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Contributions to the study of acoustic signals of grasshoppers (Orthoptera: Acrididae: Gomphocerinae) from Russia and adjacent countries. 2. Calling songs of widespread species recorded in different localities

К познанию акустических сигналов саранчовых (Orthoptera: Acrididae: Gomphocerinae) России и сопредельных стран. 2. Записи призывных сигналов широко распространенных видов из разных местонахождений

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KEY WORDS: grasshoppers, Acrididae, Gomphocerinae, songs, signals, variability, bioacoustics, Russia.

КЛЮЧЕВЫЕ СЛОВА: саранчовые, Acrididae, Gomphocerinae, сигналы, изменчивость, биоакустика, Россия.

ABSTRACT: Calling signals of 15 species of Gomphocerinae grasshoppers (Orthoptera: Acrididae) from Russia and adjacent territories are described and illustrated with oscillograms at different speeds. Signals of each species were recorded in several localities remote from each other. Geographical variation of signals temporal pattern is discussed. *Ch. albomarginatus caliginosus* Mistshenko, 1951 is regarded as separate species *Ch. caliginosus* Mistshenko, 1951, stat.n. basing on investigation of acoustic signals.

РЕЗЮМЕ. Описаны и иллюстрированы осциллограммами на нескольких скоростях развертки призывные сигналы 15 видов саранчовых подсемейства Gomphocerinae из России и с сопредельных территорий. Записи сигналов каждого вида были сделаны в двух или более удаленных друг от друга географических точках. Обсуждается географическая изменчивость сигналов. На основании анализа сигналов *Ch. albomarginatus caliginosus* Mistshenko, 1951 возведен в ранг вида *Ch. caliginosus* Mistshenko, 1951, stat.n.

In Gomphocerinae grasshoppers, the difference in temporal pattern of male calling song provides the most important precopulatory barrier of reproductive isolation. For this reason, song analysis has been actively used in systematics for discrimination between closely related species or for elucidation of the taxonomic status of dubious forms. At present, the songs of West-European species are well studied (see the recent fundamental work by Ragge and Reynolds [1998]), whereas the information on acoustic signals of Gomphocerinae from the territory of the former Soviet Union is available only for a small number of species.

In part 1 of this paper [Bukhvalova, Vedenina, 1999], we presented oscillograms of calling songs of 24 Gomphocerinae species whose signals were either never studied before, or were only recorded in West-European populations. In the present paper, recordings of widespread species from different localities, remote from each other and covering mainly the eastern part of their ranges are presented. This provides a more comprehensive knowledge of the limits of geographical variability of the song temporal structure, which is very important for the correct use of this character in taxonomic studies. Such work is also necessary for obtaining more complete data on the distribution of certain forms and for establishing their taxonomic status.

Methods of recording and analysing the songs, as well as the terms used for the song description are given in part 1 of the paper [Bukhvalova, Vedenina, 1999]. The specimens recorded are deposited in the collection of Zoological Museum of Moscow State University. As in part 1 of the paper, we mention only the references to previous publications where oscillograms are presented. Diagrams, verbal descriptions, disc recordings etc. are not taken into account.

In addition to the locality descriptions, the geographical maps are presented showing the places where specimens were collected.

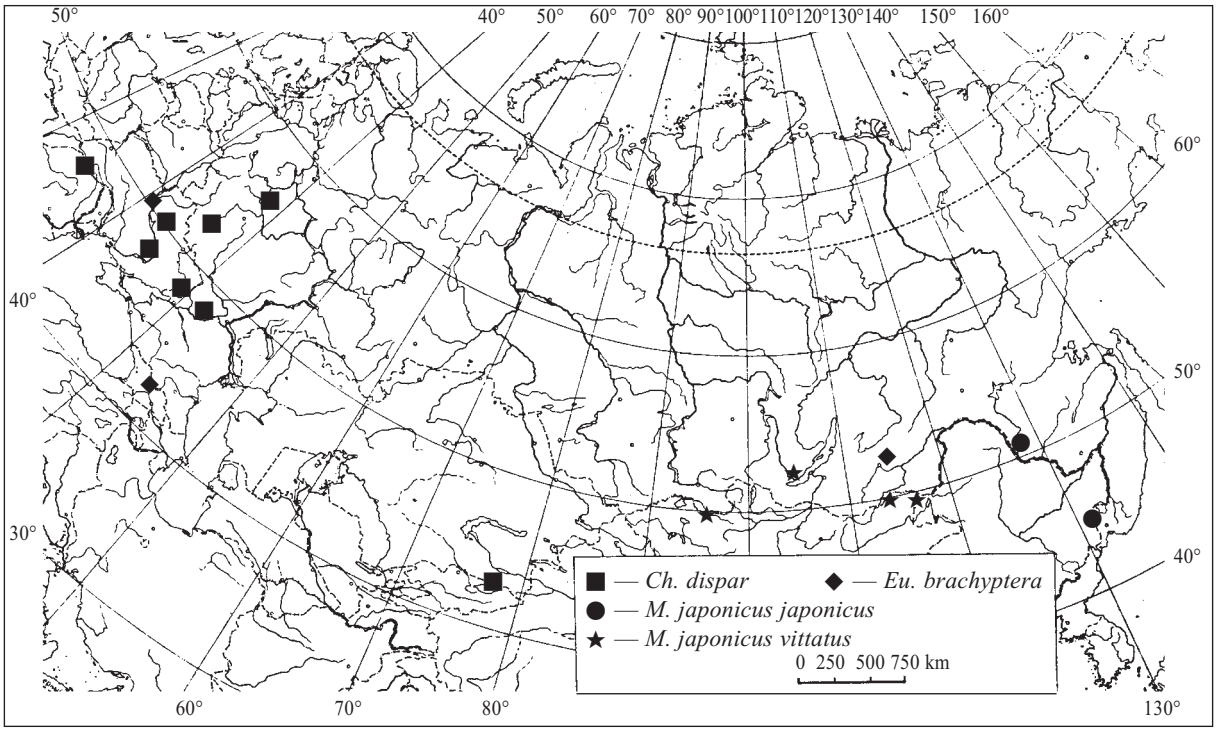


Fig. 1. Map of localities of *Chrysochraon dispar* (Germ.), *Euthystira brachyptera* (Ocsk.) and *Mongolotettix japonicus* (Boliv.).
Рис. 1. Места сбора *Chrysochraon dispar* (Germ.), *Euthystira brachyptera* (Ocsk.) и *Mongolotettix japonicus* (Boliv.).

1. *Chrysochraon dispar* (Germar, 1831)

DISTRIBUTION. From Western Europe to Siberia through central and eastern Europe, Northern Caucasus and Kazakhstan.

LOCALITIES (Fig. 1).

1. Ukraine, Zakarpatskaya Area, about 10 km NE of the Khust Town, environs of Kireshi Village, "the valley of narcissi". 25.VII.1997. 1 ♂ recorded at 36°C.

2. Ukraine, Poltava Area, Mirgorod District, Velikie Sorochintsy Village. 12.VIII.1994. 2 ♂♂ recorded at 24°C.

3. Ukraine, Dnepropetrovsk Area, Samarskiy Nature Reserve. 12.VI.1996. 1 ♂ recorded at 24°C.

4. Ukraine, Lugansk Area, Luganskiy Nature Reserve, "Proval'skaya steppe". 20.VII.1995. 1 ♂ recorded at 37°C.

5. Moscow Area, Voskresensk District, environs of Beloozerskiy Town. 8.VII.1992 7 ♂♂ recorded at 25–27°C.

6. Kursk Area, Tsentral'no-Chernozemnyi Nature Reserve, Streletskaya steppe. 27.VII.1985. 2 ♂♂ recorded at 27, 32°C.

7. Rostov Area, Oblivskiy District, environs of Sosnovy (=Oporny) Village on Chir River. 8.VIII.1991. 4 ♂♂ recorded at 30°C.

8. Kazakhstan, Almaty and Zailiyskiy Alatau Mountain Ridge in the environs of the city. 2.VII.1994. 2 ♂♂ recorded at 30–31°C.

REFERENCES TO SONG. Schmidt, Baumgarten, 1977; Zhantiev, 1981; Vedenina, 1990; Vedenina, Zhantiev, 1990; Bukhvalova, Zhantiev, 1994; Kleukers et al., 1997; Ragge, Reynolds, 1998.

SONG (Figs. 2–19). The calling song is a sequence of echemes, each lasting about 0.7–3 s and consisting of about 8-20 syllables. Each echeme begins quietly, reaching maximum intensity at about half of its duration. Male, if not disturbed, may sing continuously for about ten minutes.

The recordings from different localities are quite similar.

2. *Euthystira brachyptera* (Ocskay, 1826)

DISTRIBUTION. Western Europe, Ukraine, European part of Russia, Caucasus, Siberia, Kazakhstan, Kyrgyzstan.

LOCALITIES (Fig. 1).

1. Ukraine, Cherkassy Area, Kanevskiy Nature Reserve. 18.VI.1996. 1 ♂ recorded at 24°C.

2. Northern Caucasus, North Ossetia, basin of the Ardon River, Tsey Canyon, environs of Nizhniy Tsey Village. 2.VIII.1990. 1 ♂ recorded at 28°C.

