

Cicadas from Portugal: revised list of species with eco-ethological data (Hemiptera: Cicadidae)

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The cicada fauna from Portugal is reviewed, as a result of a joint Portuguese-French project. Thirteen species are reported (*Lyristes plebejus*, *Cicada orni*, *Cicada barbara lusitanica*, *Tibicina tomentosa*, *Tibicina quadrisignata*, *Tibicina garricola*, *Melampsalta varipes*, *Tympanistalna gastrica*, *Euryphara contentei*, *Tettigetta argentata*, *Tettigetta estrellae*, *Tettigetta josei*, *Tettigetta mariae*), while five taxa which were previously referred to in the literature, have not been found (*Tibicina corsica fairmairei*, *Tibicina haematodes*, *Tibicina nigronevosa*, *Cicadetta flaveola*, *Cicadivetta tibialis*). Based on morphological and acoustic features, the following synonymies are established: *Tettigetta argentata* (Olivier, 1790) = *Tettigetta atra* (Gomez-Menor, 1957) n. syn. and *Tettigetta estrellae* Boulard, 1982 = *Tettigetta septempulsata* Boulard & Quartau, 1991 n. syn. Data on time of emergence, geographical distribution, habitat occupation and acoustic calling behaviour are given for each species.

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Introduction

All around the Mediterranean area, cicadas are famous for the striking calling songs that males typically produce during summer time. However, the taxonomy and biology of the Mediterranean cicadas are still poorly known, being their species diversity satisfactorily estimated in just a few European countries, e.g. Slovenia (Gogala & Gogala 1999), Switzerland (Pillet 1993, Sueur & al. 2003), France including Corsica (Boulard & Mondon 1995, Puissant & Sueur 2002, Puissant 2003) and Portugal (Boulard 1982, Quartau & Fonseca 1988).

Among the Mediterranean countries, Portugal occupies a singular place in the Palaearctic region since this country lays at the western most point of Europe, is close to North Africa and is climatally affected by both Mediterranean and Atlantic influences. This country, then, in spite of its mar-

ginal character, constitutes a potential hot spot for cicada diversity. Modern investigations on the cicada fauna of Portugal started with Boulard (1982). In this work, a new genus (*Tympanistalna*) was recognised, three new species (*Tettigetta estrellae* Boulard, 1982, *Tettigetta josei* Boulard, 1982 and *Euryphara contentei* Boulard, 1982) were described and a new subspecies was considered for *Cicada barbara* Stål, 1866. This study was later completed with new species records by both Boulard (1985) (*Tibicina quadrisignata* (Hagen, 1855) and *T. baetica* (Rambur, 1840) = *T. tomentosa* (Olivier, 1790)) and Quartau & al. (2001) (*Tibicina garricola* Boulard, 1983), and with additional new species (*Tettigetta septempulsata* Boulard & Quartau, 1991; *Tettigetta mariae* Quartau & Boulard, 1995). However, recording devices used at that time by Boulard were limited in their frequency response and signals appeared

to be shifted down in frequency. At the same time, cicada research in Portugal started to focus on sound communication, investigating both biomechanical (Fonseca 1991, 1993, 1996, Fonseca & Popov 1994, Fonseca & Bennet-Clark 1998) and evolutionary factors (Quartau & al. 1999b, 2000, Quartau & Simões 2003a, Fonseca & Revez 2002a, 2002b). These bioacoustics studies dealt mostly with five taxa (*Tympanistalna gastrica* (Stål, 1854), *Cicada orni* L., *C. barbara lusitanica* Boulard, 1982, *Tibicina quadrisignata* (Hagen, 1855) and *T. garricola* Boulard, 1983).

Hence, except for a first annotated check-list of species (Quartau & Fonseca 1988), no further work has been attempted to update the present knowledge on the faunistics of the Portuguese cicadas. The present study is such a survey, where authors were able to gather and to complete data on the taxonomy, distribution and eco-ethology of the cicadas known to occur in Portugal. Moreover, two new synonymies and the habitats occupied by each species are also given.

Material and methods

Time of emergence and geographic distribution in Portugal were determined by gathering data previously published (Boulard 1982, 1985, Boulard & Quartau 1991, Quartau & Boulard 1995, Quartau & Fonseca 1988, Quartau & al. 1999b, 2001), by conducting joint field work during 2001 and 2002, and by the examination of specimens preserved in the collections of the Muséum national d'Histoire naturelle (Paris) and the collection of one of the authors (J.A.Q., Departamento de Biologia Animal, Faculdade de Ciências de Lisboa). Habitats for each species were considered as defined in Puissant & Sueur (2002) and Sueur & Puissant (2002) (Table 1).

Table 1. Definition of habitat classes after Puissant & Sueur (2002) and Sueur & Puissant (2002).

Habitat Classes	Habitat type	Percentage of ligneous plants	Height
1	grassland	< 20 %	< 0.5 m
2	short moor	20-40 %	< 0.5 m
3	high moor	20-40 %	0.5-2 m
4	open short shrubland	40-60 %	< 0.5 m
5	open high shrubland	40-60 %	0.5-2 m
6	closed short shrubland	> 60 %	< 0.5 m
7	closed high shrubland	> 60 %	0.5-2 m
8	woodland	> 40 %	> 2 m

Male calling songs were recorded in the field. Species were recorded using a Telinga Pro4PiP microphone (frequency response 40 – 18 000 Hz \pm 1 dB) connected to a Sony DAT TCD-D8 (sampling frequency: 44.1 kHz, frequency response flat within the range 20-20 000 Hz). *Tettigetta estrellae* was recorded with a Sony Uni-Directional Dynamic Microphone F-780 (frequency response: 50 – 18 000Hz) connected to a TCD-D10 Pro II digital audiotape recorder (sampling frequency: 48kHz, frequency response 20-22 000Hz \pm 1 dB). The recordings were carried out between 11 am and 6 pm, a period corresponding to the maximal acoustic activity of cicadas. Signals were then digitised from the analogue output of the DAT recorders at a sampling rate of 44.1 kHz and 16 Bit dynamic range. Signals were finally analysed in both temporal and frequency domains using SYN-TANA (Aubin 1994).

