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## On the Identity of *Decticus loudoni* Ramme, 1933 (Insecta Orthoptera Tettigoniidae) (\*)

### INTRODUCTION

The genus *Decticus* in Western Europe, according to several European authors, consists of two species: *D. verrucivorus* (Linnaeus, 1758) and *D. albifrons* (Fabricius, 1775) (GÖTZ, 1970; SAMWAYS & HARZ, 1982; HELLER, 1988; RAGGE & REYNOLDS, 1998). *D. albifrons* seems very constant throughout its range, both in morphology and in song (SAMWAYS & HARZ, 1982; RAGGE & REYNOLDS, 1998). However, the geographical variation of *D. verrucivorus* in southern Europe has led many authors to describe local populations as new species or subspecies, morphologically different from the typical northern form, *D. v. verrucivorus*. The song, however, is considered to be very uniform in Western Europe (RAGGE & REYNOLDS, 1998). By way of exception, INGRISCH ET AL. (1992) describe a local mountain form from the Iberian Peninsula, *Decticus verrucivorus assiduus*, exclusively distinguished from the typical *D. v. verrucivorus* by the song. Morphologically, this bioacoustically distinct subspecies only shows abbreviated wings (INGRISCH ET AL., 1992), a feature common in montane populations of Orthoptera.

*D. loudoni* Ramme, 1933 and *D. aprutianus* Capra, 1936 are examples of local and morphologically distinct forms described from the Italian Peninsula (RAMME, 1933; CAPRA, 1936). Both taxa are being regarded as belonging to distinct species in the *Checklist delle specie della fauna italiana* (FAILLA ET AL., 1994). So far, no details of the song of these two Italian forms have been published.

Currently our study focuses on the song, morphology and genetics of populations of *D. v. verrucivorus*, *D. aprutianus* and *D. loudoni*. The goal of this research is to clarify the identity of and the relationship between the taxa of the *D. verrucivorus* group in Italy. Furthermore, we aim to review the distribution of different taxa and to verify the taxonomic value of their bioacoustic behaviour.

In this paper the male calling song of *D. loudoni* is described and the status of this taxon is discussed, on the basis of its song and morphology.

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(\*) Lavoro accettato il 30 ottobre 1999.

## METHODS

Two of the authors (P. Fontana and V. Malagnini) visited the Puglia region (south-eastern Italy) during an expedition of the Institute of agricultural Entomology of Padua (June 1999). Two neighbouring sites with *D. loudoni* have been visited during this excursion. Data have been collected concerning habitat preferences, song and singing activity.

The song of the collected specimens has been recorded in the field and in the laboratory, with air temperature between 24 and 34 °C. In the laboratory males have been recorded separately to prevent interaction. A DCC-recorder (Philips DCC 170) with condenser microphones (Sennheiser K30AV module with ME80) and a DAT-recorder (Philips DCC 170) with condenser microphones (Sennheiser K6 module with ME62) have been used for recording. Sampled fragments (44.1 kHz, 16 bits) from the recordings have been analysed.

**Song terminology** (according to Ragge & Reynolds, 1998):

*Calling song*: the song produced by an isolated male.

*Syllable*: the sound produced by one complete opening and closing movement of the fore wings.

*Hemisyllable*: the sound produced by one unidirectional movement (opening or closing) of the fore wings.

*Echeme*: a first-order assemblage of syllables.

### Material examined:

*Decticus loudoni* Ramme, 1933: ITALY, reg. Puglia, Le Murge, Masseria Nuova del Duca, 21.VI.1999, 1 male, leg. P. Fontana, V. Malagnini & F. M. Buzzetti, coll. P. Fontana; Le Murge, Masseria Modesti, 24.VI.1999, 10 males and 7 females, leg. P. Fontana, V. Malagnini & F. M. Buzzetti, coll. P. Fontana and coll. Ist. Ent. agr., Univ. Padova; Murgia Serraficaia, 22.VII.1959, 1 male and 1 female, leg. M. La Greca, coll. P. Fontana.

*Decticus verrucivorus verrucivorus* Linnaeus, 1758: SWEDEN, Öland, Alvaret near Stenåsa, reserv Möckel, 11.VIII.1997, 1 male, leg. M. Berg, coll. P. Fontana; ITALY, reg. Trentino A. A., Val Malene (TN), Malene, 1000 m, 27.VII.1998, 1 male, leg. B. Odé, coll. P. Fontana; M. Bondone, loc. Viotte (TN), 1550 m, 10.IX.1999, leg. M. Guido, coll. P. Fontana; reg. Veneto, M. Summano (VI), loc. Sant. S. Orso, 1200 m, 9.VIII.1997, 1 male and 1 female, leg. P. Fontana, coll. P. Fontana; M. Summano (VI), loc. Vetta dell'Idolo, 1250 m, 10.IX.1997, 2 males and 2 female, leg. P. Fontana, coll. P. Fontana.

## TAXONOMY

### *Decticus loudoni* Ramme, 1933

*Locusta verrucivora*, Costa G., 1871: 482.

*Decticus loudoni* RAMME, 1933: 52; CAPRA, 1936: 164; JANNONE, 1937: 71; PAOLI, 1937: 48; LA GRECA, 1950: 4; BACCETTI, 1954: 364; LA GRECA, 1957: 114; HARZ, 1969: 216; FAILLA ET AL., 1994: 8; LA GRECA, 1996: 18.

*Decticus verrucivorus loudoni*, GÖTZ, 1970: 178; SAMWAYS & HARZ, 1982: 245.

*Decticus verrucivorus*, HELLER, 1988: 90. (partim)

? COSTA A., 1870-74: Tab. XIV, Figs. 1, 1A, 1B.