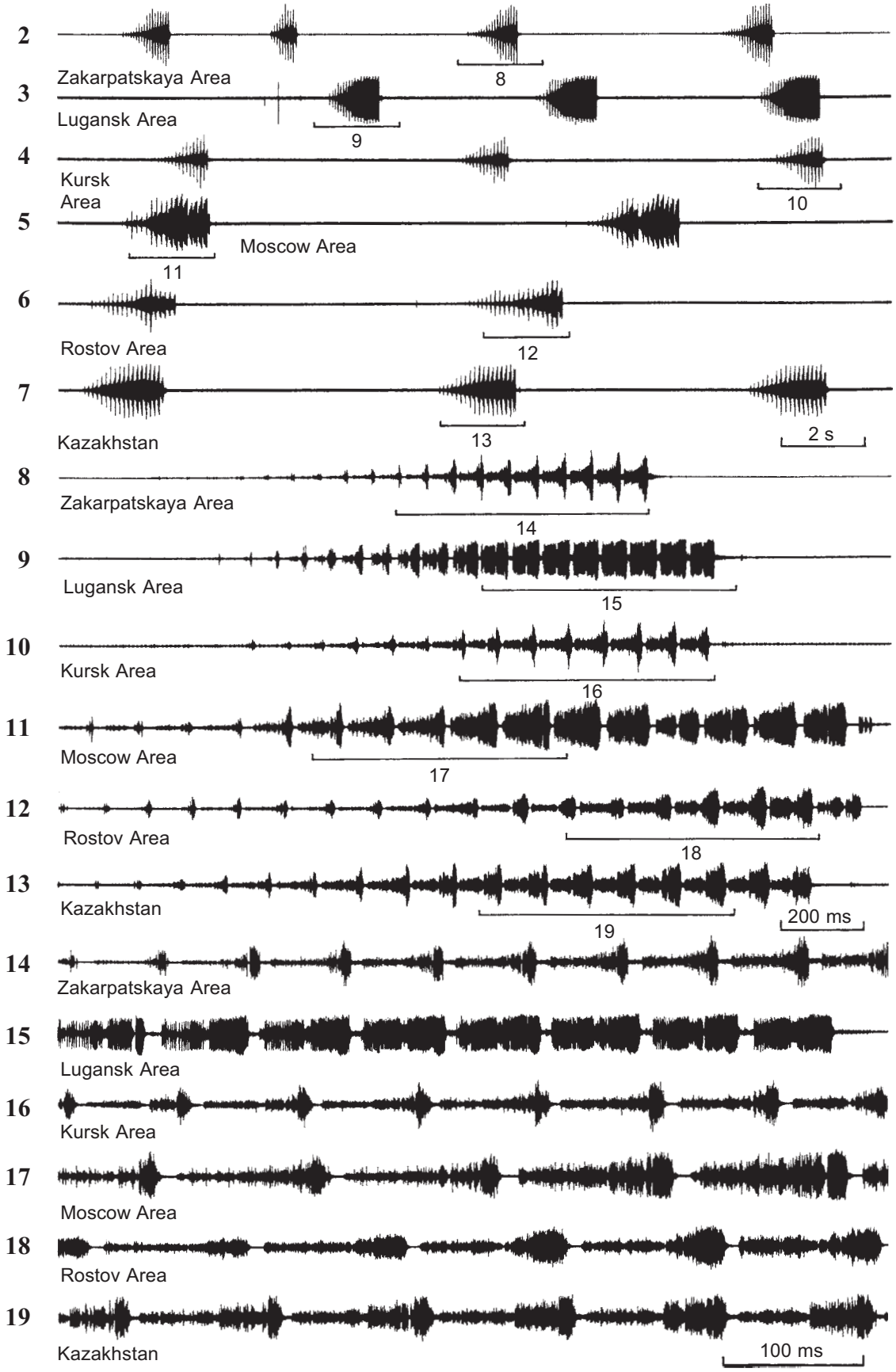
3. Chita Area, Karymskiy District, environs of Talacha River at the confluence with Ingoda River (15 km E of Urul'ga Village). 23.VI.1995. 2 ♂♂ recorded at about 30°C (shade).

REFERENCES TO SONG. Schmidt, Baumgarten, 1977; Vedenina, Zhantiev, 1990; Bukhvalova, Zhantiev, 1994; Helversen, Helversen, 1994; Kleukers et al., 1997; Ragge, Reynolds, 1998.

SONG (Figs. 20–28). The calling song is a sequence of short echemes, each lasting about 0.4–0.9 s and consisting of about 6–12 syllables. Oscillographic analysis shows that the high-amplitude syllables sometimes alternate with the low-amplitude ones (Figs. 24, 27). Male sings, sitting on a plant, and during singing, it usually moves from one plant to

Figs. 2–19. Oscillograms of the songs of *Chrysochraon dispar* (Germ.). Faster oscillograms of the parts of songs indicated as "8–19" are given on the oscillograms under the same numbers.

Рис. 2–19. Осциллограммы сигналов *Chrysochraon dispar* (Germ.). Фрагменты сигнала, помеченные как "8–19", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.


2
3
Zakarpatskaya Area
Lugansk Area
8
9
4
Kursk
Area
10
5
Moscow Area
11
6
Rostov Area
12
7
Kazakhstan
13
2 s
8
Zakarpatskaya Area
14
9
Lugansk Area
15
10
Kursk Area
16
11
Moscow Area
17
12
Rostov Area
18
13
Kazakhstan
19
200 ms
14
Zakarpatskaya Area
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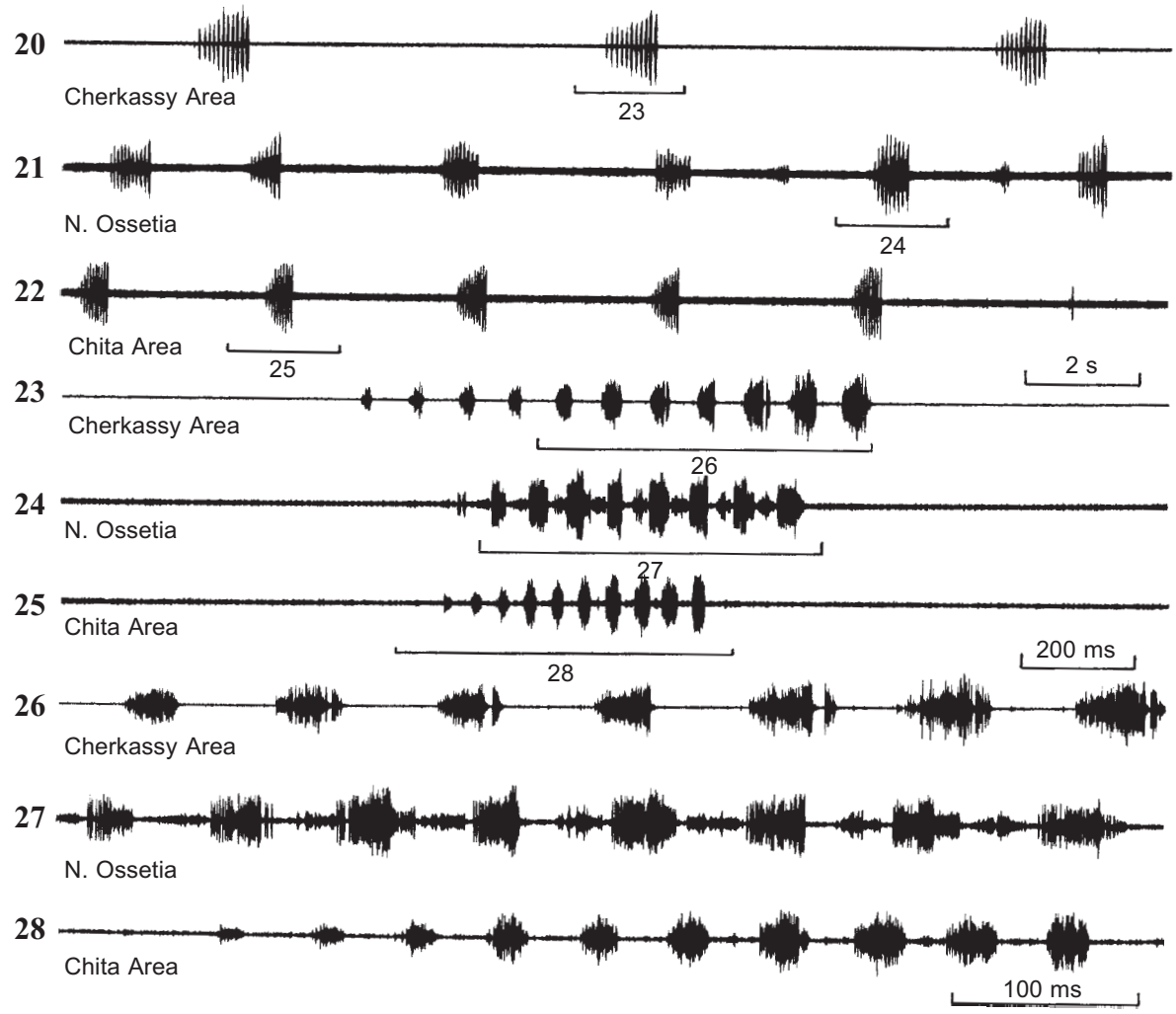
Kursk Area
17
Moscow Area
18
Rostov Area
19
Kazakhstan
100 ms



Figs. 20–28. Oscillograms of the songs of *Euthystira brachyptera* (Ocsk.). Faster oscillograms of the parts of songs indicated as "23–28" are given on the oscillograms under the same numbers.

