

Brève note – *Short note***Biodiversity eavesdropping: bioacoustics confirms the presence of *Cicadetta montana* (Insecta: Hemiptera: Cicadidae) in France**JÉRÔME SUEUR ⁽¹⁾ & STÉPHANE PUISSANT ⁽²⁾⁽¹⁾ NAMC-CNRS UMR 8620, Bât. 446, Université Paris XI, F-91405 Orsay Cedex, France

Present address: Institut de Recherche sur la Biologie de l'Insecte, CNRS UMR 6035, Université de Tours, F-37200 Tours, France

⁽²⁾ Muséum national d'Histoire naturelle, Département Systématique et Evolution – Entomologie, 4 square Saint Marsal, F-66100 Perpignan, France

Abstract. Using bioacoustic methods only, we confirm the presence of *Cicadetta montana* s. str. in France, a cicada belonging to a complex of closely related species. Specimens of *C. montana* from France have probably been kept in collections for a long time but could not be identified with certainty by morphological characters alone. The species was discovered in a single locality but it is highly probable that it will be found in many other parts of the country in particular in the north and east of France. This simple study illustrates how much bioacoustic studies can help in monitoring biodiversity, in particular biodiversity of closely related species and/or of species living in habitats difficult to reach or where visual contact is highly limited.

Résumé. Suivi de la biodiversité par l'écoute : confirmation par la bioacoustique de la présence de *Cicadetta montana* (Insecta : Hemiptera : Cicadidae) en France. Uniquement à partir d'analyses bioacoustiques, nous confirmons la présence en France de *Cicadetta montana* s. str., espèce appartenant à un complexe d'espèces proches. *C. montana* de France était probablement conservée depuis longtemps dans les collections mais elle n'a pas pu être identifiée de façon certaine par la seule analyse de caractères morphologiques. Cette espèce a été découverte dans une seule localité mais il est hautement probable qu'elle soit présente dans de nombreuses autres parties du pays, notamment au nord et à l'est du territoire. Cette étude simple illustre combien les études bioacoustiques peuvent être utiles à l'inventaire de la biodiversité, en particulier dans le cas d'espèces proches et/ou d'espèces occupant des habitats difficiles d'accès ou avec un contact visuel fortement réduit.

Keywords: Bioacoustics, closely related species, remote detection, Cicadidae.

Under some particular circumstances, terrestrial animals may be very difficult to observe and, consequently, to collect for inventories and faunistic studies. The lack of visual contact or the presence of species living in habitats difficult to reach by the observer may indeed lead to missing a portion of the biodiversity in a particular locality. This is particularly the case for species that live in caves, are nocturnal, or inhabit the canopy. However, some of these potentially problematic species regularly produce light or sound for communication purposes that inadvertently reveal their presence to the observer (Bradbury & Vehrencamp 1998). Such a signal production can then be exploited to remotely assess and monitor biodiversity (Riede 1993, 1997). This is particularly true for canopy cicadas (Hemiptera, Cicadidae) where males repeatedly produce calling songs to attract females at long distance (Boulard 2006). Such cicadas are often heard but rarely

seen. Consequently, when referring to a previous reliable description of their calling song, it is easy to detect their presence. It is then possible to gain information on the population distribution and dynamics.

We use here such evidence to report for the first time the presence in France of a small (≈ 20 mm), discrete, treetop cicada: *Cicadetta montana* s. str. (Scopoli 1772), hereafter referred to as *C. montana*. The name *C. montana* has been erroneously attributed for a long time to another closely related species whose valid name is, however, *C. brevipennis* Fieber 1876 (Gogala & Trilar 2004). *C. montana* belongs, in fact, to a complex of closely related species which has been recently reviewed by Gogala & Trilar (2004). This complex is a nice case study of hidden biodiversity revealed by bioacoustics (Sueur 2006). Six taxa with similar morphology but distinct calling behaviour are now recognised in Europe: *C. montana*; *C. concinna* (Germar 1821) (= *C. podolica* Eichwald 1830); *C. brevipennis*; *C. fangoana* Boulard 1976; *C. macedonica* Schedl 1999; and *C. cerdaniensis* Puissant & Boulard 2000. Each species can be identified with certainty by listening to its calling song alone. This

E-mail: jerome.sueur@univ-tours.fr, stephane.puissant@wanadoo.fr

Accepté le 16 novembre 2006

explains why when referring only to voucher specimens in collections several species occurring in France have been considered by mistake under a single name: *C. montana* and later *C. brevipennis*.

