended was *Tibicina haematodes* of Wagner (1967) (M. Boulard, pers. comm.).

#### ***Tymocicada gorbunovi* Becker-Migdisova, 1954**

*Tymocicada gorbunovi* Becker-Migdisova, 1954: 800–804.

**Age and origin:** 23–16 Ma. Early Miocene, Neogene, Cenozoic. West Siberia, Russia.

**Status:** Cicadinae, Cryptotympanini. A right forewing, complete, 43 mm long x 13.9 mm wide, part and counterpart, holotype, in Borissiak Paleontological Institute, Moscow (BPI), reg. no. PIN 437/2(9) (Fig. 14; Pl. 4, fig. 1). Becker-Migdisova (1954) regarded this fossil as closest to the extant genus *Cosmopsaltria* Stål, 1866 (tribe Cosmopsaltriini). *Tymocicada* was described as differing from *Cosmopsaltria* in having a longer anterior branch to vein CuA and the cell between Sc and Ra slightly broader. *Tymocicada* does have some similarities to *Cosmopsaltria* but is also equally similar to several other genera such as some species (as pointed out by Becker-Migdisova) of *Platylomia* (Dundubiini) and *Pomponia* (Psithyristriini). *Tymocicada* also has similarities to *Chremistica*, *Lyristes*, *Auritibicen* and *Cryptotympana* (all Cryptotympanini), and in particular *Cryptotympana*, especially *C. intermedia* from India. Therefore there must be some doubt as to tribal placement although it seems closest to the Cryptotympanini. Important diagnostic features of *Tymocicada* are its long apical cell 8 that is almost as long as the cubital cell, the placement and wide separation of veins M and CuA at the basal cell, and the clear separation of veins Sc and RA. The combination of these three features distinguishes *Tymocicada*. There are four other fossil fragments in the BPI from the same strata that could be attributed to *Tymocicada* and may be conspecific with *T. gorbunovi* including a hindwing (Pl. 4, fig. 2).

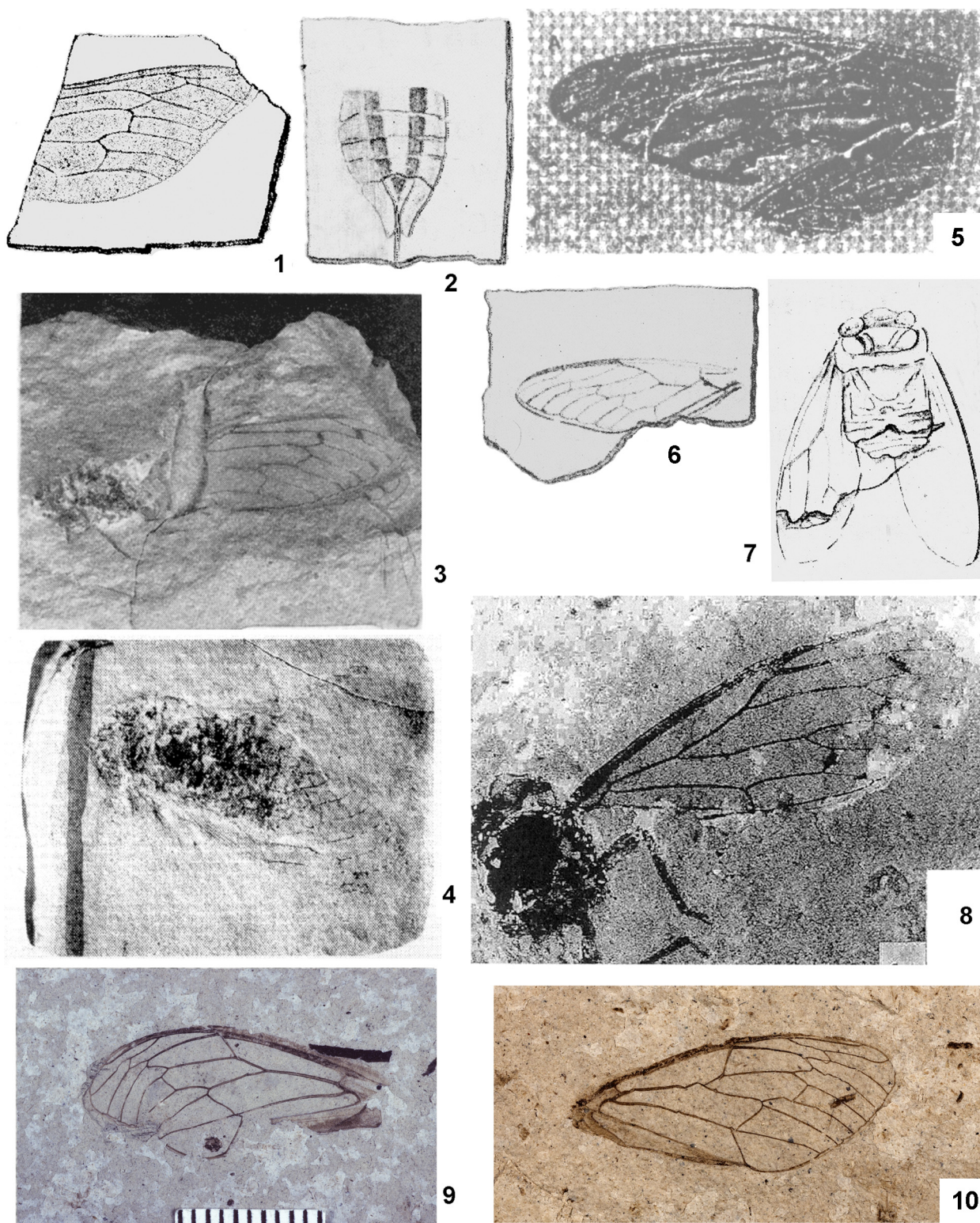
#### ***Yezoterpnosia nigricosta* (Motschulsky, 1866)**