Рис. 20–28. Осциллограммы сигналов *Euthystira brachyptera* (Ocsk.). Фрагменты сигнала, помеченные как "23–28", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.

another. Male, if not disturbed, may sing continuously for several minutes.

Male songs from different localities are quite similar.

3. *Mongolotettix japonicus* (I. Bolivar, 1898)

DISTRIBUTION.

M. japonicus japonicus (I. Bolivar, 1898): Amur Area, Maritime Province, Korea, Japan.

M. japonicus vittatus (Uvarov, 1914): southern parts of middle and eastern Siberia, Mongolia, northern China.

LOCALITIES (Fig. 1).

M. japonicus japonicus:

1. Amur Area, environs of Kostyukovka Village 30–40 km W of Svobodny Town. Forest glade. 7.VII.1995. 1 ♂ recorded at 27°C in the field (shade).

2. Southern Maritime Province, Pogranichny District, environs of Barabash-Levada Village. 17.VII.1995. 5 ♂♂ recorded at 30–32°C (shade) in the field.

M. japonicus vittatus:

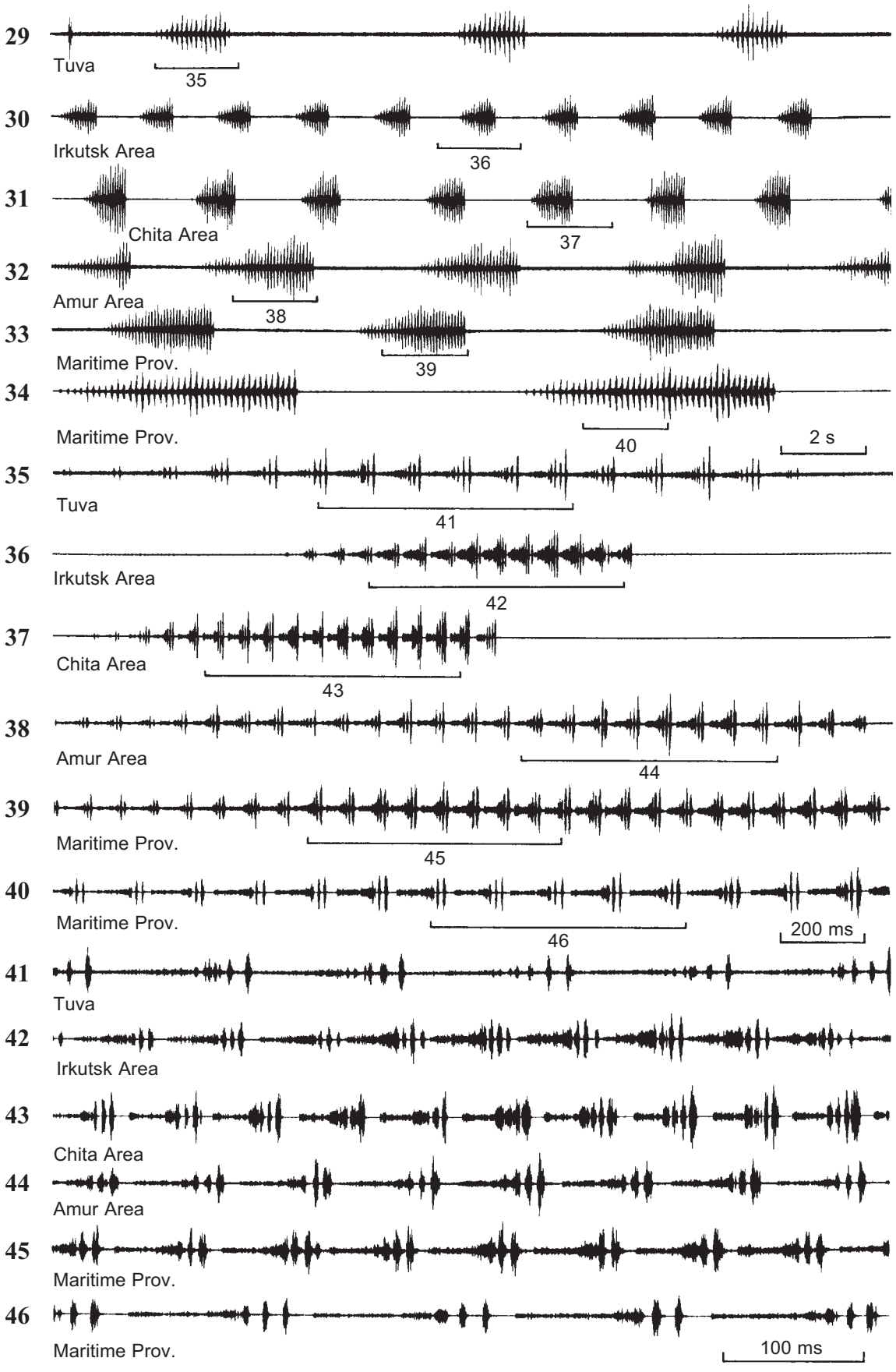
1. Southern Tuva, environs of Erzin Village, dry meadow on the border of Tes-Khem River flood-plain. 8.VIII.1989. 2 ♂♂ recorded at 26 and 31°C.

2. Irkutsk Area, in the vicinity of Baikal Lake, environs of Listvyanka. 25.VIII.1988. 1 ♂ recorded at 28°C.

3. Chita Area, Ononskiy District, "Daurskiy" Nature Reserve, northern shore of Zun-Torey Lake. 17.VI.1995. 1 ♂ recorded at 28°C (shade).

Figs. 29–46. Oscillograms of the songs of *Mongolotettix japonicus japonicus* (Boliv.) (32–34, 38–40, 44–46) and *M. japonicus vittatus* (Uv.) (29–31, 35–37, 41–43). Faster oscillograms of the parts of songs indicated as "35–46" are given on the oscillograms under the same numbers.

Рис.. Осциллограммы сигналов *Mongolotettix japonicus japonicus* (Boliv.) (32–34, 38–40, 44–46) и *M. japonicus vittatus* (Uv.) (29–31, 35–37, 41–43). Фрагменты сигнала, помеченные как "35–46", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.


29
Tuva
35
30
Irkutsk Area
36
31
Chita Area
37
32
Amur Area
38
33
Maritime Prov.
39
34
Maritime Prov.
40
2 s
35
Tuva
41
36
Irkutsk Area
42
37
Chita Area
43
38
Amur Area
44
39
Maritime Prov.
45
40
Maritime Prov.
46
200 ms
41
Tuva
42
Irkutsk Area
43
Chita Area
44
Amur Area
45
Maritime Prov.
46
Maritime Prov.
100 ms

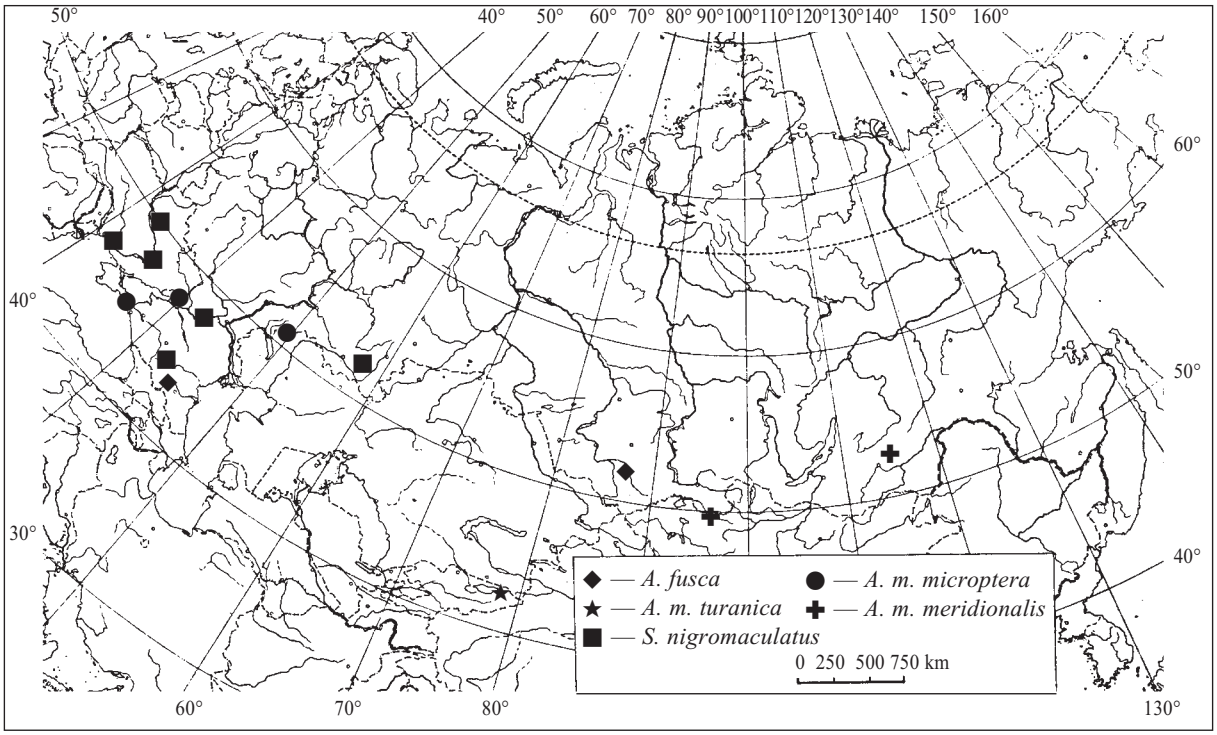


Fig. 47. Map of localities of *Arcyptera fusca* (Pall.), *A. microptera microptera* (F.-W.), *A. microptera turanica* (Uv.), *A. microptera meridionalis* (Ikonn.) and *Stenobothrus nigromaculatus* (H.-S.).