Compared to other Hemiptera families, Cicadidae total very few taxa in France. It numbers only 16 species and one subspecies on the mainland and in Corsica (Puissant 2006). The confirmation of an additional species in France can then be considered as important information in the general current effort for monitoring biodiversity in France and Europe.

Observations

C. montana was found in Arrancourt (Fontenette, Essonne, France, 48°19.507' N, 2°10.719' E, elevation 117 m) from the 4th until the 30th June 2006. The site consisted of woods interspaced with open areas (fig. 1). Wood vegetation was mainly composed of hazel tree (*Corylus avellana* L.), sessile oaktree (*Quercus robur* L.), Scotch pine (*Pinus sylvestris* L.), poplar tree (*Populus alba* L.) and dogwood (*Cornus sanguinea* L.). The open area consisted of grassland with some juniper (*Juniperus communis* L.), dog rose (*Rosa* sp.) and hawthorn (*Crataegus oxyacantha* L.). Following the vegetation classification established by Defaut (1996 2001), the site belongs to the collinean or temperate axeric class with subcontinental climatic subdivision (abbreviation: Cc).

Males were always heard in the woody part of the habitat. The population was very sparse including not more than 15 calling males. They were very difficult to localise, singing very rarely and always from a high position in the trees (calling position height > 3–4 m).

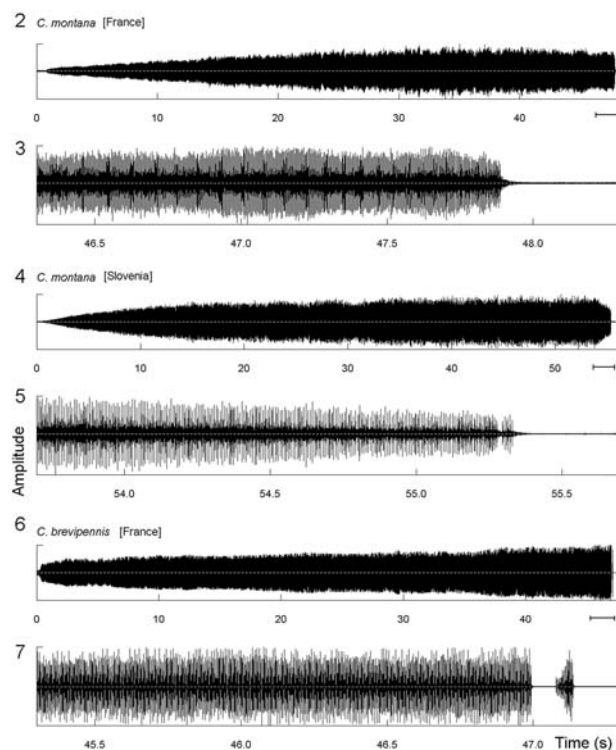
To ensure species identification, calling songs were recorded using a Sennheiser ME64 cardioid microphone (frequency response: ± 2.5 dB between 0.04 and 20 kHz) connected to a Marantz PMD 670 digital recorder (44.1 kHz sampling frequency, 16 bit precision). Signals were then analysed using Seewave (Sueur *et al.* 2006) a custom-made library of the R platform (R Development Core Team 2004).



Figure 1
Habitat of *C. montana* in Arrancourt (France). Males were always heard perched in the trees at a minimum height of about 3–4 m.