Results and comments

Habitats used by each species are given in Table 1 and are summarized in Fig. 1. The male calling song for each species is given in Figs. 2-15.

Subfamily Cicadinae, tribe Platyleurini

Lyristes plebejus (Scopoli, 1763)

Time of emergence: from late June until August.

Geographical range: widely distributed, mostly in the central area. Collected in Baixo Alentejo (Serra do Mendro), Alto Alentejo (Portalegre, Castelo de Vide), Estremadura (Serra da Arrábida, Monte da Caparica) and Ribatejo (Alburitel, Serra de Aire e Candeeiros, Tomar, Vila Nova de Ourém).

Habitat: mainly in open woods. Habitat classes: 3, 5 and mostly 7 and 8.

Calling behaviour: static and isolated calling males perched on branches of a great variety of plants, such as *Olea europaea*, as already described for French populations (Claridge & al. 1979) and *Pinus pinaster*, *Zea mays*, *Vitis vinifera*, etc. A calling song emitted by a male from Portugal was described by Quartau & Rebelo (1994).

Found with *Cicada orni*, *C. barbara lusitanica*, *Tibicina quadrisignata* and *Tettigetta argentata*.

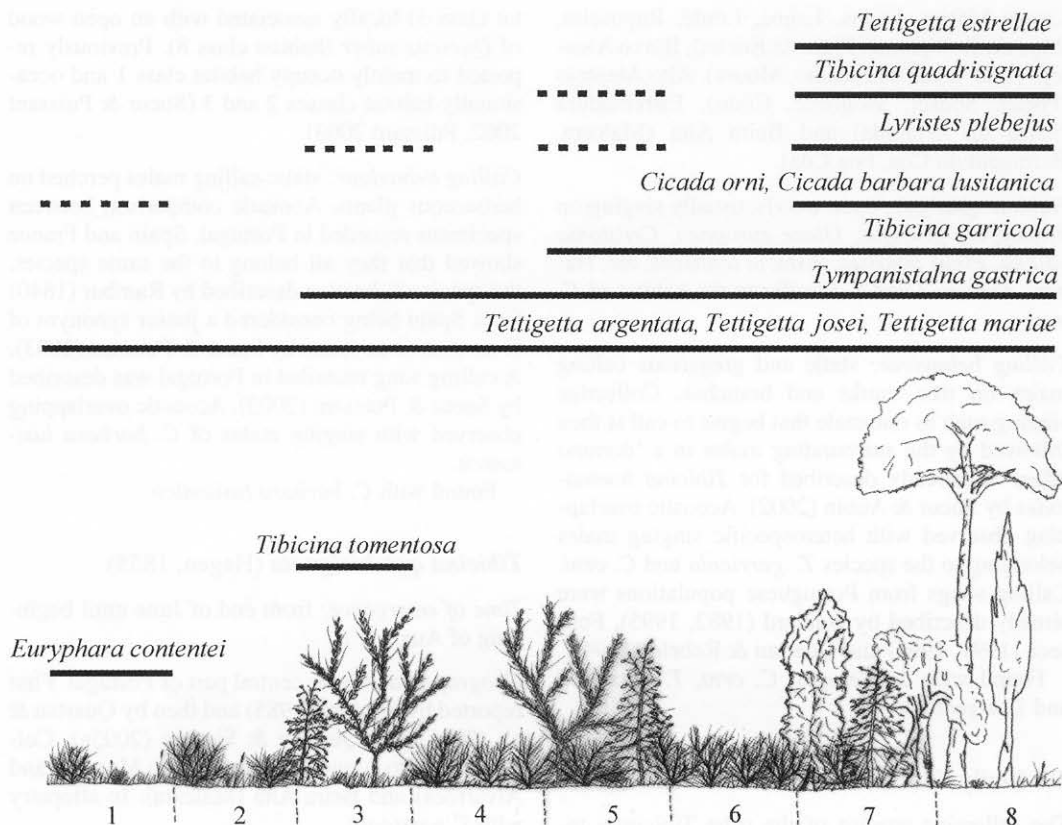


Fig. 1. Habitat occasionally (dotted line) or mainly (solid line) used by cicadas in Portugal. See Table 1 for a definition of habitat classes.

Subfamily Cicadinae, tribe Cicadini

Cicada orni Linnaeus, 1758

Time of emergence: from June until October.

Geographical range: all over the country. Collected in Algarve (Castro Marim, Loulé, Tavira), Baixo Alentejo (Ferreira do Alentejo, Serra do Mendro, Vidigueira), Alto Alentejo (Portel, Estremoz, Sousel, Elvas, Campo Maior, Monforte, Alter do Chão, Crato), Estremadura (Sesimbra, Serra da Arrábida, Monte da Caparica, Lisboa, Loures), Ribatejo (Serra de Aire e Candeeiros, Tomar) and Beira Litoral (Coimbra).

Habitat: generally found in open woodlands. Males calling on trees such as *Cupressus* spp., *Eucalyptus globulus*, *Olea europaea*, *Pinus pinaster*, *Pinus alepensis*, *Quercus* spp., found also on

some fruit and garden trees. Habitat classes: 7 and 8. Females can also be observed in habitat class 1, when laying their eggs in herbaceous plants.

Calling behaviour: static and gregarious calling males on tree trunks and branches. Calling song from Portugal populations was already described by Fonseca (1991), Quartau & Rebelo (1994), Quartau & al. (1999b, 2000).

Found with *L. plebejus*, *C. barbara lusitanica* and *T. argentata*.