Рис. 47. Места сбора *Arcyptera fusca* (Pall.), *A. microptera microptera* (F.-W.), *A. microptera turanica* (Uv.), *A. microptera meridionalis* (Ikonn.) и *Stenobothrus nigromaculatus* (H.-S.).

4. Chita Area, Ononskiy District, the bank of Onon River 5 km W of Nizhniy Tsasuchey Village. 17, 19.VI.1995. 3 ♂♂ recorded at 28–31°C (shade).

REFERENCES TO SONG.

M. japonicus japonicus: unknown.

M. japonicus vittatus: Bukhvalova, Zhantiev, 1994 (as *M. mistshenkoi* Chogsomzhav)

SONG (Figs. 29–46). The calling song of the nominal subspecies consists of echemes, each lasting about 2–5 s and separated by intervals of 3–5 s (Figs. 32–34, 38–40, 44–46). The echeme begins quietly, reaching maximum intensity within the last third of its duration, but ends with two or three more quiet syllables. The echeme is composed of about 35–40 syllables. Oscillographic analysis shows that in a second part of each syllable, there are 2–5 separate pulses completely broken up by gaps. Male, if not disturbed, may sing continuously up to 20–30 minutes, sitting on the same plant and not moving to another.

In the calling song of the western subspecies *M. japonicus vittatus,* the duration of echeme and the intervals between echemes are at least twice shorter than in nominal subspecies (Figs. 29–31, 35–37, 41–43). Echemes are composed of 13–17 syllables. Meanwhile, the structure of the syllables is quite similar to that in nominal subspecies.

NOTES. Difference between signals of *M. japonicus japonicus* and *M. japonicus vittatus* is not great, but very distinct (Figs. 29–31 and 32–34) and this is one more evidence that these forms should be regarded as different subspecies.

The signal of *M. japonicus vittatus* from Tuva was previously erroneously described by Bukhvalova and Zhantiev [1994] under the name *M. mistshenkoi*.

4. *Arcyptera fusca* (Pallas, 1773)

DISTRIBUTION. Western Europe (mostly in mountains), Ukraine, southern part of European Russia, Caucasus, Northern and Eastern Kazakhstan, Southern Siberia, Yakutia, Amur Area (eastwards as far as Zeya River), Mongolia, north-east China.

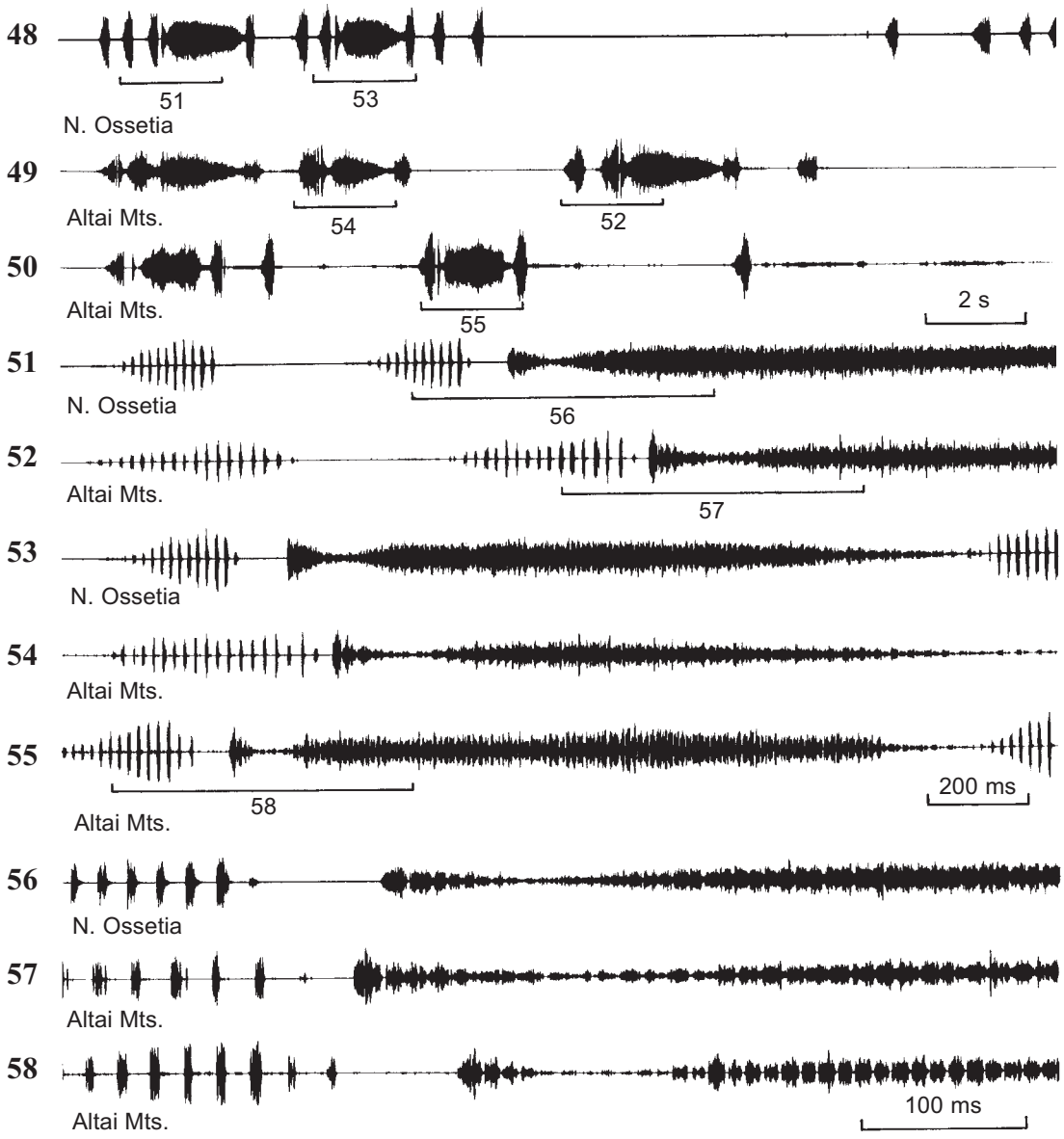
LOCALITIES (Fig. 47).

1. Northern Caucasus, North Ossetia, basin of the Ardon River, Tsey Canyon, subalpine meadows in the environs of Nizhniy Tsey Village, altitude above sea level approximately 1800 m. 2–9.VIII.1990. 6 ♂♂ recorded at 25–28°C.

2. Altai Mountains, southern shore of Teletskoe Lake, Chiri, 15.VII.1999. Signals of 3 ♂♂ recorded at 25°C (shade) in the field.

REFERENCES TO SONG. Faber, 1957; García et al., 1987 (cited after Ragge, Reynolds, 1998); Xi et al., 1992 (cited after Ragge, Reynolds, 1998); Bukhvalova, 1993; Bukhvalova, Zhantiev, 1994; García et al., 1996; Ragge, Reynolds, 1998.

SONG (Figs. 48–58). The calling song consists of two different components. The first component is a syllable, lasting approximately 0.2–0.5 s and consisting of about 13–20 short discrete pulses in the song of individuals from Altai Mountains (Figs. 52, 54), and about 9–12 pulses in the song of Ossetian specimens (Figs. 51, 53). The second component is a dense echeme that sounds like a loud hiss and lasts 1.5–2.5 s. Oscillographic analysis shows that pulses of the echeme are almost indistinct. The echeme begins with abrupt loud pulse, then intensity decreases, but within 0.1–0.2 s it increases again. The echeme may have several amplitude maximums. In typical situation, male produces from one to three syllables of the first component, followed by one echeme of the second component



Figs. 48–58. Oscillograms of the songs of *Arcyptera fusca* (Pall.). 50, 55, 58 — songs of the male with one hind leg. Faster oscillograms of the parts of songs indicated as "51–58" are given on the oscillograms under the same numbers.

Рис.. Осциллограммы сигналов *Arcyptera fusca* (Pall.). 50, 55, 58 — сигналы самца с одной задней ногой. Фрагменты сигнала, помеченные как "51–58", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.

and then, from one to three syllables again. Occasionally male produces one or several syllables of the first component only.

A distance between two localities where the recorded specimens were collected exceeds 3300 km, nevertheless individual signals from these geographical points are quite similar.

5. *Arcyptera labiata* (Brullé, 1832)

DISTRIBUTION. Greece, Asia Minor.

LOCALITY. Central Greece, Fthiotis, about 35 km northwest of Lamia, environs of Loutra Kaitsas (not shown on the map). Stony slopes with low vegetation. 26.V., 4.VI.1998. 2 ♂♂ recorded at 31, 26°C (shade) in the field.