There is only a single reliable acoustic diagnostic character to discriminate between *C. montana* and *C. brevipennis*: the calling song, made of a single phrase, of *C. brevipennis* always ends with a short terminal and quite separated echeme whereas this never occurs in *C. montana* (fig. 5, 7). It has been supposed that these species also differ in the duration of this phrase, the phrase of *C. brevipennis* being much shorter than the one of *C. montana* (Gogala & Trilar 2004). However, phrases of *C. brevipennis* can last as long as those of *C. montana* (fig. 4, 6). Such long phrases are indeed commonly recorded for males calling from isolated spots and shorter phrases are observed when males belong to groups of several individuals. Moreover, a distinct courtship song is known for *C. brevipennis* (Puissant 2001 – under the name *C. montana*) whereas in *C. montana* it has never been found (Gogala & Trilar 2004).

Among the 14 calling songs analysed, none showed the short terminal echeme (fig. 3). They also did not show any significant differences in comparison with the reference calling song of *C. montana* recorded by Matija Gogala in a locality close to the *locus typicus* (Stražar: 50 km from Idrija, 15 km from Ljubljana, Slovenia) (fig. 2–5). In addition to the calling structure, *C. montana* from France seems to differ from *C. brevipennis* by two other behavioural traits. In France, *C. montana* does not occupy



Figures 2–7
Oscillograms (amplitude vs time) of the calling songs of *Cicadetta* species. 2, complete calling song of *C. montana* recorded in Arrancourt (France); 3, terminal part of the calling song indicated by the segment in 2; 4, complete calling song of *C. montana* recorded close to the type locality (Slovenia, M. Gogala); 5, terminal part of the calling song indicated by the segment in 4; 6, complete calling song of *C. brevipennis* recorded in Torreilles-Plage (France); 7, terminal part of the calling song indicated by the segment in 6 and showing the separated echeme. The signals displayed in 3, 5 and 7 all last 2 s.

open habitat even if available whereas *C. brevipennis* does. In addition, *C. montana* may produce choruses with some delay between males. The structure of the chorus could parallel the one previously described for *Tibicina* species (Sueur 2003).

Discussion and conclusion

The calling songs we recorded in France clearly follow closely the pattern of those previously recorded in Slovenia and attributed to *C. montana*. These observations constitute the first report of *C. montana* in France. *C. montana* has probably been collected previously and many specimens in the collections of the Muséum national d'Histoire naturelle (Paris) might refer to this species. However, no morphological characters are yet available to identify them with certainty.

The site elevation is low compared to South-East Europe site that are all above 600 m (M. Gogala pers. obsv.) but they belong obviously to the same phytoclimatical context, the collinean class (Cc). It is evident that *C. montana* can be found at similar or higher altitude in many other localities in France, probably mainly in the North and East part of the country, the species having never been reported in the southern départements where *C. brevipennis* occurs instead (Alpes-de-Haute-Provence – 04, Alpes-Maritimes – 06, Ariège – 09, Aude – 11, Drôme – 26, Haute-Garonne – 31, Hérault – 34, Pyrénées-Orientales – 66, Tarn – 81, Tarn-et-Garonne – 82, Vaucluse – 84) and where intense searching has been carried out (Puissant, 2006). *C. montana* is now reported from Great Britain (Ragge & Reynolds 1998), Germany, Slovenia (Gogala & Trilar 2004), Switzerland (Hertach, 2004), Macedonia (Gogala *et al.* 2005), Austria (Trilar & Holzinger 2004) and France (this study). As also suggested by Gogala & Trilar (2004), its presence should be confirmed in other Middle and Middle-East European countries.

Acknowledgments. We greatly thank Matija Gogala for sending us his recording of *C. montana* made close to the type locality and Michel Boulard, Sakis Drosopoulos, José A. Quartau, Matija Gogala, Allen F. Sanborn and Tomi Trilar for their helpful comments on the manuscript. We are also grateful to Caroline Simonis and Nadine Fille for their continuous support.