**Type material:** *Holotypus* male: ITALY, reg. Puglia, loc. Spongano (Lecce), VI.1931, leg. Baron Von Loudon, Zool. Mus. Berlin.

*Decticus loudoni* has been described by RAMME (1933), on the basis of a male specimen. A few years later CAPRA (1936) has described the female. Remarkably, only the Italian orthopterologists retain the specific status of *D. loudoni* (JANNONE, 1937; PAOLI, 1937; LA GRECA, 1950; BACCETTI, 1954; LA GRECA, 1957; FAILLA ET AL., 1994; LA GRECA, 1996), whereas many European authors treat *D. loudoni* as a subspecies (GÖTZ, 1970; SAMWAYS & HARZ, 1982) or a junior synonym (HELLER, 1988; RAGGE & REYNOLDS, 1998) of *D. verrucivorus*.

Some authors consider *Decticus loudoni* to be related to *D. annalisae* Ramme, 1929 (RAMME, 1933; CAPRA, 1936; LA GRECA, 1957), a species from northern Iran, or to *D. mithati* Ramme, 1939 (LA GRECA, 1957), from southern Turkey. However, GÖTZ (1970) and SAMWAYS & HARZ (1982) have regarded these two taxa as being only local forms of *D. v. verrucivorus*. CAPRA (1936) suggests that *D. loudoni* is closely related to *D. aprutianus*, despite a difference in size. The fact that both *D. loudoni* and *D. aprutianus* are confined to the southern part of the Italian Peninsula lends some support to this speculation.

## DISTRIBUTION

*D. loudoni* is confined to south-eastern Italy, from Apricena (Foggia, Puglia region) in the north to Spongano (Lecce, Puglia region) in the south (Fig. 1). The species is present in eastern Campania but seems to be absent in the Calabria and Basilicata regions. It is found between about 100 m in the plain and about 700 m in the hills. Unexpectedly, LA GRECA (1950) reports a female specimen near Bisaccia village, at 900 m in the Campania region. We have not studied this specimen, but this record needs to confirmation, as it seems to be beyond the limits of distribution of *D. loudoni*.

In the adjacent high mountains of the southern Apennines, *D. loudoni* seems to be replaced by *D. aprutianus*. All known localities of *D. loudoni* are listed in Tab. 1.

## HABITAT

The typical habitat of *D. loudoni* in the Puglia region is characterised by dry, stony and hilly meadows, the so-called “Murge”. The “Murge” are semi-natural grasslands, rarely tilled and only lightly grazed. The sparse vegetation consists of herbs and grasses, with scattered small bushes. According to our observations, *D. loudoni* prefers untilled and scarcely grazed meadows instead of cultivated fields or pastures. It demonstrated that a very large population of *D. loudoni* was present in the locality Masseria Modesti, where semi-natural grasslands predominate. Only one specimen was found in the neighbouring locality Masseria Nuova del Duca, which is characterised by the presence of arable fields and pastures.