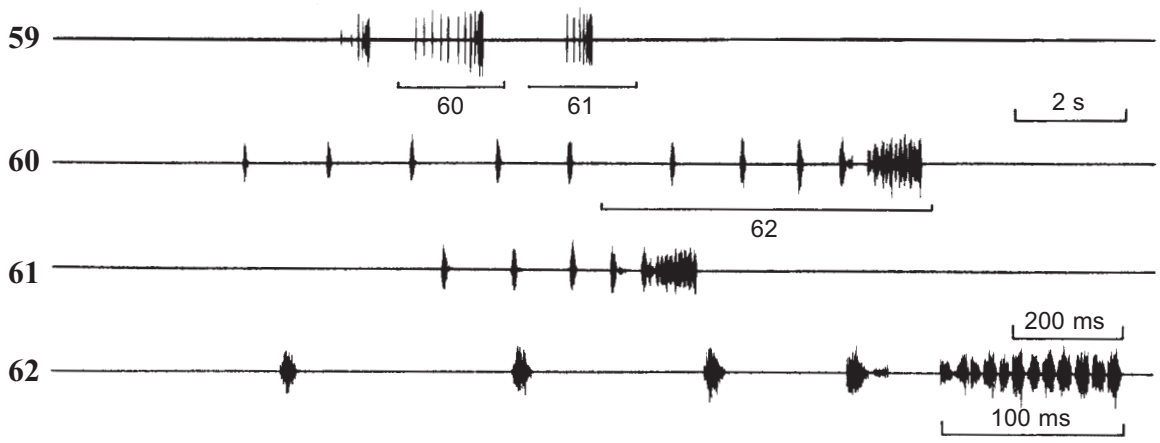
REFERENCES TO SONG. Unknown.

SONG (Figs. 59–62). The calling signal consists of two parts with different temporal pattern. The first part contains several short syllables of highly variable number and following with variable intervals. The second part is an echeme lasting about 0.8–1.2 s and consisting of 9–12 dense syllables.

6. *Arcyptera microptera* (Fischer-Waldheim, 1833)

DISTRIBUTION.

A. microptera microptera: Western Europe (now known very locally — in the northern half of Spain, the French Alps and Austria), Ukraine, south of European Russia, Northern Caucasus, northern Kazakhstan, western Siberia, north-western Mongolia.



Figs. 59–62. Oscillograms of the songs of *Arcyptera labiata* (Brullé). Faster oscillograms of the parts of songs indicated as "60–62" are given on the oscillograms under the same numbers.

Рис. 59–62. Осциллограммы сигналов *Arcyptera labiata* (Brullé). Фрагменты сигнала, помеченные как "60–62", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.

A. microptera turanica (Uvarov, 1927): mountains of southern Kazakhstan and Middle Asia.

A. microptera meridionalis (Ikonnikov, 1911): Tuva, eastern Siberia, Mongolia, northern China (Manchuria).

LOCALITIES (Fig. 47).

A. microptera microptera:

1. Crimea, Kerchenskiy Peninsula, E shore of Kazantipskiy Bay, environs of Zolotoe Village. 26.VI.1997. 1 ♂ recorded at 25–28°C (shade).

2. Ukraine, Lugansk Area, Luganskiy Nature Reserve, "Proval'skaya steppe". 20.VII.1995. 3 ♂♂ recorded at 33°C.

3. Eastern part of Saratov Area, 15 km north-east of the Ozinki Town. Steppe, places with gramineous vegetation. 22.VI.1996. 2 ♂♂ recorded at 28°C (shade).

A. microptera turanica: Kazakhstan, environs of Almaty, Zailiyskiy Alatau Mountain Ridge, Aksayskoe Ravine, slopes with steppe vegetation. 1–2.VII.1994. 2 ♂♂ recorded at 31–32°C.

A. microptera meridionalis:

1. Southern Tuva, environs of Erzin Village. 29.VII.1989. 2 ♂♂ recorded at 25°C.

2. Chita Area, Karymskiy District, Talacha River at the confluence with Ingoda River (15 km E of Urul'ga Village). 26.VI.1995. 2 ♂♂ recorded at 28–29°C (shade).

REFERENCES TO SONG.

A. microptera microptera: García et al., 1987 (cited after Ragge, Reynolds, 1998); García et al., 1996; Ragge, Reynolds, 1998.

A. microptera turanica: unknown.

A. microptera meridionalis: Bukhvalova, Zhantiev, 1994.

SONG (Figs. 63–90). Temporal pattern of the calling song is almost the same as in the previous species. In nominal subspecies, the syllables in the echeme are quite distinct in the oscillogram, as in *A. labiata* (Figs. 75–77), but in *A. m. turanica* and *A. m. meridionalis* the gaps between syllables sometimes are not distinguishable (Figs. 83–84, 89–90). Moreover, in *A. m. microptera*, a short sequence consisting of 3–4 echemes can precede the main part of the signal (Figs. 67–69, 73–74).

NOTES. Signals of *A. labiata* and of all subspecies of *A. microptera* studied are very similar in temporal structure and sometimes are almost indistinguishable (in *A. labiata* and *A. m. microptera* or in *A. m. turanica* and *A. m. meridionalis*). Besides, oscillograms of songs of *Arcyptera brevipennis* (Brunner-Wattenwyl, 1861) presented in García et al. [1996] are also nearly identical to our recordings of *A. labiata* and *A. microptera*. It is quite possible that these three forms are conspecific. On the other hand, they have some morphological differences; moreover, the certain forms are partly simpatric (*A. labiata* and *A. microptera nigriloba* Uvarov, 1942 — Willemse, 1984 and pers. comm.). For this reason, the establishing of synonymy of these forms without more close investigation of their morphology, ecology and distribution seems to be premature.

7. *Stenobothrus nigromaculatus* (Herrich-Schäffer, 1840)

DISTRIBUTION. From Western Europe to Caucasus, Transcaucasia, Kazakhstan, Kyrgyzstan and southern Siberia.

LOCALITIES (Fig. 47).

1. Ukraine, Nikolaev Area, Pervomaiskiy District, environs of Kuripchino Village. 28.VI.1997. 1 ♂ recorded at 29°C.

2. Ukraine, Poltava Area, Shishakskiy District, Boronivka Village. 14.VIII.1997. 1 ♂ recorded at 28°C.

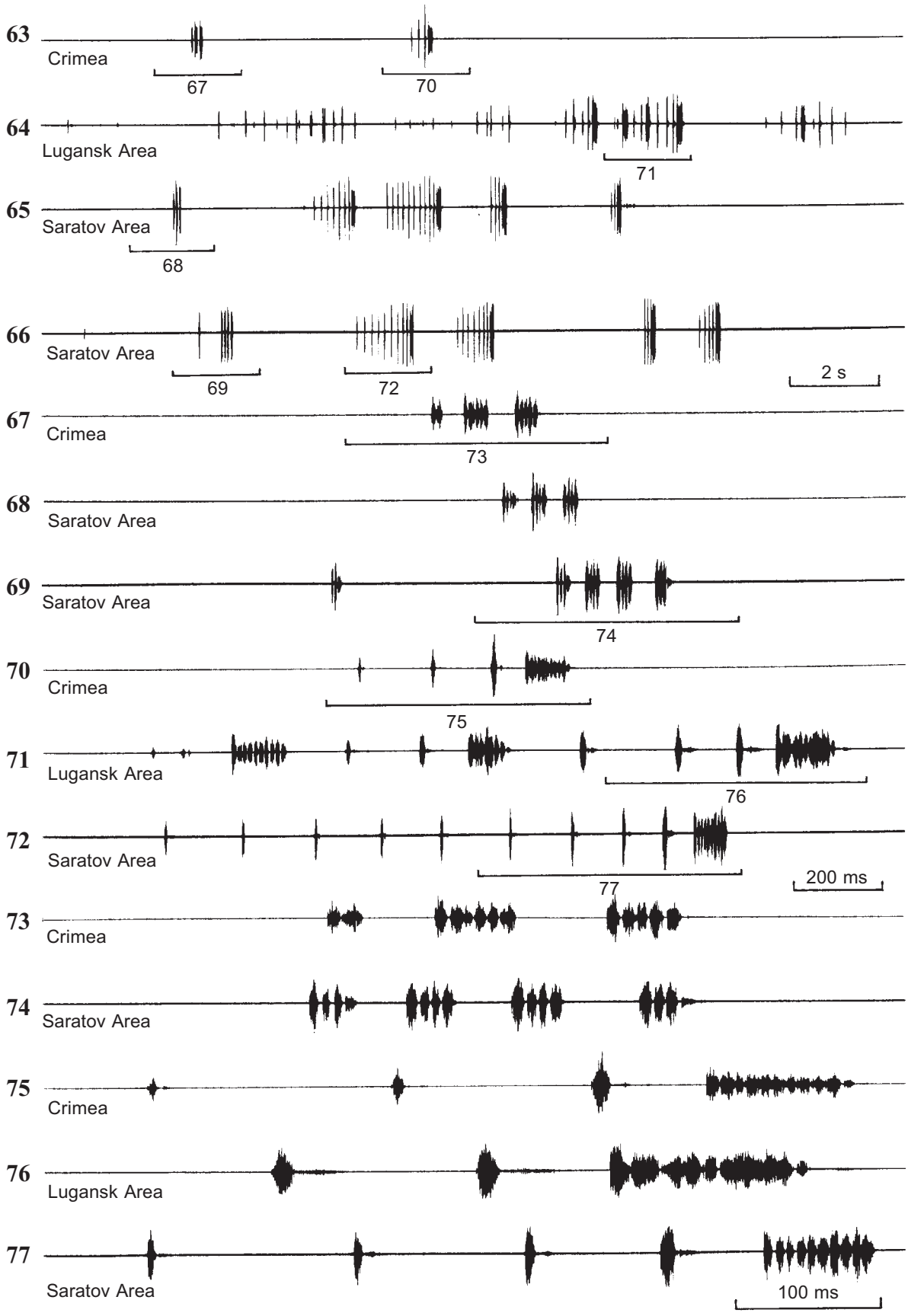
3. Ukraine, Dnepropetrovsk Area, Samarskiy Nature Reserve. 12.VI.1996. 1 ♂ recorded at 31°C.