References

- Boulard M.** 2006. Acoustics signals, diversity and behaviour of cicadas (Cicadidae, Hemiptera), p. 331-349 *in*: **Drosopoulos S., Claridge M. F. (eds.)**, *Insect Sounds and Communication*, Taylor & Francis, Boca Raton.
- Bradbury J.W., Vehrencamp S.L.** 1998. *Principles of Animal Communication*. Sinauer Associates Sunderland, Massachusetts, 882 p.
- Defaut B.** 1996. Un système d'étages phytoclimatiques pour le domaine paléarctique. Corrélations entre végétation et paramètres climatiques. *Matériaux Entomocénétiques* **1**: 5-46.
- Defaut B.** 2001. Carte de la végétation de la France. *Matériaux Entomocénétiques* **6**: 113-121.
- Gogala M., Trilar T.** 2004. Bioacoustic investigations and taxonomic consideration on the *Cicadetta montana* species complex (Homoptera: Cicadoidea: Tibicinidae). *Anais da Academia Brasileira de Ciências* **76**: 316-324.
- Gogala M., Trilar T., Krpač V.** 2005. Fauna of singing cicadas (Auchenorrhyncha: Cicadoidea) of Macedonia - a bioacoustic survey. *Acta Entomologica Slovenica* **13**: 103-126.
- Hertach T.** 2004. Beitrag zur Klärung des Artkomplexes *Cicadetta montana* - Bergzikade (Hemiptera, Cicadidae): Entdeckung einer Singzikadenart mit ungewissen taxonomischem Status in der Nordschweiz. *Mitteilungen der Entomologischen Gesellschaft Basel* **54**: 58-66.
- Puissant S.** 2001. Eco-éthologie de *Cicadetta montana* (Scopoli, 1772) en France. *Ecole pratique des hautes Etudes, Biologie et Evolution des Insectes*, **13**: 111-117.
- Puissant S.** 2006. *Contribution à la connaissance des cigales de France: géonémie et écologie des populations (Hemiptera, Cicadidae)*. ASCETE, Bédeilhac, 193 p.
- Ragge D.R., Reynolds J.** 1998. *The songs of the Grasshoppers and Crickets of Western Europe*. Hartley Books, Colchester, Essex, England, 591 p.
- R Development Core Team.** 2004. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria, <http://www.r-project.org>
- Riede K.** 1993. Monitoring biodiversity: analysis of Amazonian rainforest sounds. *Ambio* **22**: 546-548.
- Riede K.** 1997. Bioacoustic monitoring of insect communities in a Bornean rainforest canopy, p. 442-452 *in* **Stork N.E., Adis J., Didham R.K. (eds.)**, *Canopy Arthropods*, Chapman & Hall, London.
- Sueur J.** 2003. Indirect and direct acoustic aggression in cicadas: first observations in the Palaearctic genus *Tibicina* Amyot (Hemiptera: Cicadomorpha: Cicadidae). *Journal of Natural History* **37**: 2931-2948.
- Sueur J.** 2006. Insect species and their songs, p. 207-217 *in*: **Drosopoulos S., Claridge M. F. (eds.)**, *Insect Sounds and Communication*, Taylor & Francis, Boca Raton.
- Sueur J., Aubin T., Simonis-Sueur C.** 2006. *Seewave*. Université Paris XI & Muséum national d'Histoire naturelle, Paris, <http://cran.r-project.org/src/contrib/Descriptions/seewave.html>
- Trilar T., Holzinger W.E.** 2004. Bioakustische Nachweise von drei Arten des *Cicadetta montana*-Komplexes aus Österreich (Insecta: Hemiptera: Cicadoidea). *Linzer biologische Beiträge* **36**: 1383-1386.

La loi du 11 mars 1957 n'autorisant, aux termes des alinéas 2 et 3 de l'article 41, d'une part, que les « copies ou reproductions strictement réservées à l'usage privé du copiste et non destinées à une utilisation collective » et d'autre part, que les analyses et les courtes citations dans un but d'exemple ou d'illustration, « toute représentation ou reproduction, intégrale ou partielle, faite sans le consentement de l'auteur ou de ses ayants droit ou ayants cause, est illicite » (alinéa 1^{er} de l'article 40).

Cette représentation ou reproduction, par quelque procédé que ce soit, constituerait donc une contrefaçon sanctionnée par les articles 425 et suivants du Code pénal.