Cicada barbara lusitanica Boulard, 1982

Time of emergence: from end of June until September.

Geographical range: mostly in the southern part of Portugal. Collected in Algarve (Alcalar, Alvor,

Castro Marim, Lagos, Lagoa, Loulé, Raposeira, Poço do Boliqueime, Praia da Rocha), Baixo Alentejo (Vila Verde de Ficalho, Moura), Alto Alentejo (Portel, Sousel, Monforte, Crato), Estremadura (Serra da Arrábida) and Beira Alta (Malcata, Barragem do Côa, Foz Côa).

Habitat: garrigue, open woods, usually singing on *Eucalyptus globulus*, *Olea europaea*, *Ceratonia siliqua*, *Pinus pinaster*, *Pistacia lentiscus*, etc. Habitat classes: 7 and 8. Similar to the habitat of *C. orni*.

Calling behaviour: static and gregarious calling males on tree trunks and branches. Collective singing such as one male that begins to call is then followed by the surrounding males in a 'domino effect' as already described for *Tibicina haematodes* by Sueur & Aubin (2002). Acoustic overlapping observed with heterospecific singing males belonging to the species *T. garricola* and *C. orni*. Calling songs from Portuguese populations were already described by Boulard (1982, 1995), Fonseca (1991, 1996) and Quartau & Rebelo (1994).

Found with *L. plebejus*, *C. orni*, *T. garricola* and *T. argentata*.

Subfamily Tibicininae, tribe Tibicinini

The following species of the tribe Tibicinini referred to by Quartau & Fonseca (1988) have not been found in Portugal: *Tibicina corsica fairmairei* Boulard, 1984, *Tibicina haematodes* (Scopoli, 1763) and *Tibicina nigronervosa* Fieber, 1876. *T. corsica fairmairei* has probably been misidentified with *T. garricola*. The probability of occurrence of *T. haematodes* and *T. nigronervosa* in Portugal is very low. To our knowledge, the western limit of *T. haematodes* distribution is in France and *T. nigronervosa* seems to be endemic to Corsica and Sardinia.

Tibicina tomentosa (Olivier, 1790)

Time of emergence: from June until July.

Geographical range: apparently very localised. Collected in Beja (Mértola) in 2001 and Algarve (Raposeira) in 1982 by J.-F. Vayssi re (in Boulard, 1985), but not found since then in the latter locality.

Habitat: a single calling male observed on *Cistus* sp. The specimen was calling in a high moor (habi-

tat class 3) locally associated with an open wood of *Quercus suber* (habitat class 8). Previously reported to mainly occupy habitat class 1 and occasionally habitat classes 2 and 3 (Sueur & Puissant 2002, Puissant 2003).

Calling behaviour: static calling males perched on herbaceous plants. Acoustic comparison between specimens recorded in Portugal, Spain and France showed that they all belong to the same species, the species *T. baetica* described by Rambur (1840) from Spain being considered a junior synonym of *T. tomentosa* as stated by Sueur & Puissant (2003). A calling song recorded in Portugal was described by Sueur & Puissant (2003). Acoustic overlapping observed with singing males of *C. barbara lusitanica*.

Found with *C. barbara lusitanica*.

Tibicina quadrisignata (Hagen, 1855)

Time of emergence: from end of June until beginning of August.

Geographical range: central part of Portugal. First reported by Boulard (1985) and then by Quartau & al. (2001) and Quartau & Sim es (2003a). Collected in Alto Alentejo (Serra de S o Mamede and Alvarr es) and Beira Alta (Malcata). In allopatry with *T. garricola*.

Habitat: open woods with *Cistus* spp., singing on *Castanea sativa*, *Cistus ladanifer*, *Olea europaea*, *Pinus pinaster* and *Quercus pyrenaica*. Habitat classes: 5, 7 and 8. Populations were more dense when occupying habitat classes 7 and 8. Similar habitat structure in France as already described by Sueur & Puissant (2002) and Puissant (2003).

Calling behaviour: static calling males. Calling song from Portugal populations already described by Quartau & Sim es (2003a) and Sueur & Aubin (2003). The description given by Fonseca (1991) should refer to *T. garricola* Boulard, 1983 instead.

Found with *Tettigetta argentata* and *Cicada barbara lusitanica*.

Tibicina garricola Boulard, 1983

Time of emergence: from end of June until beginning of August.

Geographical range: central part of Portugal. First reported by Quartau & al. (2001). Collected in