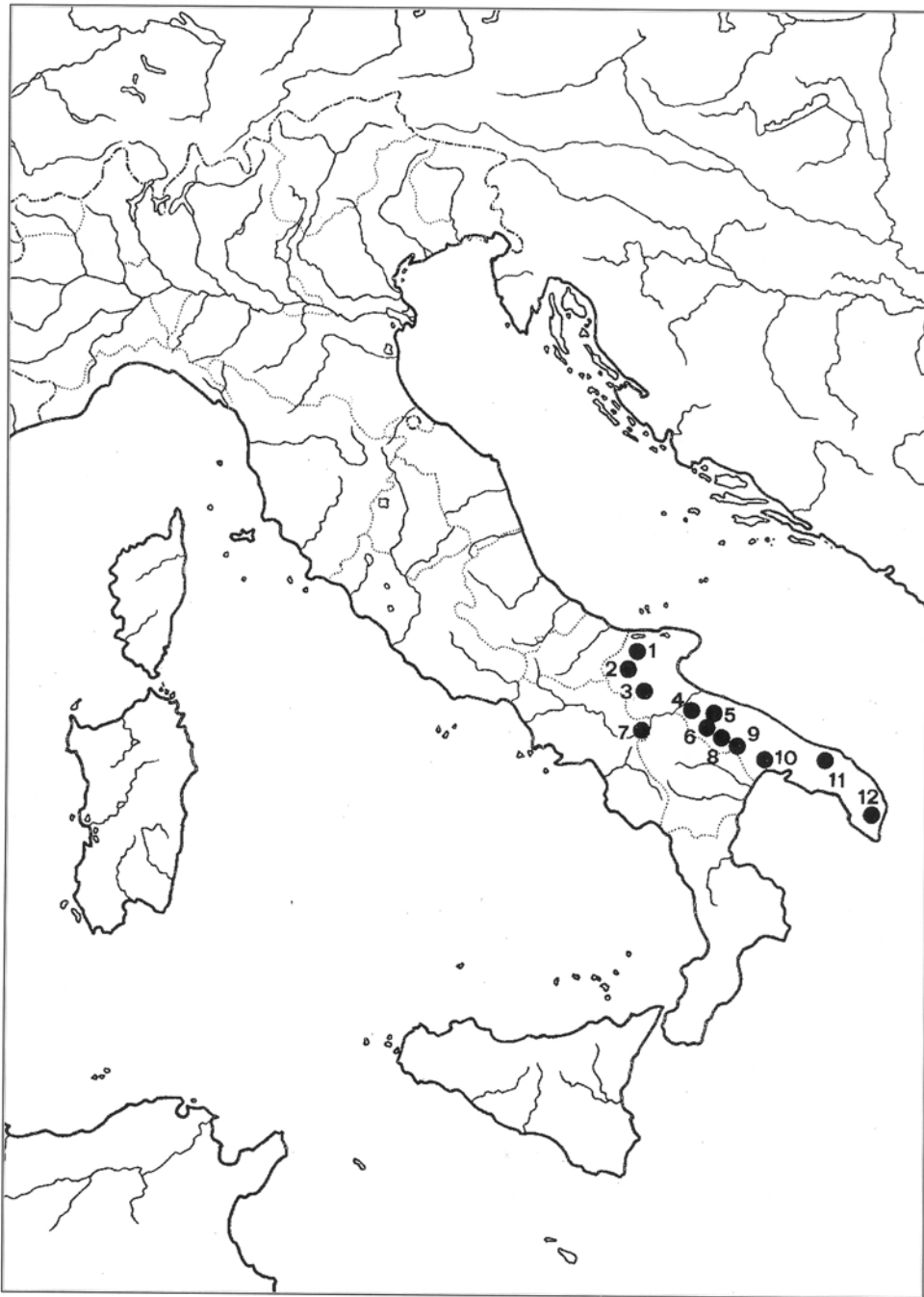


Fig. I - Distribution of *D. loudoni*. 1: Apricena (Foggia); 2: S. Severo (Foggia); 3: Perazzone (Foggia); 4: Spinazzola (Bari); 5: Masseria Nuova del Duca (Bari); 6: Masseria Modesti (Bari); 7: Bisaccia (Avellino) [this record has to be confirmed]; 8: Murgia Serraficaia (Bari); 9: Murgia Parisi, Altamura (Bari); 10: Palagianò (Taranto); 11: S. Vito dei Normanni (Brindisi); 12: Spongano (Lecce).



Fig. II - Habitat of *D. loudoni*. ITALY, reg. Puglia, Murge, Masseria Modesti. Photo Paolo Fontana, 24.VI.1999.



Fig. III A-B - Adult male and adult female of *D. loudoni*. ITALY, reg. Puglia, Murge, Masseria Modesti. Photo Paolo Fontana, 24.VI.1999.

Tab. 1 - Known localities of *D. loudoni*

Reg. Puglia, Salento	COSTA G., 1871
Reg. Puglia, Penisola Salentina, Spongano (Lecce)	RAMME, 1933
Reg. Puglia, Apricena (Foggia)	CAPRA, 1936; Paoli, 1937
Reg. Puglia, Perazzone, presso Troia (Foggia)	CAPRA, 1936; Paoli, 1937
Reg. Puglia, S. Severo (Foggia)	JANNONE, 1937
Reg. Puglia, S. Vito dei Normanni (Brindisi)	JANNONE, 1937
Reg. Puglia, Palagiano (Taranto)	JANNONE, 1937
Reg. Campania, Bisaccia (Avellino) <sup>1</sup>	LA GRECA, 1950
Reg. Puglia, Murgia Serraficaia (Bari)	LA GRECA, 1957
Reg. Puglia, Murgia Parisi, Altamura (Bari)	LA GRECA, 1957
Reg. Puglia, Spinazzola (Bari)	LA GRECA, 1957
Reg. Puglia, Murge, Masseria Nuova del Duca	Leg. Fontana, Malagnini & Buzzetti
Reg. Puglia, Murge, Masseria modesti	Leg. Fontana, Malagnini & Buzzetti

<sup>1)</sup> this record needs confirmation

According to La Greca (1957) *D. loudoni* is typical of the orthopteroafauna of the "Murge". In the sites visited the following species were found:

Species	Masseria Modesti	Masseria Nuova del Duca
<i>Tylopsis liliifolia</i> (Fabricius, 1793)	*	
<i>Acrometopa italica</i> Ramme, 1927		*
<i>Tettigonia viridissima</i> Linnaeus, 1758		*
<i>Platycleis i. intermedia</i> (Serville, 1839)	*	
<i>Montana stricta</i> (Zeller, 1849)	*	
<i>Sepiana sepium</i> (Yersin, 1854)	*	
<i>Pholidoptera femorata</i> (Fieber, 1853)	*	
<i>Saga pedo</i> (Pallas, 1771)	*	
<i>Ephippiger apulus apulus</i> (Ramme, 1933)	*	*
<i>Prionotropis appula</i> (O. G. Costa, 1836)	*	*
<i>Calliptamus</i> sp. (nymphs)	*	
<i>Oedipoda</i> sp. (nymphs)	*	
<i>Glyptothrus b. brunneus</i> (Thunberg, 1815)	*	
<i>Euchorthippus declivus</i> (Brisout, 1848)	*	

## MORPHOLOGY

*Decticus loudoni* has been described by RAMME (1933) and CAPRA (1936). Superficially, the species is characterised by its large size, short wings (Fig. 3) and a more or less straight ovipositor (Fig. 5, E).