*Terpnosia nigricosta* (Motschulsky): Fujiyama, 1969: 870–872; Fujiyama, 1979: 146–148.

*Yezoterpnosia nigricosta* (Motschulsky): Lee, 2012: 257.

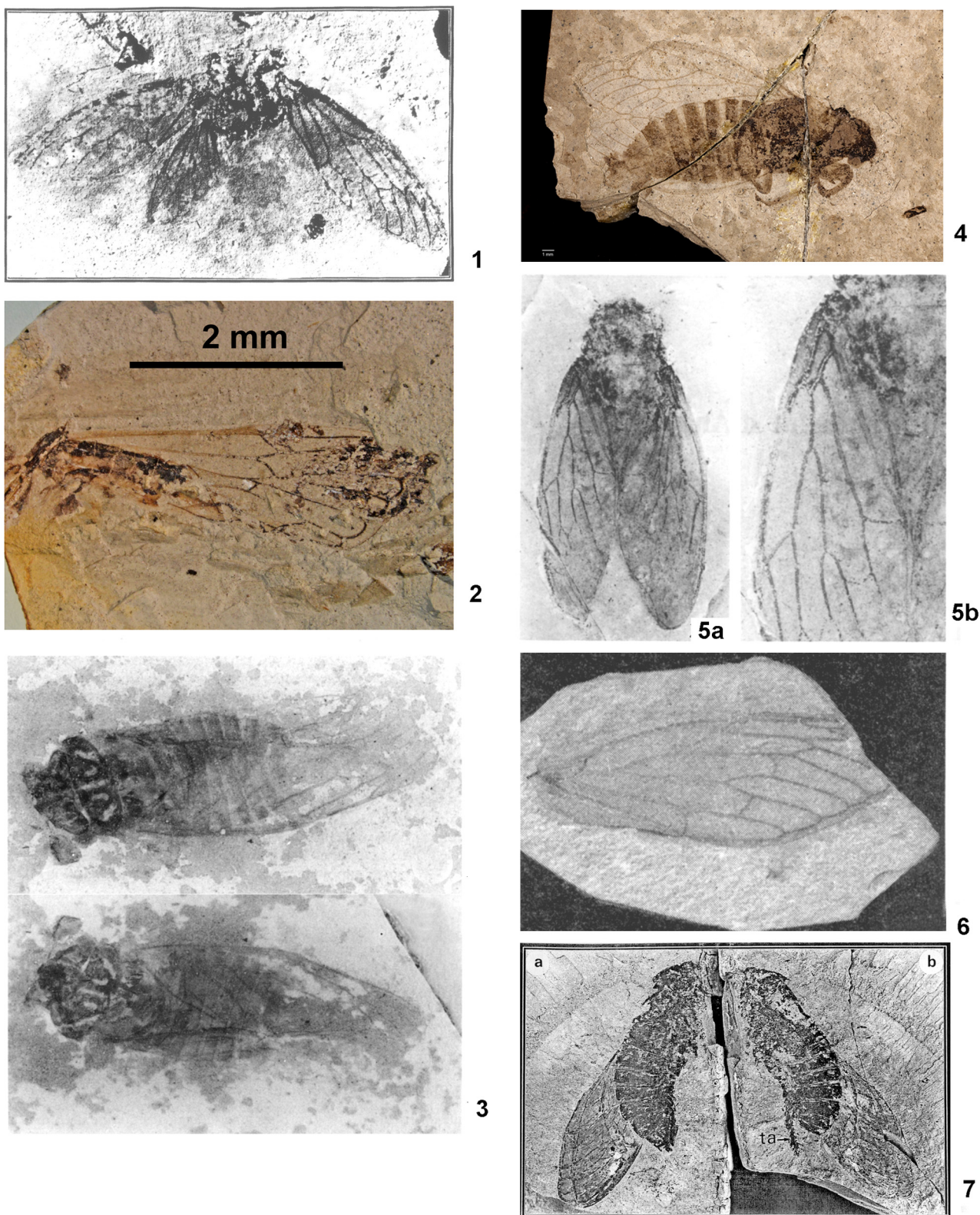
**Age and origin:** 0.038–0.033 Ma. Late Pleistocene, Quaternary, Cenozoic. Naka-Shiobara, Tochigi Prefecture, Japan (the age of the site is discussed in Fujiyama, 1979: 142).





**PLATE 1.** (1) *Camuracicada aichhorni* gen. n., comb. n., Heer's original image of the fossil, his fig. 2, from Heer (1853). (2) *Cicada bifasciata*, *nomen dubium*, Heer's original image of the fossil, his fig. 4, from Heer (1853). (3) *Cicada* sp. aff. *orni*, from Wagner (1967). (4) *Cicadatra? serresi*, from Meunier (1915). (5) *Graptopsaltria inaba* fossil, from Fujiyama (1982). (6) *Paleopsalta ungeri* gen. n., comb. n., fossil, from Heer (1853). (7) *Lyristes? emathion* fossil, interpretation after Heer (1853). (8) *Hyalessa lapidescens* comb. n., dorsal impression, from Zhang (1989). (9) *Lithocicada perita*, holotype, in American Museum of Natural History, USA; AMNH-FI 18915; image Herbert Meyer. (10) *Lithocicada perita*; in University of Colorado; USA; UCM 4554; not a type; image David Zelagin.