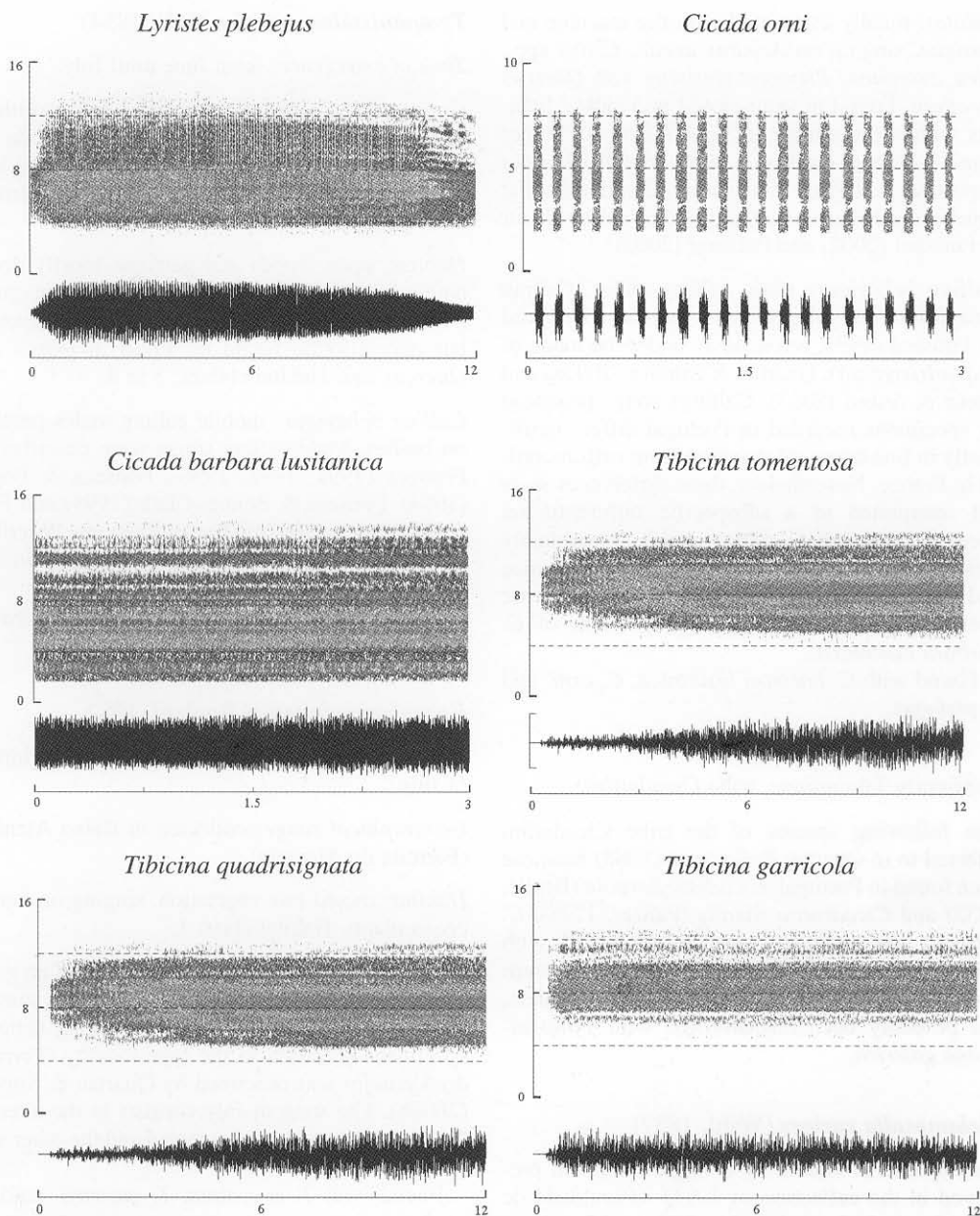


Fig. 2. Male calling song of *Lyristes plebejus*, *Cicada orni*, *Cicada barbara lusitanica*, *Tibicina tomentosa*, *Tibicina quadrisignata* and *Tibicina garricola*. Horizontal axis: time in seconds. Vertical axis: frequencies in kHz. Sampling frequency: 44.1 kHz. FFT length: 4096 points.

Estremadura (Serra da Arrábida, Estoril-Albarraque) and Ribatejo (Fátima, Tomar). In allopatry with *T. quadrisignata* (Quartau & Simões, 2003a). In France, allopatry not initially recognised by

Sueur & Puissant (2002), but probably occurring and thus contributing to the isolation between *T. garricola* and *T. quadrisignata*, as later stated by Puissant (2003).

Habitat: mainly associated with the macchie and garrigue, singing on *Arbutus unedo*, *Cistus* spp., *Olea europaea*, *Pistacea lentiscus* and *Quercus coccifera*. Found in semi-closed and closed habitats with a percentage of ligneous plants higher than 40 (habitat classes: 5 to 8), height being not important in habitat occupation. Similar habitat structure in France as already described by Sueur & Puissant (2002) and Puissant (2003).

Calling behaviour: static calling males. Calling song from Portugal populations already described by Fonseca (1996, erroneously under the name of *T. quadrisignata*), Quartau & Simões (2003a) and Sueur & Aubin (2003). Callings songs produced by specimens recorded in Portugal differ significantly in fine temporal structure from calls recorded in France. Nevertheless, these differences were not interpreted as a subspecific differentiation because intermediate values could and probably exist for populations distributed between France and Portugal (Sueur & Aubin 2003). Acoustic overlapping observed with singing males of *C. barbara lusitanica*.

Found with *C. barbara lusitanica*, *C. orni*. and *L. plebejus*.

Subfamily Tibicininae, tribe Cicadettini

The following species of the tribe Cicadettini referred to in Quartau & Fonseca (1988) have not been found in Portugal: *Cicadetta flaveola* (Brullé, 1832) and *Cicadivetta tibialis* (Panzer, 1798). *C. flaveola* has probably been misidentified with *Euryphara contentei*. *C. tibialis*, which western distribution limit is on the French-Italian borders, has probably been misidentified with *Tympanistalna gastrica*.

Melampsalta varipes (Waltl, 1837)

This species is known by a single specimen preserved in the collection of J.A.Q. (Faculdade de Ciências de Lisboa) found in Lisboa (Monsanto) in June 1979, by A. Serrano. Reported by J.-F. Vayssières in June 1982 in Algarve (Raposeira) (in Boulard, 1985) but has not been collected since then. Its present distribution in Portugal is still to be investigated, as well as its behaviour and ecology.

Tympanistalna gastrica (Stål, 1854)

Time of emergence: from June until July.

Geographical range: central and southern Portugal. Collected in Estremadura (Serra da Arrábida, Sesimbra, Albarraque, Carcavelos, Linha de Sintra-Cascais,) and Baixo Alentejo (Ferreira do Alentejo).

Habitat: open woods and garrigue mostly dominated by *Quercus coccifera*, singing on small bushes and mixed low vegetation such as grasses, but may also be found on *Pinus alepensis* and *Quercus ilex*. Habitat classes: 3 to 8.