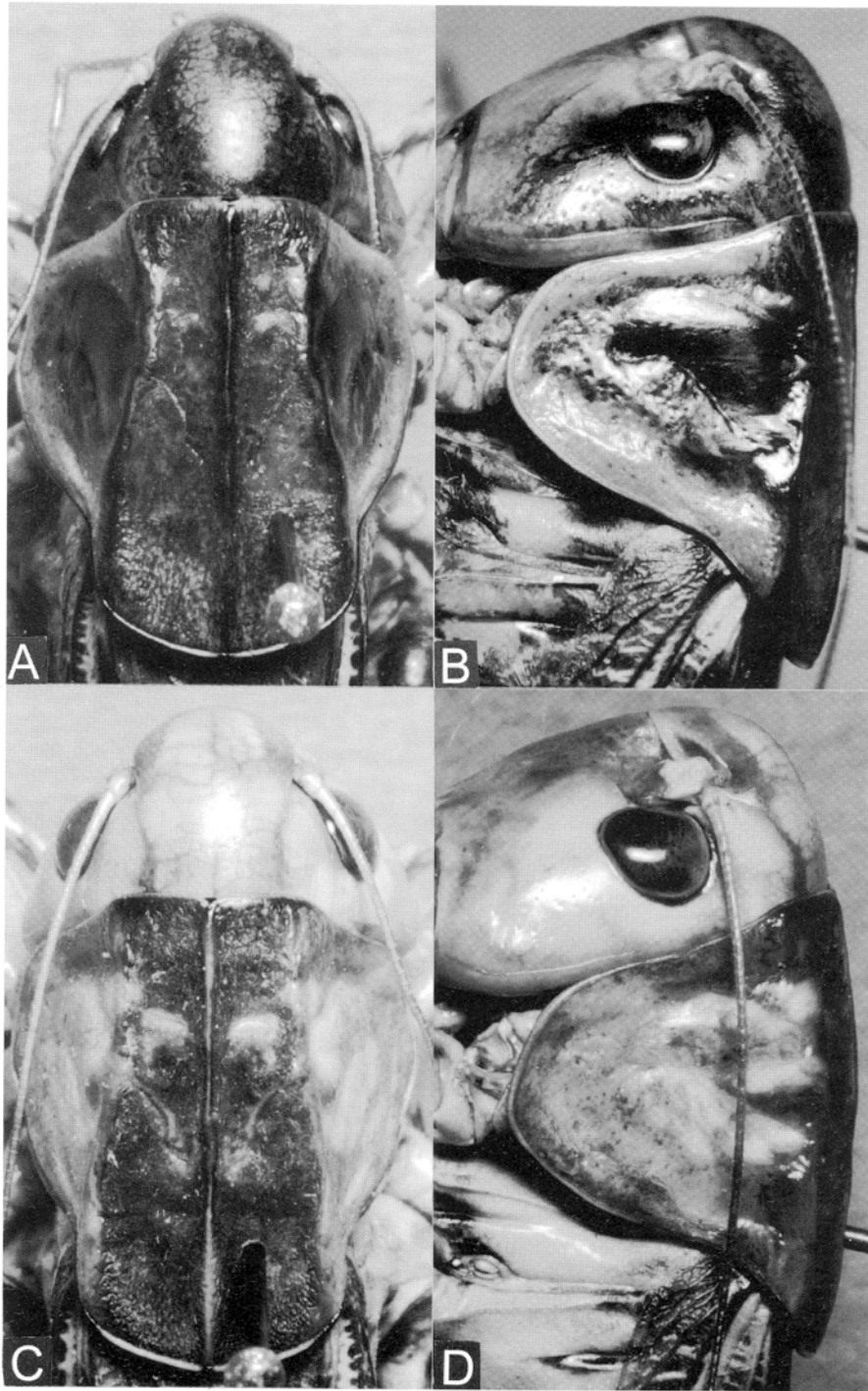


Fig. IV A-D - *D. loudoni*. ITALY, reg. Puglia, Murge, Masseria Modesti. A-D: lateral and dorsal view of head and pronotum of male (A-B) and female (C-D).