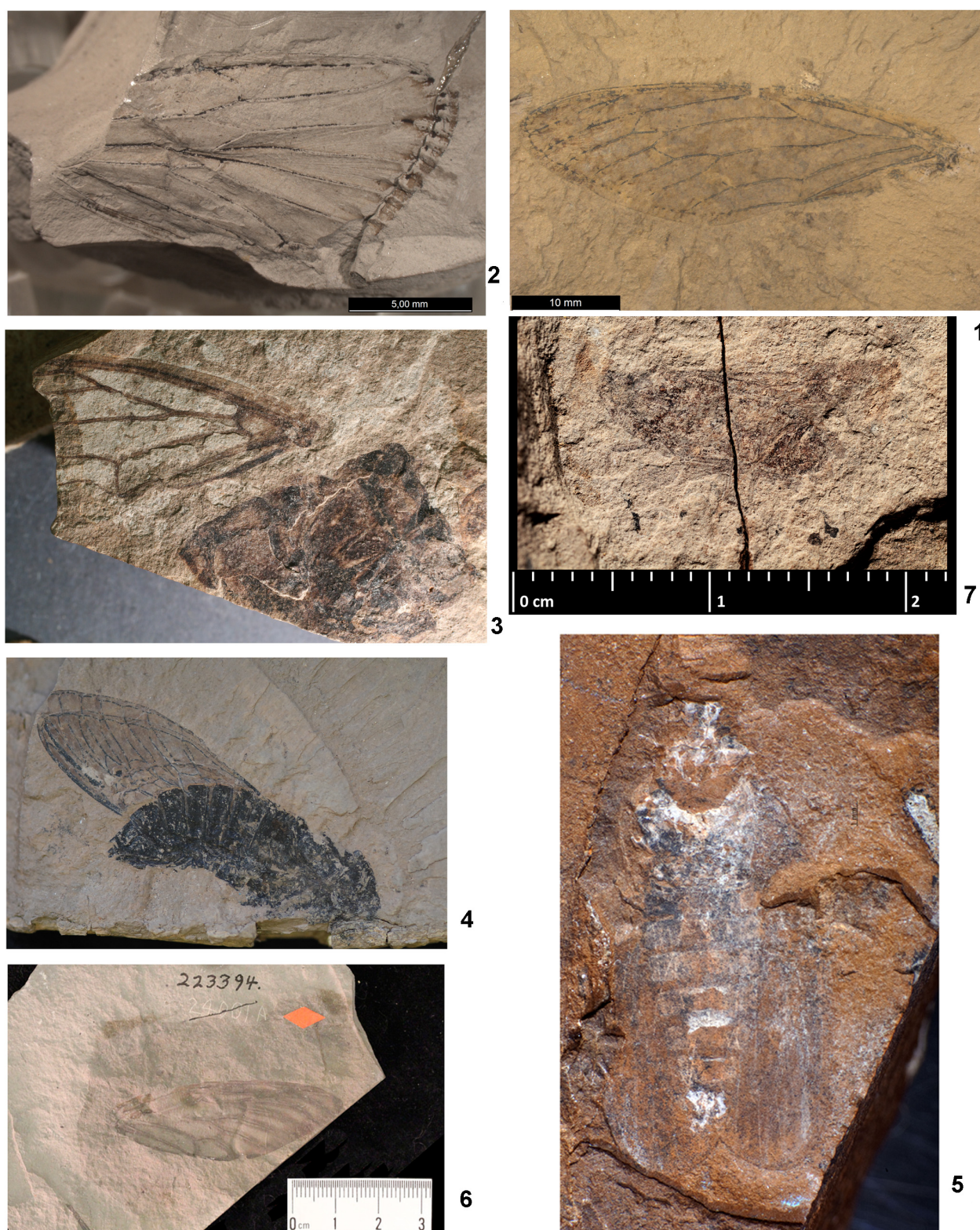
**PLATE 2.** (1) *Lyristes renei*, holotype, from Riou (1995). (2) *Auritibicen* sp. aff. *japonicus* comb. n., in Osaka Museum of Natural History, image Shigehiko Shiyake. (3) *Paracicadetta oligocenica*, holotype, part and counterpart, from Boulard & Nel (1990). (4) *Platypedia primigenia*, nearly entire specimen, wings superimposed over ventro-lateral body, in Colorado University Museum of Natural History, USA; UCM 29658, not the type; image David Zelagin. (5a) *Tibicina gigantea* holotype, dorsal, entire specimen, from Boulard & Riou (1989). (5b) *Tibicina gigantea* close-up of left forewing base, from Boulard & Riou (1989). (6) *Tibicina haematodes*, forewing, from Wagner (1967). (7) *Tibicina sakalai*, holotype, including counterpart, female, lateral, from Prokop & Boulard (2000).