Calling behaviour: mobile calling males perched on bushes. Male calling songs were described in Fonseca (1991, 1993, 1996), Fonseca & Popov (1994), Fonseca & Bennet-Clark (1998) and Fonseca & Revez (2002a). The calling song described by Boulard (1982, 1995) was inaccurate in frequency, being down shifted.

Found with *E. contentei*, *T. argentata*, *T. garriicola*, *C. barbara lusitanica* and *C. orni*.

Euryphara contentei Boulard, 1982

Time of emergence: from June until the beginning of July.

Geographical range: collected in Baixo Alentejo (Ferreira do Alentejo).

Habitat: mixed low vegetation, singing on herbaceous plants. Habitat class: 1.

Calling behaviour: calling males isolated on grass stems. Boulard (1995) reported the calling song of a male from Spain and later the calling song of specimens recorded in the type-locality (Ferreira do Alentejo) was described by Quartau & Simões (2003b). The song mainly consists in the alternation of two parts, one interrupted and the other sustained.

Found with *T. argentata*, *T. gastrica* and *C. orni*.

Tettigetia argentata (Olivier, 1790)

Taxonomical comment: *Tettigetia atra* (Gomez-Menor, 1957) was originally described as a darker variety of *Tettigetia argentata* (Olivier, 1790). Boulard (1982) considered that the differences between the two species were large enough to con-

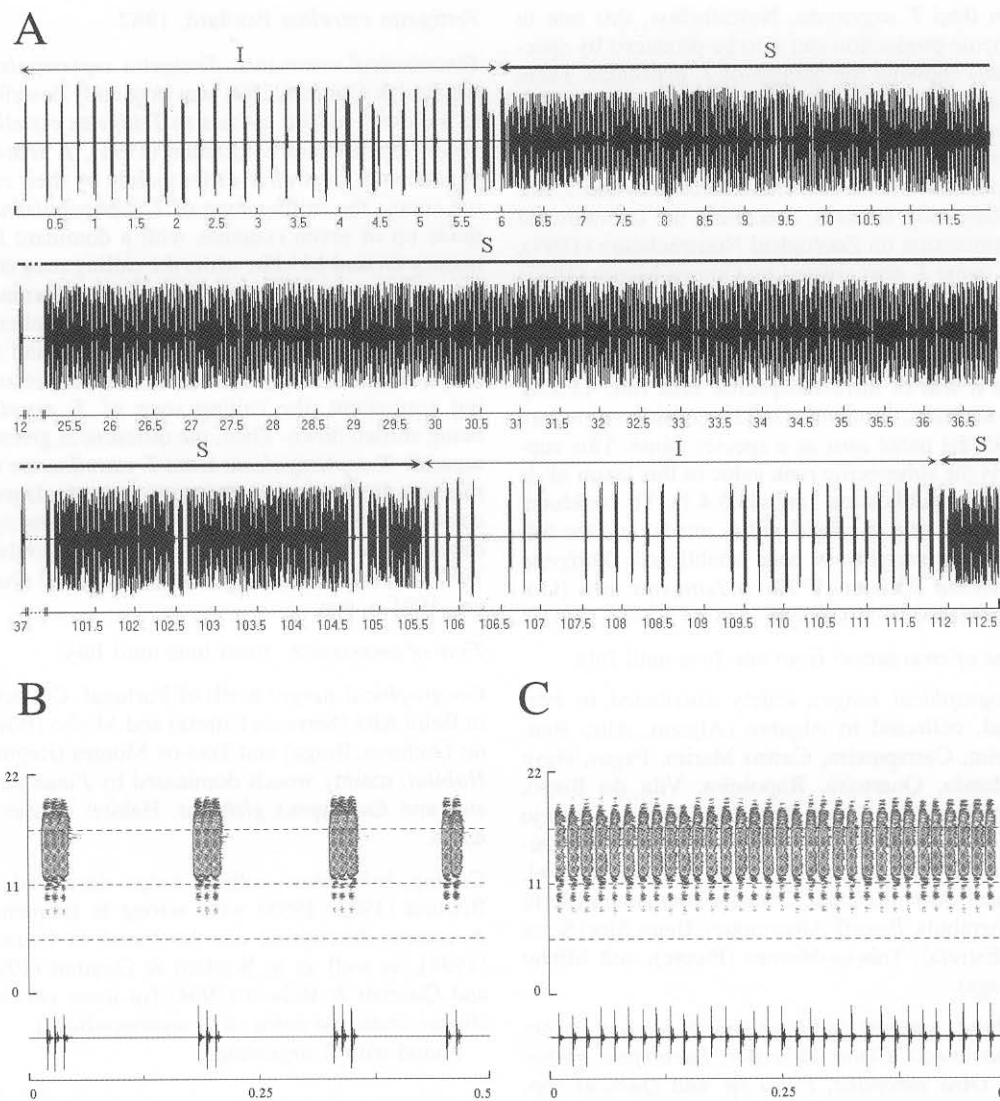


Fig. 3. Male calling song of *Euryphara contentei*: (A) oscillogram (time vs absolute amplitude) of a typical male calling song (ambient temperature: 35.5°C). The song consists in the alternation of two parts, an irregular succession of short echemes (part I) and a sustained buzzing (part S). Horizontal axis: time in seconds (note the interruption of X-axis at 12s and 37s), vertical axis: absolute amplitude; (B) Detailed oscillogram of part I showing four successive echemes, three triple-pulse and one double-pulse; (C) Detailed oscillogram of part S showing 32 successive pulse units. (B) and (C): vertical axis: frequencies in kHz. Sampling frequency: 44.1 kHz. FFT length: 4096 points.