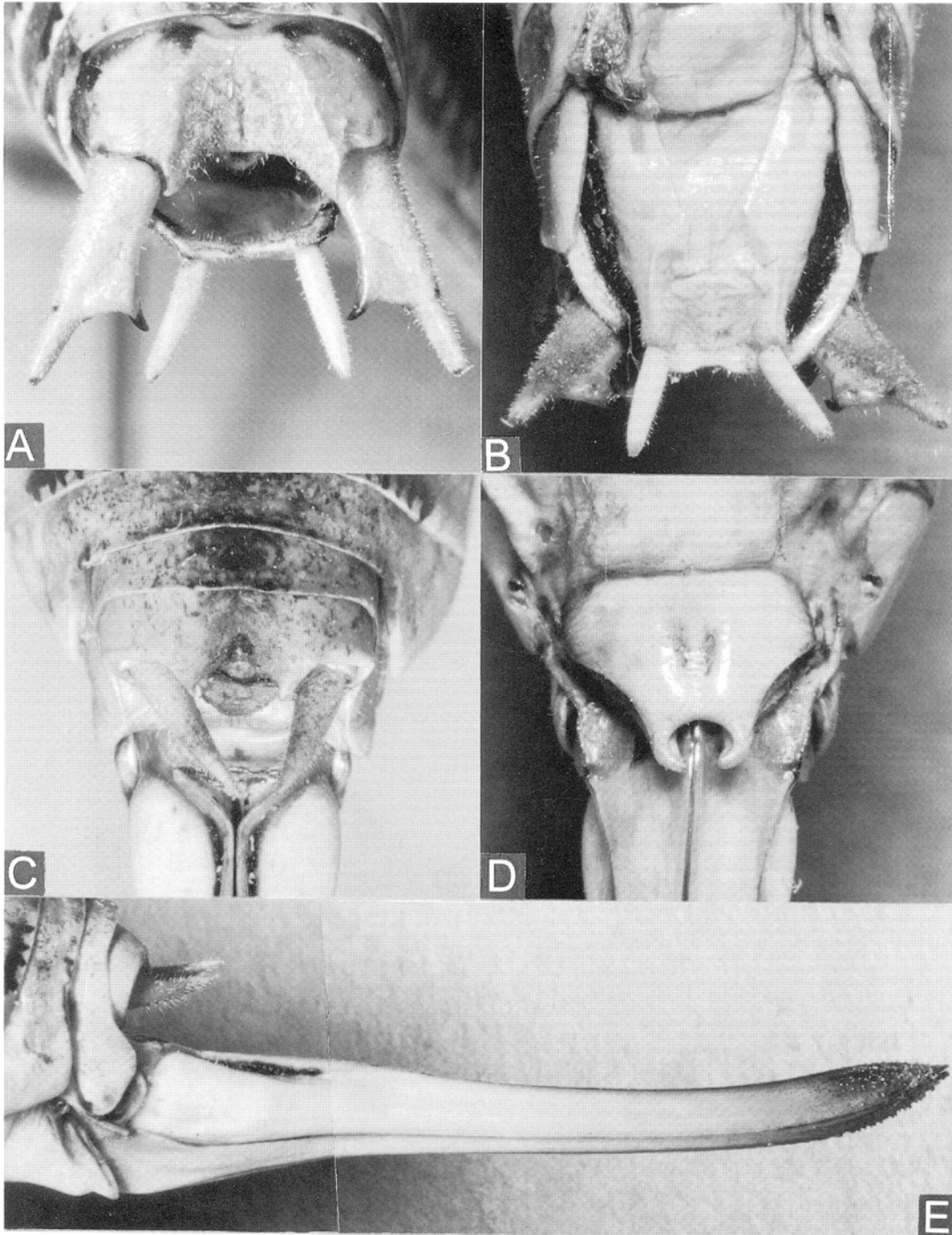


Fig. V A-E - *D. loudoni*. ITALY, reg. Puglia, Murge, Masseria Modesti. Male supra anal plate, cerci and subgenital plate apex (A, B); female supra anal plate, subgenital plate and lateral view of ovipositor (C-E).



Compared to *D. v. verrucivorus*, pronotum keels (Fig. 4, A-D) are straighter and less divergent distally. Furthermore, the pronotum keels are more pronounced, especially the median keel. Titillators are slender (Fig. 7, A) and bear many teeth, arranged in two rows in the median part (Fig. 6, B). The basal part of the titillators is thickened and bears many teeth and tubercles (Fig. 6, A). By contrast, the basal part of the titillators of *D. v. verrucivorus* is smooth or bears only small teeth and is never thickened. These characters were found in all investigated specimens of both species.

The stridulatory file of *D. loudoni* (Fig. 7, B-C) is clearly S-shaped and has 79-91 pegs. By contrast, the stridulatory file of *D. v. verrucivorus* is only faintly S-shaped and carries 64-83 pegs (HELLER, 1988), while *D. v. assiduus* has 70 pegs (INGRISCH ET AL, 1992).

The stridulatory file of *D. loudoni* is characterised by quite big pegs in the proximal part. The size of the pegs in the median part is about 2/3 of the size of the proximal pegs and the size of the pegs in the distal part is about 1/2 to 1/3 of the size of the proximal pegs. Some measurements of *D. loudoni* are given in table 2.

Tab. 2 - Measurements of *D. loudoni*, based on examined material and literature

	examined material <sup>1</sup>		literature <sup>2</sup>	
	AVERAGE	RANGE	AVERAGE	RANGE
Male pronotum length (mm)	10,5	10,0 - 10,9	9,8	8,9 - 11,0
Male tegmina length (mm)	20,1	18,1 - 21,0	20,0	17,4 - 22,5
Male hind femur length (mm)	35,7	34,3 - 37,8	34,6	31,7 - 38,0
Number of pegs of the stridulatory file	85	79 - 91	-	-
Female pronotum length (mm)	11,0	10,3 - 11,9	11,7	9,8 - 12,8
Female tegmina length (mm)	20,9	18,4 - 25,2	21,0	18,0 - 23,0
Female hind femur length (mm)	37,9	36,4 - 39,8	38,7	33,0 - 42,0
Female ovipositor length (mm)	23,3	22,0 - 24,5	21,4	20,5 - 22,5

<sup>1)</sup> Examined material: 7 females and 9 males.

<sup>2)</sup> RAMME, 1936; CAPRA, 1936; JANNONE, 1937; LA GRECA, 1950; HARZ, 1969 (3 males and 5 females).

## SONG

The species was heard singing in the morning and the early afternoon, with air temperature between 24 and 34 °C. The song consists of a long sequence of sound elements of variable duration. Characteristically, these elements are repeated increasingly rapidly from the beginning of a sequence.

Oscillographic analysis of the song shows some similarity with the song of *D. v. verrucivorus* (Fig 8 B3, 7 B4). The wing movement of *D. v. verrucivorus*, as it has been described by HELLER (1988), proved to apply to the oscillograms of *D.*