**PLATE 3.** (1) *Graptopsaltria* aff. *nigrofusca* forewing; in National Museum of Nature and Science, Japan; NSM-PA12018; image courtesy Yasunari Shigeta. (2) *Tanna?* sp. hindwing; in National Museum of Nature and Science, Japan; NSM-PA12017; image courtesy Yasunari Shigeta. (3) *Auritibicen bihamatus* forewing; in National Museum of Nature and Science, Japan; NSM-PA12045; image courtesy Yasunari Shigeta. (4) *Minyscapheus dominicanus*, holotype, whole specimen in amber; in collection George Poinar; image courtesy George Poinar. (5) *Miocenoprasia grasseti*, holotype, ventral impression; in Riou collection, Musée de Paléontologie, La Voulte-sur-Rhône, France; image courtesy Bernard Riou. (6) *Yezoterpnosia nigricosta* forewing; in National Museum of Nature and Science, Japan; NSM-PA12019; image courtesy Yasunari Shigeta. (7) *Dominicicada youngi*, holotype, hatchling in amber; in collection George Poinar; image courtesy George Poinar. (8) *Burmacicada protera*, holotype, hatchling in amber; in collection George Poinar; image courtesy George Poinar.





**PLATE 4.** (1) *Tymocicada gorbunovi*, holotype, forewing, part and counterpart; in Borissiak Paleontological Institute, Russian Academy of Sciences; PIN437/2(9); images courtesy Dmitry Shcherbakov. (2) *?Tymocicada gorbunovi*, hindwing; in Borissiak Paleontological Institute, Russian Academy of Sciences; PIN437-22; not a type; image courtesy Dmitry Shcherbakov. (3) *Lyristes* sp., base of forewing, collection of Thomas Berner; TB 876; image Jakub Prokop. (4) *Tibicina sakalai*, holotype, lateral body and wings; in National Museum, Prague; JP9711; image Jakub Prokop. (5) *Griphologus lowei*, holotype, entire dorsal specimen; in Australian Museum, Sydney; AMF.35725; image Stefanie Oberprieler. (6) *Davisia bearcreekensis*, holotype, forewing; in Peabody Museum of Natural History, Yale University, YPM IP 223394; image Jessica Utrup. (7) *Chremistica? beauchampi*, holotype; in Muséum National d'Histoire Naturelle, Paris, F.R07036; image Gaëlle Doitieu (e-recolnat Project, MNHN).

**Status:** Cicadinae, Leptopsaltriini, Euterpnosiina. Three specimens: 1) left forewing almost complete with counterpart (Fujiyama 1969); 2) forewing showing under surface of which some veins are broken (Fujiyama 1979) (Fig. 13); 3) a head, pronotum and mesonotum together with basal parts of forewings, with counterpart (Fujiyama 1969). Identified and described by Fujiyama (1969, 1979) as the extant species *Terpnosia nigrigosta*. However, *Terpnosia nigrigosta* (then in tribe Cicadini, subtribe Psithyristriina) has recently been transferred to the genus *Yezoterpnosia* (Lee 2012), but now in tribe Leptopsaltriini, subtribe Euterpnosiina) (Lee & Emery, 2013). Fujiyama gives detailed analyses for the identity of these young fossils and there conclusions are considered reasonable.

***Yezoterpnosia* sp. aff. *vacua* (Olivier, 1790) comb. n.**

*Terpnosia* sp. aff. *vacua* (Olivier): Kinugasa & Miyatake, 1979: 2–6, pls 1–2.

**Age and origin:** 11.6–5.3 Ma. Late Miocene, Neogene, Cenozoic. Tatsumi-tôge, Tottori Prefecture, Japan.

**Status:** Cicadinae, Leptopsaltriini, Euterpnosiina. Two thirds of a forewing with basal portion missing, 20.8 mm long (Figs 17a, 17b). Originally identified as in the genus *Terpnosia* but *Terpnosia vacua* (then in tribe Cicadini, subtribe Psithyristriina) has recently been transferred to the genus *Yezoterpnosia* (Lee 2012), but now in tribe Leptopsaltriini, subtribe Euterpnosiina) (Lee & Emery, 2013). Kinugasa & Miyatake (1979) give a detailed analysis for the identity of this species assuming it to belong to an extant Japanese genus. While this may be true there is always the possibility it may belong to a similar genus now extinct in Japan but in the absence of other evidence the determination is accepted.

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