sider *T. atra* as a valid species. Indeed, following Boulard (1982), *T. atra* could be differentiated by the following features: longer and larger body, darker dorsal body part and darker wing venation, no or almost no fascia on the mesonotum, wings

more sharpened. However, these features are also found in some specimens of *T. argentata* from Portugal and France. In addition following Boulard (1982, 1985), calling songs emitted by males of *T. atra* would show longer inter-echeme dura-

tion than *T. argentata*. Nevertheless, this rate in echeme production can also be produced by specimens showing the habitus of *T. argentata*. Then, *T. atra* can be considered just as a variety of *T. argentata*. It does not show a restricted distribution, is found with other varieties inside a single population and is not characterised by particular calling song features. Following the International Commission on Zoological Nomenclature (1999), the name *T. atra* created by Gomez-Menor (1957) is available. This name is deemed as a subspecific name because the author published it before 1961 and used the 'v' symbol without clearly stating that it was of infra-subspecific rank (art. 45.6.4). In addition, Boulard (1982) considered before 1985 the name *atra* as a species name. This supports the subspecific rank value of this taxon of its original publication (art. 45.6.4.1). To conclude, the name *atra* is considered as invalid and the following synonymy is here established: *Tettigetta argentata* (Olivier, 1790) = *Tettigetta atra* (Gomez-Menor, 1957) **n. syn.**

Time of emergence: from late June until July.

Geographical range: widely distributed in Portugal, collected in Algarve (Aljezur, Alte, Bensafim, Carrapateira, Castro Marim, Fagos, Nave Redonda, Quarteira, Raposeira, Vila do Bispo, Vila Real de Santo António), Baixo Alentejo (Mértola, Ferreira do Alentejo, Aljezur, Zambujeira, Grândola, Melides), Alto Alentejo (Portel, Sousel, Alter do Chão, Crato), Estremadura (Serra da Arrábida, Estoril-Albarraque), Beira Alta (Serra da Estrela), Trás-os-Montes (Picote), and Minho (Braga).

Habitat: garrigue and open woods, singing on *Arbutus unedo*, *Cistus ladanifer*, *Eucalyptus globulus*, *Olea europaea*, *Pinus* sp. and *Quercus* spp. Habitat classes: 1 to 8.

Calling behaviour: mobile calling males. The song described by Boulard (1982, 1995) under the name *T. atra* was shifted in frequency. It thus corresponds to a unreliable recording of *T. argentata*. Correct acoustic descriptions of calling songs produced by *T. argentata* in Portugal are available in Fonseca (1991), Quartau & al. (1999a) and Fonseca & Revez (2002a) who were already unable to separate both species.

Found with all other observed species.

Tettigetta estrellae Boulard, 1982

Taxonomical comments: *Tettigetta septempulsata* Boulard & Quartau, 1991 was originally described as a closely related species to *Tettigetta estrellae*. Following Boulard & Quartau (1991), *T. septempulsata* and *T. estrellae* differ mainly by their calling songs: the calling song of *T. septempulsata* is made up of seven echemes with a dominant frequency around 14 kHz, while the calling song of *T. estrellae* is made of ten echemes with a dominant frequency around 8 kHz. However, the number of echemes is variable among both species and the frequency differences are due to different recording equipment, the calling song of *T. estrellae* being shifted down. Then, the differences given to separate *T. septempulsata* from *T. estrellae* are not relevant. In conclusion, the name *septempulsata* is considered as invalid and the following new synonymy is established: *Tettigetta estrellae* Boulard, 1982 = *Tettigetta septempulsata* Boulard & Quartau, 1991 **n. syn.**

Time of emergence: from June until July.

Geographical range: north of Portugal. Collected in Beira Alta (Serra da Estrela) and Minho (Póvoa do Lanhoso, Braga) and Trás-os-Montes (Régua). *Habitat*: mainly woods dominated by *Pinus pinaster* and *Eucalyptus globulus*. Habitat classes: 7 and 8.

Calling behaviour: calling songs described by Boulard (1982, 1995) were wrong in frequency. A correct description can be found in Fonseca (1991), as well as in Boulard & Quartau (1991) and Quartau & Rebelo (1994) (in these two last studies under the name of *T. septempulsata*).

Found with *T. argentata*.

Tettigetta josei Boulard, 1982

Time of emergence: from June until August.

Geographical range: found only in Algarve (Carvoeiro, Loulé, Monchique, Portimão, Raposeira, Santa Bárbara de Nexe, São Romão, Tavira, Vila do Bispo, Vilamoura). *Habitat*: mixed low vegetation with small bushes as *Cistus* spp. and herbaceous plants. Sometimes also found on trees. Habitat classes: 1-8.

Calling behaviour: somewhat static caller but can sometimes fly to another calling site. The abdomen is raised during sound production. Boulard