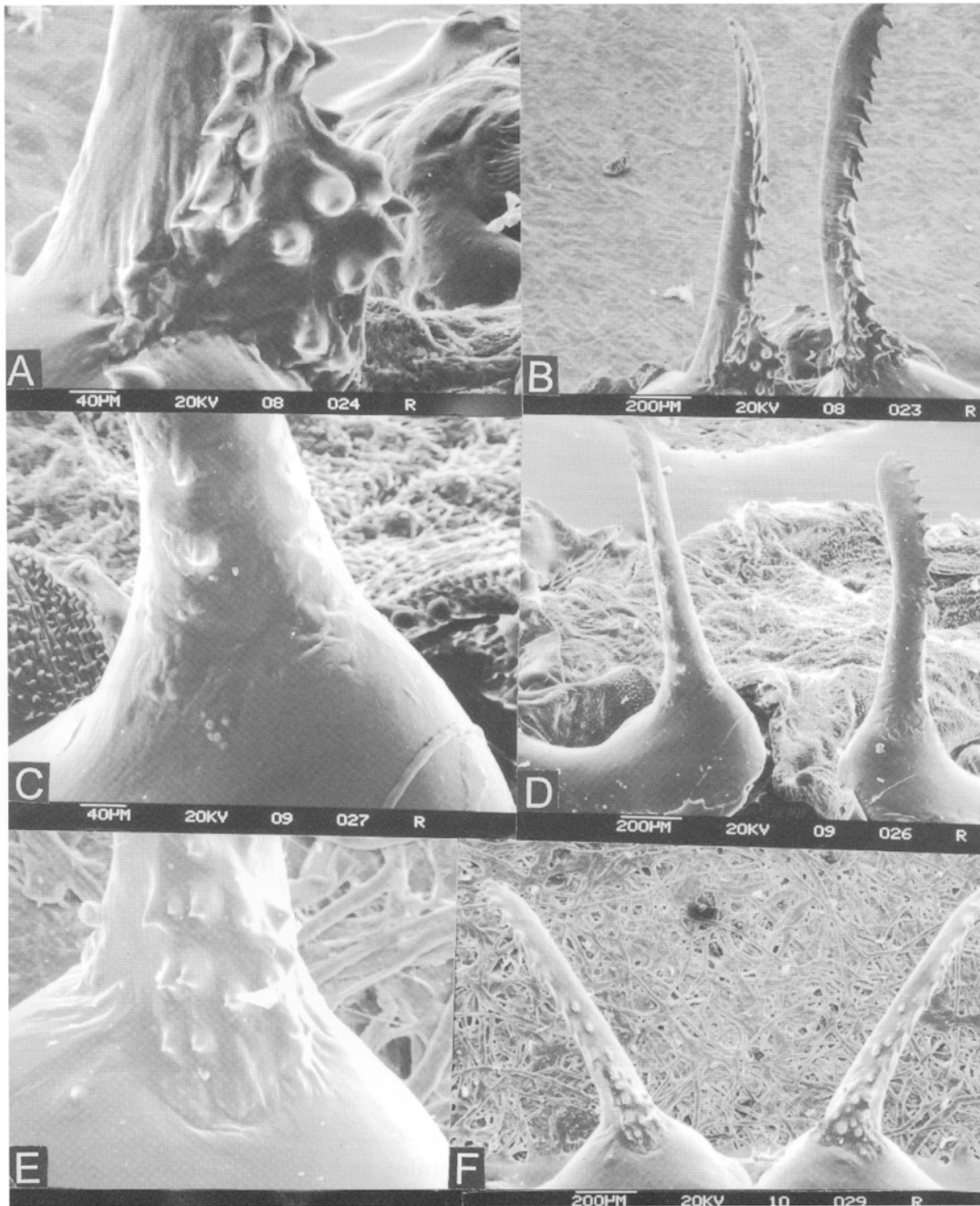


Fig. VI A-F - A-B: *D. loudoni*. ITALY, reg. Puglia, Murge, Masseria Modesti. Titillators in anterior lateral view (A), and anterior view (B). C-D: *D. v. verrucivorus*. SWEDEN, Oland, Alvaret near Stenåsa, reserv Möckel. Titillators in anterior lateral view (C), and anterior view (D). E-F: *D. v. verrucivorus*. ITALY, M. Summano (VI), loc. Sant. S. Orso, 1200 m. Titillators in anterior lateral view (E), and anterior view (F). Electron microscope (Cambridge Stereoscan 250) photo's by P. Fontana.