4. Northern Caucasus, North Ossetia, environs of Zintsar Village 15 km S of Alagir Town, Sadono-Unal Kettle. 5.VIII.1990. 7 ♂♂ recorded at 25 and 32°C.

5. Rostov Area, Oblivskiy District, environs of Sosnovy (=Oporny) Village on Chir River. 11.VIII.1992. 1 ♂ recorded at 34°C.

Figs. 63–77. Oscillograms of the songs of *Arcyptera microptera microptera* (F.-W.). Faster oscillograms of the parts of songs indicated as "67–77" are given on the oscillograms under the same numbers.

Рис. 63–77. Осциллограммы сигналов *Arcyptera microptera microptera* (F.-W.). Фрагменты сигнала, помеченные как "67–77", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.


63
Crimea
67
70
64
Lugansk Area
71
65
Saratov Area
68
66
Saratov Area
69
72
2 s
67
Crimea
73
68
Saratov Area
69
Saratov Area
74
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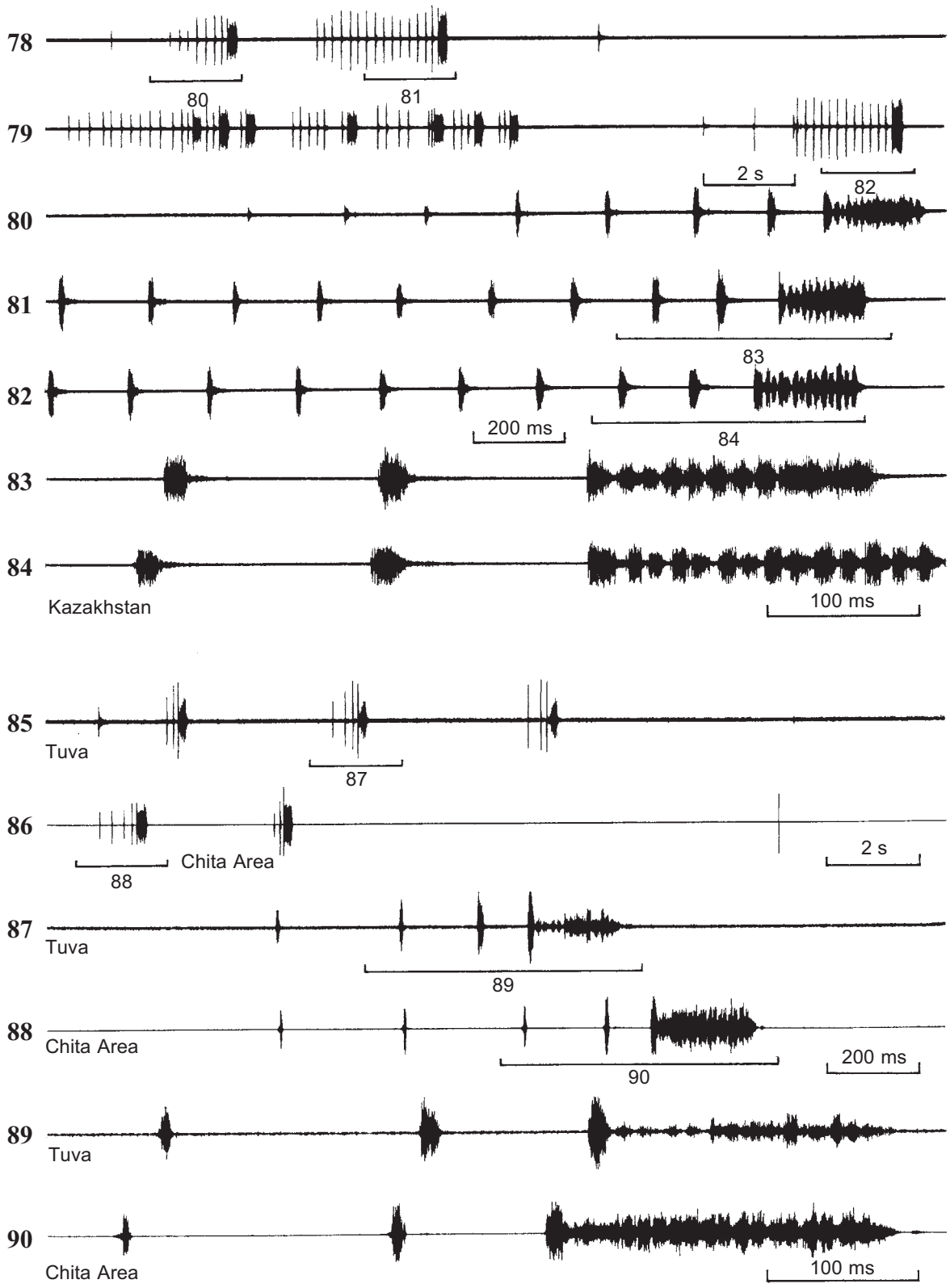
Crimea
75
71
Lugansk Area
76
72
Saratov Area
77
200 ms
73
Crimea
74
Saratov Area
75
Crimea
76
Lugansk Area
77
Saratov Area
100 ms



Figs. 78–90. Oscillograms of the songs of *A. microptera turanica* (Uv.) (78–84) and *A. microptera meridionalis* (Ikonn.) (85–90). Faster oscillograms of the parts of songs indicated as "80–84" and "87–90" are given on the oscillograms under the same numbers.

Рис. 78–90. Осциллограммы сигналов *A. microptera turanica* (Uv.) (78–84) и *A. microptera meridionalis* (Ikonn.) (85–90). Фрагменты сигнала, помеченные как "80–84" и "87–90", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.

6. Orenburg Area, 25 km W of Orsk, bank of Guberlya River in the environs of Guberlya Railway Station. Steppe hills. 9.VII.1996. 1 ♂ recorded at 30-34°C in the field.

REFERENCES TO SONG. Schmidt, Schach, 1978; Ragge, 1987; Bukhvalova, Zhantiev, 1994; Ragge, Reynolds, 1998.

SONG (Figs. 91–106). The song is a series of echemes repeated with intervals about 1.5–3 s. The echeme lasts about 1 s, reaching maximum intensity towards its end. The echeme consists of syllables following at a rate about 60–100/s. Oscillographic analysis shows that the syllable sometimes consists of low- and high-amplitude pulses.

The signals of individuals from different localities are quite similar and do not differ from those of West-European specimens.

8. *Stauroderus scalaris* (Fischer-Waldheim, 1846)

DISTRIBUTION. From Western Europe to Siberia and Mongolia through Caucasus, Kazakhstan and Middle Asia. In the mountains.

LOCALITIES (Fig. 107).

1. Central Greece, Ipiros, between Ioannina and Dodoni (not shown on the map). 9.VI.1998, collected as larvae. 1 ♂ recorded at 31°C.

2. Northern Caucasus, North Ossetia, Ardon River basin, Tsey Canyon, subalpine meadows on the slopes of Tseyskiy Mountain Ridge, altitude above sea level approximately 1800 m. 26–28.VII.1990. 5 ♂♂ recorded at 28–29°C.

3. Kazakhstan, Zailiyskiy Alatau Mountain Ridge, Almatinskiy Nature Reserve. 23.VI.1986. 1 ♂ recorded at 28°C.

4. Kazakhstan, Zailiyskiy Alatau Mountain Ridge, the Big Almaty ravine, 29.VI.1994. 3 ♂♂ recorded at 30°C.

5. Altai Mountains, northern shore of Teletskoe Lake, environs of Yaylyu Village. 8.VII.1999. Signals of 1 ♂ recorded at 29°C.

REFERENCES TO SONG. Elsner, Popov, 1978; Bukhvalova, Zhantiev, 1994; Ragge, Reynolds, 1998.

SONG (Figs. 108–121). The calling song is an echeme-sequence lasting about 10–30 s. The echemes are repeated at a rate of about 1–2/s, each lasting about 0.6–0.8 s. Each echeme consists of two parts: about 7–10 short syllables are followed by 8–14 longer ones.

NOTES. The signals of the males from different localities are similar to each other. However, a ratio of amplitudes of two echeme parts in the signals of males from the North Ossetia (Figs. 108, 110, 115, 119) is inverse in comparison to those in the songs recorded from other localities.

9. *Megaulacobothrus aetalinus* (Zubowski, 1899)

DISTRIBUTION.