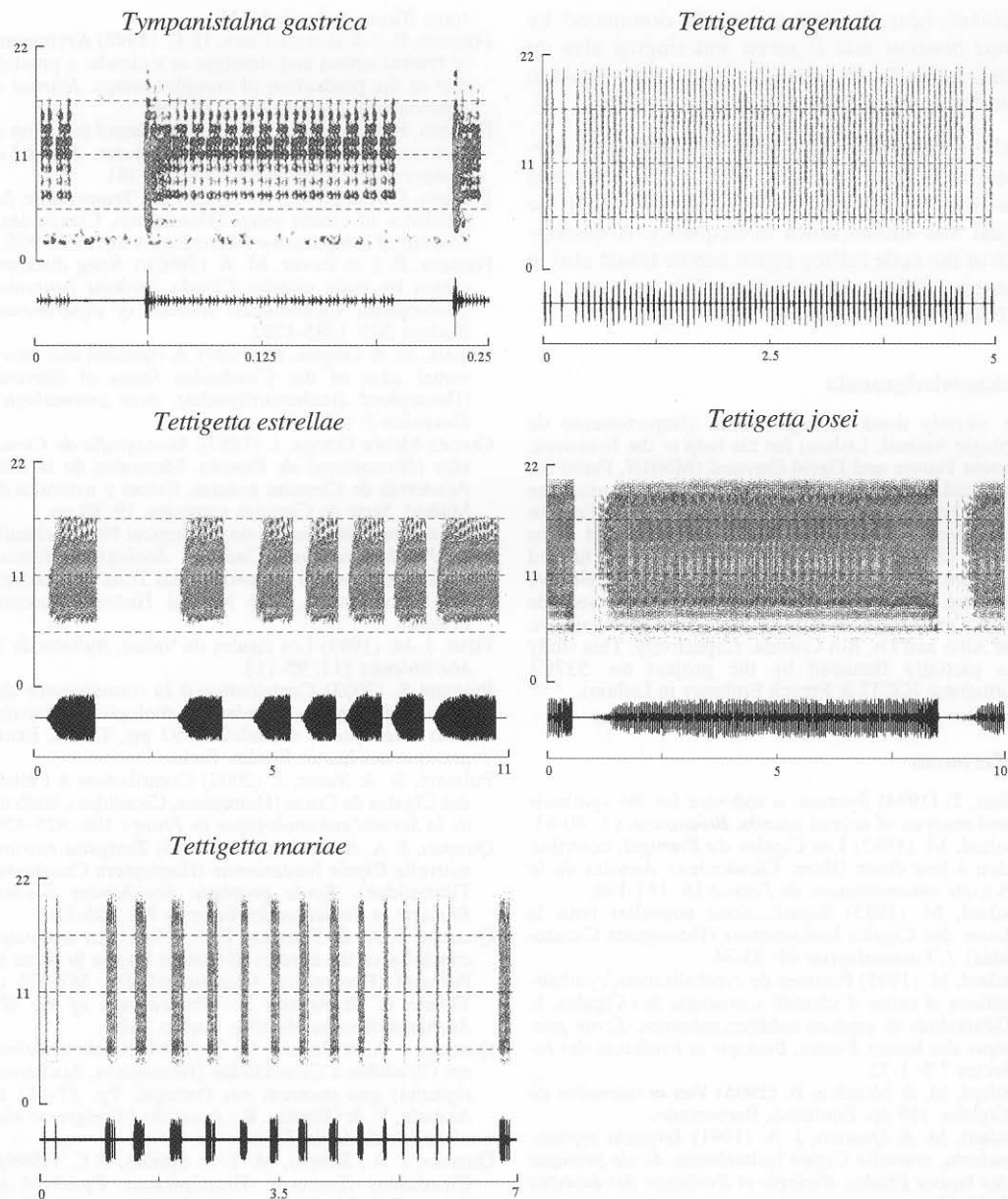


Fig. 4. Male calling song of *Tympanistalna gastrica*, *Tettigetta argentata*, *Tettigetta estrellae*, *Tettigetta josei* and *Tettigetta mariae*. Horizontal axis: time in seconds. Vertical axis: frequencies in kHz. Sampling frequency: 44 1 kHz. FFT length: 4096 points.

(1982, 1991, 1995) acoustic descriptions are shifted down in frequency. A correct description of male calling song is given by Fonseca (1991, 1996).

Found with *T. mariae*.

Tettigetta mariae Quartau & Boulard, 1995

Time of emergence: from July until August.

Geographical range: collected in Algarve (Vilamoura, Quarteira, Quinta do Lago, Castro Marim).

Habitat: near the sea in woods dominated by *Pinus pinaster* and *P. pinea* and singing also on *Cistus ladanifer* and *Olea europaea*. Also found in marshes along the sea. Habitat classes: 1-8.

Calling behaviour: static calling males often perched on bushes and trees. The calling song was described by Quartau & Boulard (1995) but the signal was shifted down in frequency. A description of the male calling signal can be found also in Fonseca (1991) under the name *Tettigetta* sp.

Found with *T. argentata* and *T. josei*.