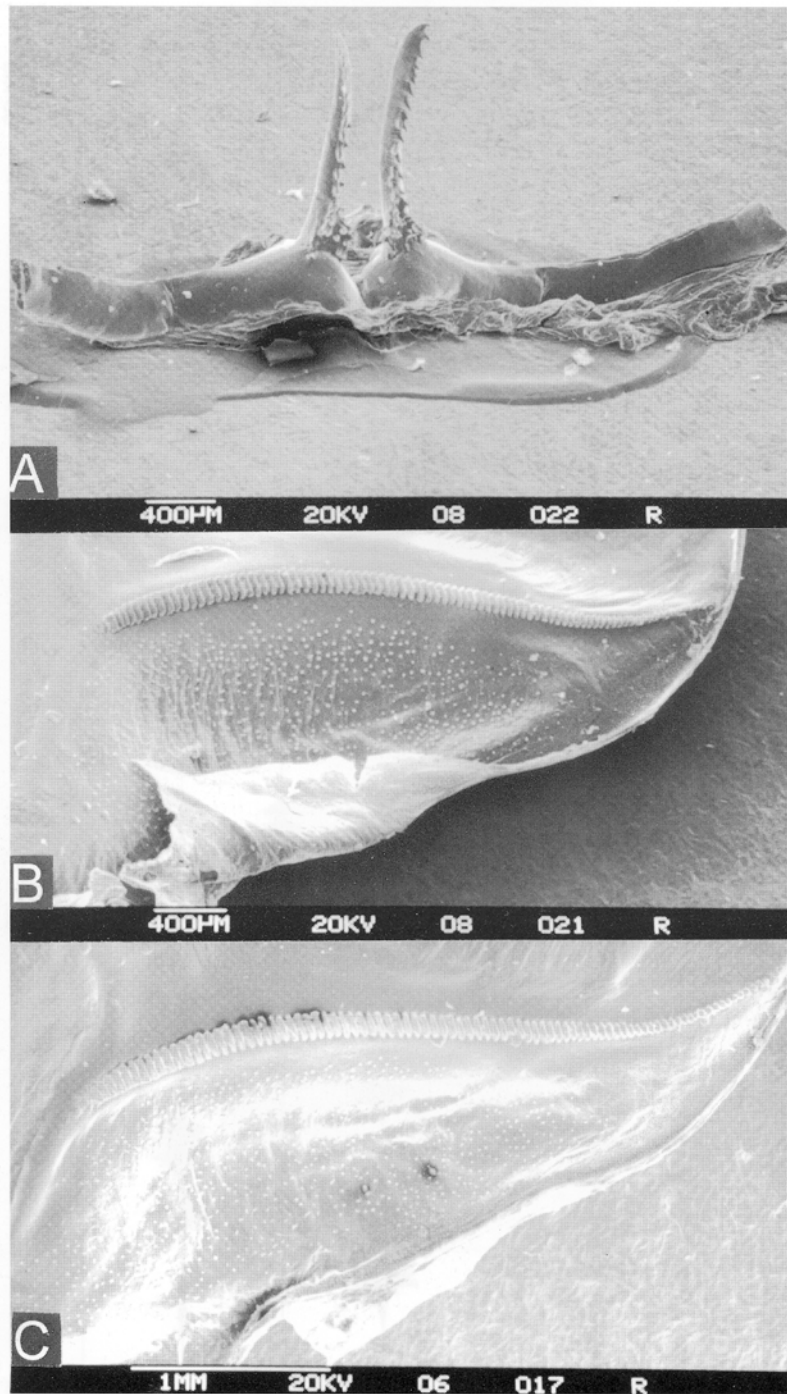


Fig. VII A-F - A-C: *D. loudoni*. ITALY, reg. Puglia, Murge, Masserià Modesti. Titillators in anterior view (A), Stridulatory file: overview of file (B-C) Electron microscope (Cambridge Stereoscan 250) photo's by P. Fontana.

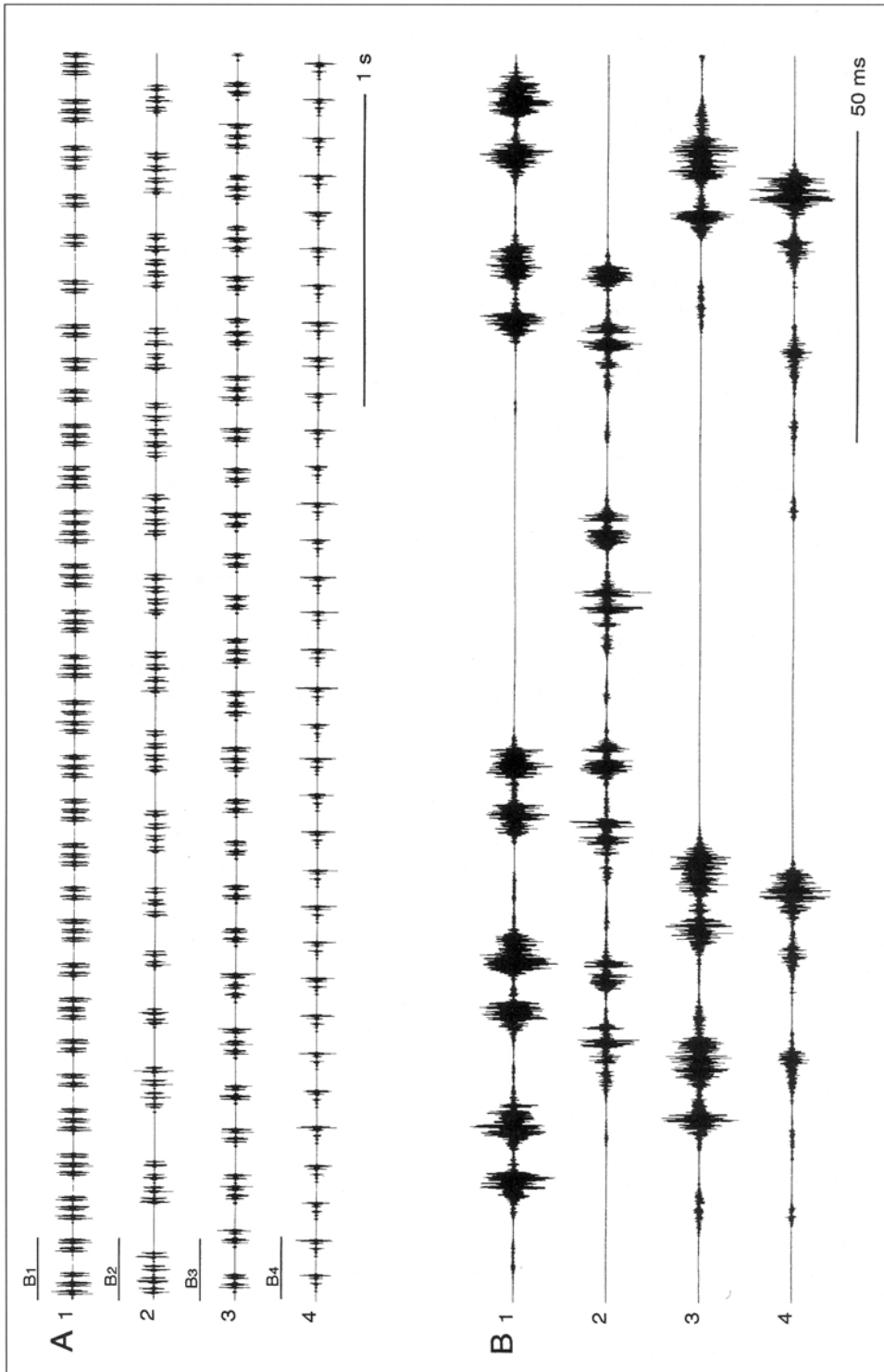


Fig. VIII A-B - Oscillograms of the song of three specimens of *D. loudoni*, ITALY, reg. Puglia, Murge, Masseria Modesti and one specimen of *D. verrucosus*, ITALY, reg. Trentino A. A., Val Malene (TN), Malene, 1000 m. A: overview of 4 s; B: detail of 200 ms. *D. loudoni*. 1: 32 °C; 2: 27 °C; 3: 34 °C. Studio recordings by P. Fontana. *D. v. verrucosus*. 4: 26 °C. Studio recording by B. Orlé.