M. aetalinus aetalinus (Zubowski, 1899): all Southern Siberia, Russian Far East with the exception of the southern part of Maritime Province; northern China (Manchuria).

M. aetalinus kongausensis Caudell, 1927: southern part of Maritime Province (Russian Far East).

LOCALITIES (Fig. 132).

M. aetalinus aetalinus: Altai Mountains, southern end of Teletskoe Lake, Chulyshman River valley about 0.5 km south of Balykcha Village. 17.VII.1999. 4 ♂♂ recorded at 34–38°C.

M. aetalinus kongausensis: Southern Maritime Province, Pogranichniy District, environs of Barabash-Levada Village. 16.VII.1995. 2 ♂♂ recorded at 24–25°C.

REFERENCES TO SONG.

M. aetalinus aetalinus: unknown.

M. aetalinus kongausensis: Bukhvalova, Vedenina, 1999.

SONG (Figs. 122–131, 133 –167). Males of the nominal subspecies spontaneously produce the songs of two types. The signal of the first type is a series of about 6–12 echemes, separated by intervals of 2–6 s in average (Figs. 158–167). Usually, each echeme begins with a sequence of about 9–30 relatively low-amplitude syllables (occasionally this part can be somewhat reduced); then a sequence of the higher-amplitude syllables follows. The higher-amplitude syllables usually consist of one short pulse and several more prolonged ones, but sometimes their temporal structure is irregular.

The song of the second type (Figs. 122–131, 133–157) has a duration of about one minute and may be divided into three parts differing from each other in temporal structure. It starts with a sequence of syllables similar to the first part of the echeme described above, but lasting more than 10 s (Figs. 133–134, 146). Syllables gradually become louder and the gaps between them become more indistinct towards the end of the sequence (Fig. 134). Thus, the first part of the signal changes into the second one which consists of hardly distinguishable syllables, merging with each other, and sounds like a prolonged buzzing noise, reaching maximum intensity towards the end (Figs. 135–136, 147–148). Then this part abruptly terminates and the third (end) one, consisting of the short high-amplitude pulses that alternate with the groups of 6-8 low-amplitude ones, follows (Figs. 137, 149).

Male usually produces the song of the first type (short echemes). Then the first part of the short echeme suddenly lengthens and the song of the first type changes into the song of the second type. The songs of both types were produced by the individuals, sitting alone and not apparently involving in courtship or rivalry behaviour. Therefore, the function of these two signals remains obscure. Under natural conditions, the song of the first type can be heard more often.

In *M. aetalinus kongausensis,* the song of the second type was only heard and recorded (Figs. 122, 124–125, 128–131, 138–145, 150–157). Moreover, it slightly differs from that in the nominal subspecies. In the very beginning, the gaps between syllables are obscured, thus the difference between the first and the second parts of the song is not so evident as in the nominal subspecies (Figs. 138, 142). The third song part is rather quiet, whereas in the nominal subspecies, it is of almost the same intensity as the second song part (Figs. 122, 124–125 and 123). It must be noted that difference in pulse and syllable repetition rate and other quantitative parameters between signals of two subspecies results from considerable difference in the temperatures during recording.

10. *Chorthippus macrocerus* (Fischer-Waldheim, 1846)

DISTRIBUTION.

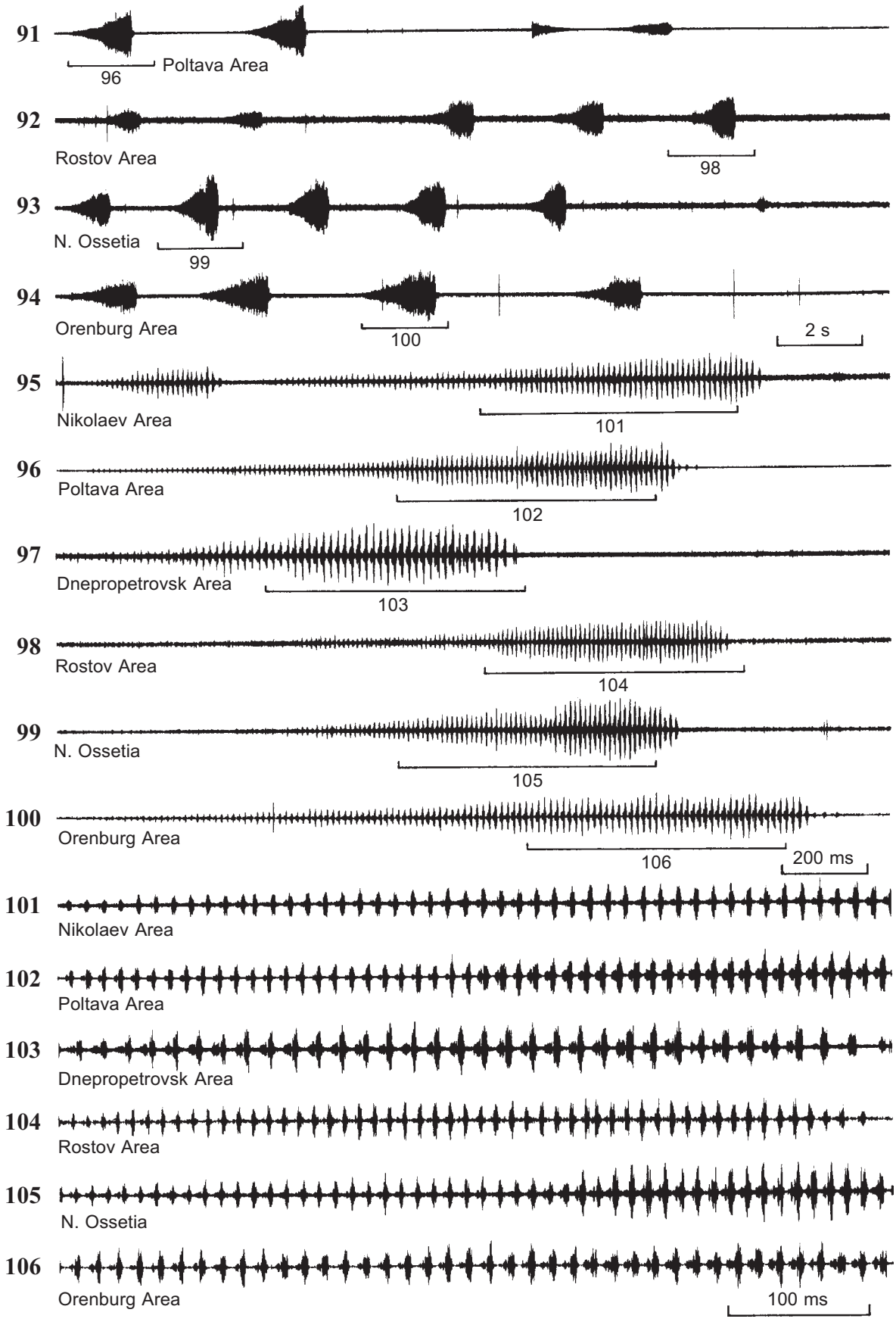
Ch. macrocerus purpuratus (Vorontsovsky, 1928): Ukraine, southern half of European Russia, Caucasus, northern and western Kazakhstan, southern part of Middle Asia, also, northern regions of Turkey, Iran and Afghanistan, [Bey-Bienko, Mistshenko, 1951, Kritskaya, 1972].

Ch. macrocerus ponticus Mistshenko, 1951: Krasnodar Area, Black Sea shore: environs of Gelendzhik and Tuapse, type locality — environs of Nebug Village near Tuapse.

LOCALITIES (Fig. 132).

Ch. macrocerus purpuratus:

1. Moldova, about 5 km north of Dubossary Town, forest glades. 4.VIII.1997. 3 ♂♂ recorded at 40°C.


91
96
Poltava Area
92
Rostov Area
98
93
N. Ossetia
99
94
Orenburg Area
100
2 s
95
Nikolaev Area
101
96
Poltava Area
102
97
Dnepropetrovsk Area
103
98
Rostov Area
104
99
N. Ossetia
105
100
Orenburg Area
106
200 ms
101
Nikolaev Area
102
Poltava Area
103
Dnepropetrovsk Area
104
Rostov Area
105
N. Ossetia
106
Orenburg Area
100 ms