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References

- Aubin, T. (1994) Syntana: a software for the synthesis and analysis of animal sounds. *Bioacoustics* 6: 80-81.
- Boulard, M. (1982) Les Cigales du Portugal, contribution à leur étude (Hom. Cicadoidea). *Annales de la Société entomologique de France* 18: 181-198.
- Boulard, M. (1985) Signalisations nouvelles pour la faune des Cigales lusitaniennes (Homoptera Cicadoidea). *L'Entomologiste* 41: 33-34.
- Boulard, M. (1995) Postures de cymbalisation, cymbalisations et cartes d'identité acoustique des Cigales. 1. Généralités et espèces méditerranéennes. *Ecole pratique des hautes Etudes, Biologie et Evolution des Insectes* 7/8: 1-72.
- Boulard, M. & Mondon, B. (1995) *Vies et mémoires de Cigales*. 159 pp. Equinoxe, Barbenetane.
- Boulard, M. & Quartau, J. A. (1991) *Tettigeta septempulsata*, nouvelle Cigale lusitanienne. *Ecole pratique des hautes Etudes, Biologie et Evolution des Insectes* 4: 49-56.
- Claridge, M. F., Wilson, M. R. & Singhrao, J. S. (1979) The songs and calling sites of two European cicadas. *Ecological Entomology* 4: 225-229.
- Fonseca, P. J. (1991) Characteristics of the acoustic signals in nine species of cicadas (Homoptera, Cicadidae). *Bioacoustics* 3: 173-182.
- Fonseca, P. J. (1993) Directional hearing of a cicada: biophysical aspects. *Journal of comparative Physiology A* 172: 767-774.
- Fonseca, P. J. (1996) Sound production in cicadas: timbal muscle activity during calling song and protest song. *Bioacoustics* 7: 13-31.
- Fonseca, P. J. & Bennet-Clark, H. C. (1998) Asymmetry of tymbal action and structure in a cicada: a possible role in the production of complex songs. *Journal of experimental Biology* 201: 717-730.
- Fonseca, P. J. & Popov, A. V. (1994) Sound radiation in a cicada: the role of different structures. *Journal of comparative Physiology A* 175: 349-361.
- Fonseca, P. J. & Revez, M. A. (2002a) Temperature dependence of cicada songs (Homoptera, Cicadoidea). *Journal of comparative Physiology A* 187: 971-976.
- Fonseca, P. J. & Revez, M. A. (2002b). Song discrimination by male cicadas *Cicada barbara lusitanica* (Homoptera, Cicadoidea). *Journal of experimental Biology* 205: 1285-1292.
- Gogala, M. & Gogala, A. (1999). A checklist and provisional atlas of the Cicadoidea fauna of Slovenia (Homoptera: Auchenorrhyncha). *Acta entomologica Slovenica* 7: 119-128.
- Gomez-Menor Ortega, J. (1957). *Monografía de Cicadidos (Homoptera) de España*. Memorias de la Real Academia de Ciencias exactas, físicas y naturales de Madrid. Serie de Ciencias naturales, 19: 89 pp.
- International Commission on Zoological Nomenclature, (1999) *International Code of Zoological Nomenclature*. xxix + 306 p. International Trust for Zoological Nomenclature, The Natural History Museum, London.
- Pillet, J.-M. (1993) Les cigales du Valais. *Bulletin de la Murithienne* 111: 95-113.
- Puissant S. (2003) *Contribution à la connaissance des Cigales de France: géonémie et écologie des populations (Hemiptera, Cicadidae)*. 92 pp. Thesis, Ecole pratique des hautes Etudes, Paris.
- Puissant, S. & Sueur, J. (2002) Contribution à l'étude des Cigales de Corse (Hemiptera, Cicadidae). *Bulletin de la Société entomologique de France* 106: 429-436.
- Quartau, J. A. & Boulard, M. (1995) *Tettigetta mariae*, nouvelle Cigale lusitanienne (Homoptera Cicadoidea Tibicinidae). *Ecole pratique des hautes Etudes, Biologie et Evolution des Insectes* 7/8: 105-110.
- Quartau, J. A. & Fonseca, P. J. (1988) An annotated check-list of the species of cicadas known to occur in Portugal (Homoptera: Cicadoidea). Pp. 367-375 in Vidano C. & Arzone A.: *Proceedings of the 6th Auchenorrhyncha Meeting*, Torino, Italy.
- Quartau, J. A. & Rebelo, M. T. (1994) Sinais acústicos em Cicadidae e Cicadellidae (Homoptera, Auchenorrhyncha) que ocorrem em Portugal. Pp. 37-142 in Almada, V. & Oliveira, R.: *Actas do I Congresso Nacional de Etologia*. Lisboa.
- Quartau, J. A., Rebelo, M. T. & Simões, P. C. (1999a) Cicadídeos (Insectos, Homópteros). Pp.69-74 in Santos-Reis M. & Correia A. I.: *Caracterização da Flora e Fauna do Montado da Herdade da Ribeira Abaixo (Grândola - Baixo Alentejo)*. Centro de Biologia Ambiental, Lisboa.
- Quartau, J. A., Rebelo, M. T., Simões, P. C., Fernandes, T. M., Claridge, M. F., Drosopoulos, S. & Morgan, J. C. (1999b) Acoustic signals of *Cicada orni* L. in Portugal and Greece (Hemiptera: Auchenorrhyncha: Cicadomorpha: Cicadidae). *Reichenbachia, Staatliches Museum für Tierkunde Dresden* 33: 71-80.
- Quartau, J. A., Seabra, S. & Sanborn, A. (2000). Effect of ambient air temperature on the 'calling song of

- Cicada orni* Linnaeus, 1758 (Hemiptera: Cicadidae) in Portugal. *Acta zoologica Cracoviensia* 43: 193-198.
- Quartau, J. A. & Simões, P. C. (2003a) Bioacoustic and morphological differentiation in two allopatric species of the genus *Tibicina* Amyot (Hemiptera: Cicadoidea) in Portugal. *Deutsche entomologische Zeitschrift* 50: 113-119.
- Quartau, J.A. & Simões, P. C. (2003b) First description of the acoustic signals produced by *Euryphara contentei* Boulard, 1982 (Insecta : Hemiptera, Cicadoidea) in Portugal. *Arquivos do Museu Bocage*: in press.
- Quartau, J. A., Simões, P. C., Rebelo, M. T., & André, G. (2001) On two species of the genus *Tibicina* Amyot, 1847 (Hemiptera, Cicadoidea) in Portugal, with one new record. *Arquivos do Museu Bocage*, Nova Série 3: 401-412.
- Rambur, J. P. (1840) Seconde section des Hémiptères. Les Homoptères. Latreille. *Faune entomologique de l'Andalousie* 5: 177-304.
- Sueur, J. & Aubin, T. (2002) Acoustic communication in the Palaearctic red cicada *Tibicina haematodes*: chorus organisation, calling song structure, and signal recognition. *Canadian Journal of Zoology* 80: 126-136.
- Sueur, J. & Aubin, T. (2003) Specificity of cicada calling songs in the genus *Tibicina* (Hemiptera: Cicadidae). *Systematic Entomology*, 28: 481-492.
- Sueur, J. & Puissant, S. (2002) Spatial and ecological isolation in cicadas: first data from *Tibicina* (Hemiptera: Cicadoidea) in France. *European Journal of Entomology* 99: 477-484.
- Sueur, J. & Puissant, S. (2003) Analysis of sound behaviour leads to new synonymy in Mediterranean cicadas (Hemiptera, Cicadidae, *Tibicina*). *Deutsche entomologische Zeitschrift* 50: 121-127.
- Sueur, J., Puissant, S. & Pillet, J.-M. (2003) An Eastern Mediterranean cicada in the West: first record of *Tibicina steveni* (Krynicky, 1837) in Switzerland and France (Hemiptera, Cicadidae, Tibicininae). *Revue française d'Entomologie* 25: 105-111.

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