*loudoni*, in particular to the syllabic structure within echemes. It therefore seemed reasonable to deduce the wing movement of *D. loudoni* from the oscillograms. Thus, the calling song can be described as a long sequence of echemes. When a male starts singing, echemes are well separated, but the repetition rate is gradually increased up to 4-8 echemes/s (fig. 8 A1-3). A sequence like this usually lasts for several minutes. The echemes within a sequence, lasting about 30-200 ms, vary greatly in the number of syllables they contain. Syllables are always grouped two by two, so echemes contain an even number of syllables and consist of at least 4, but sometimes of up to 10 syllables (fig. 8 A1-3). The first syllable of a group, lasting about 16-25 ms, consists of a quiet opening hemisyllable and a loud closing hemisyllable (fig. 8 B1-3). The second syllable of a group is shorter than the first one and lasts about 10-20 ms. The second opening hemisyllable is often quiet or absent and therefore hardly visible in the oscillograms.

The song of *D. loudoni* is very different from the song of the other European taxa of the genus. Although the basic wing movement, with pairs of syllables, is the same as in *D. v. verrucivorus*, all pairs of syllables are more or less equal in *D. loudoni* (fig 8 B3). By contrast, in *D. v. verrucivorus* the first pair is clearly less pronounced than the second pair (fig 8 B4). Furthermore, the echemes in a sequence of *D. v. verrucivorus* have a fixed length (2 pairs of syllables) and a fixed repetition rate, whereas the echemes of *D. loudoni* vary both in length (2-5 pairs of syllables) and in repetition rate.

The song of *D. loudoni* is also different from the continuous song of *D. v. assiduus* (see Ragge & Reynolds, 1998) and, according to our preliminary analyses, the song of *D. aprutianus*. The latter species seems to have a bioacoustic identity as well.

## DISCUSSION

In the past, variation in the song of Orthoptera has not been accepted as the only character to distinguish valid species (Ragge & Reynolds, 1998). We strongly agree with this point of view. Song characters need to be supported with morphological evidence or with evidence of an ethological barrier that prevents hybridisation between the taxa. This has lead Ingrisich et al. (1992) to describe a population of *D. verrucivorus* with a deviant song as a subspecies only, even though the song of this subspecies is strikingly different from the typical *D. v. verrucivorus*. Morphologically, this subspecies is characterised only by relatively short wings, a character frequently met with in montane populations. The apparent absence of any substantiating morphological support for a specific status has led the authors to accept the subspecific status as a compromise.

The previous discussion provided the basis for our evaluation of the status of *D. loudoni*. *D. loudoni* is another short-winged species, just like *D. aprutianus* and some other montane populations of *D. verrucivorus*. Yet, *D. loudoni* proves to be easily recognised by its large size and characters of the pronotum, titillators and ovipositor. Furthermore, the species has a distinctive male calling song, different from the song of the typical *D. v. verrucivorus* and from other short-winged taxa of the genus in southern Europe, including *D. v. assiduus* and *D. aprutianus*. It

is hard to believe that such a distinct calling song would not provide a kind of ethological barrier between *D. loudoni* and the other taxa.

Concluding, in our opinion the morphological differences with the typical *D. v. verrucivorus* are evident and, in combination with an allopatric distribution and a markedly different song, confirm the specific status of *D. loudoni*. In the near future we hope to find more evidence for the specific status of *D. loudoni*, on the basis of our genetic research.

The distribution of *D. loudoni* is limited to the Puglia region in Italy. Although we have not encountered actual threats to the species, this endemic species and its habitat need protection.

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#### SUMMARY

The authors present the first-ever description of the song of *Decticus loudoni* Ramme, an endemic bush-cricket of south-eastern Italy. The male calling song of *Decticus loudoni* Ramme shows significant differences with the other European species of the genus. On the basis of song and morphology, *D. loudoni* is confirmed to be a distinct species, although its status has formerly been disputed. Several morphological characters of the male and the female are illustrated. Furthermore, the present knowledge on habitat and distribution of *Decticus loudoni* is presented.

KEY WORDS: Insecta, Orthoptera, Tettigoniidae, *Decticus loudoni* Ramme, Morphology, Bioacoustics.

#### L'identità di *Decticus loudoni* Ramme, 1933 (Insecta Orthoptera Tettigoniidae)

#### RIASSUNTO

Gli Autori presentano per la prima volta la descrizione del canto di *Decticus loudoni* Ramme, un ensifero endemico dell'Italia meridionale. Il canto di *Decticus loudoni* Ramme presenta differenze significative rispetto alle altre specie europee del genere. Sulla base del suo canto caratteristico e della sua morfologia, *D. loudoni* è confermato come specie distinta. Sono inoltre illustrate le principali caratteristiche morfologiche del maschio e della femmina. L'habitat e la distribuzione di *Decticus loudoni* sono ulteriormente precisati.

PAROLE CHIAVE: Insecta, Orthoptera, Tettigoniidae, *Decticus loudoni* Ramme, Morfologia, Bioacustica.

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