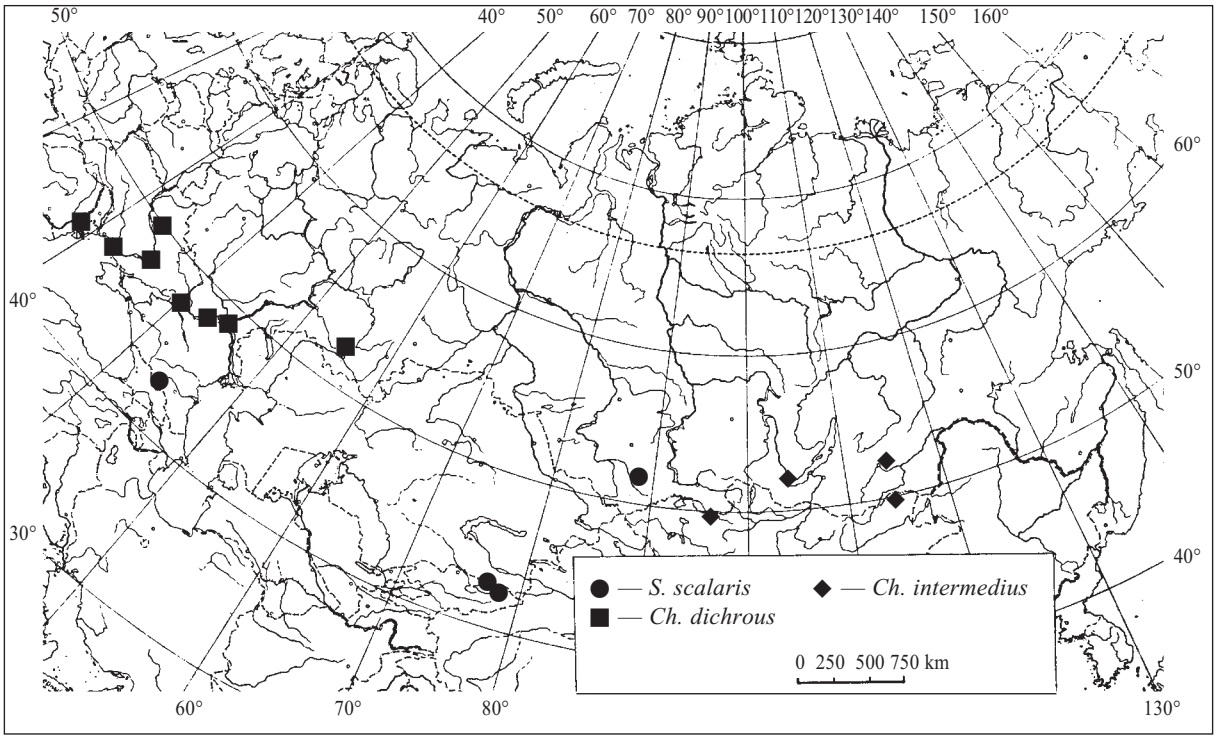


Fig. 107. Map of localities of *Stauroderus scalaris* (F.-W.), *Chorthippus intermedius* (B.-Bien.) and *Ch. dichrous* (Ev.). Locality No.1 of *S. scalaris* (Greece) not shown on the map.

Рис. 107. Места сбора *Stauroderus scalaris* (F.-W.), *Chorthippus intermedius* (B.-Bien.) и *Ch. dichrous* (Ev.). Для *S. scalaris* местонахождение № 1 (Греция) на карте не показано.

2. Ukraine, Kherson Area, Chernomorskiy Nature Reserve. 29.VII.1995. 1 ♂ recorded at 32°C in the field.

3. Ukraine, Poltava Area, Mirgorodskiy District, Velikie Sorochintsy Village. 21.VII–20.VIII.1993, 4.VIII.1994. 4 ♂♂ recorded at 28–31°C.

4. Ukraine, Kharkov Area, about 10 km north of Shevchenkovo Town, environs of Petrovka Village. 5.VII.1996. 1 ♂ recorded at 35°C.

5. Ukraine, Lugansk Area, Luganskiy Nature Reserve, "Proval'skaya steppe". 21.VII.1995. 2 ♂♂ recorded at 31°C.

6. Kursk Area, Tsentral'no-Chernozemnyi Nature Reserve, Streletskaya Steppe. Oak forest glades. 10.VIII.1985. 5 ♂♂ recorded at 26–28°C.

7. Rostov Area, Oblivskiy District, environs of Sosnovy (=Oporny) Village on the Chir River. 14–18.VIII.1992. 6 ♂♂ recorded at 29°C.

8. Volgograd. 11.VIII.1992. 4 ♂♂ recorded at 28°C.

9. Northern Caucasus, North Ossetia, environs of Zintsar Village 15 km S of Alagir Town, Sadono-Unal Kettle. 5.VIII.1990. 1 ♂ recorded at 25°C.

10. Northern Caucasus, North Ossetia, Ardon River basin, Tsey Canyon, subalpine meadows on the slopes of Tseyskiy Mountain Ridge, altitude above sea level approximately 1800 m. 26–29.VII.1990. 9 ♂♂ recorded at 26–30°C.

Ch. macrocerus ponticus: Krasnodar Province, Gelendzhik District, environs of Praskoveevka Village 5 km S of Dzhankhot Town. Mowed meadow near the river. 11.VII.1997. 3 ♂♂ recorded in the field at 29°C (shade). The place is situated about 70 km NW of type locality.

REFERENCES TO SONG.

Ch. macrocerus purpuratus: Vedenina, Zhantiev 1990; Bukhvalova, Zhantiev, 1994.

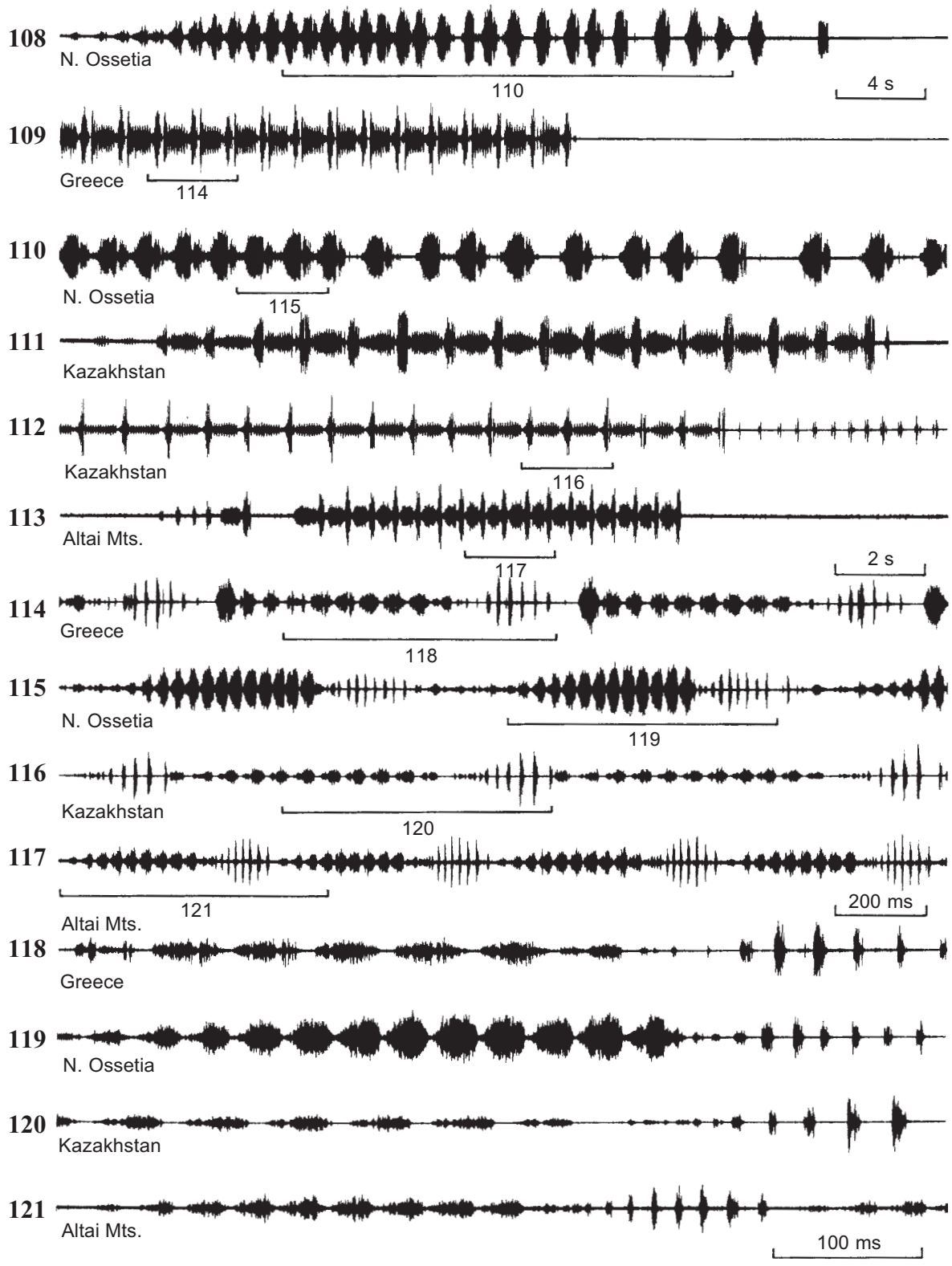
Ch. macrocerus ponticus: unknown.

SONG (Figs. 168–204). The calling signal is an echeme of syllables repeated at a rate of about 4–6/s; sometimes this rate becomes slightly higher towards the end of the echeme. The echeme duration is very variable — about 3.5–15 s, sometimes longer, and the number of the syllables varies in the range of about 20–50. The echeme usually begins quietly, reaching maximum intensity very fast. Oscillographic analysis shows that a high-amplitude part of the syllable consists of the distinct pulses separated by gaps. However, sometimes the gaps disappeared towards the end of the song and the pulses become indistinguishable in the last syllables (Figs. 179–180, 184–185, 188–190, 199, 201–202).

NOTES. The songs of the specimens attributed to different subspecies of *Ch. macrocerus* have no significant difference. Duration of the echeme varies greatly, however, it varies in different specimens referred to the same subspecies. The recorded males collected in different localities have no significant morphological difference. For this reason we refer our specimens to these two subspecies only on the base of geographical points where they were collected.

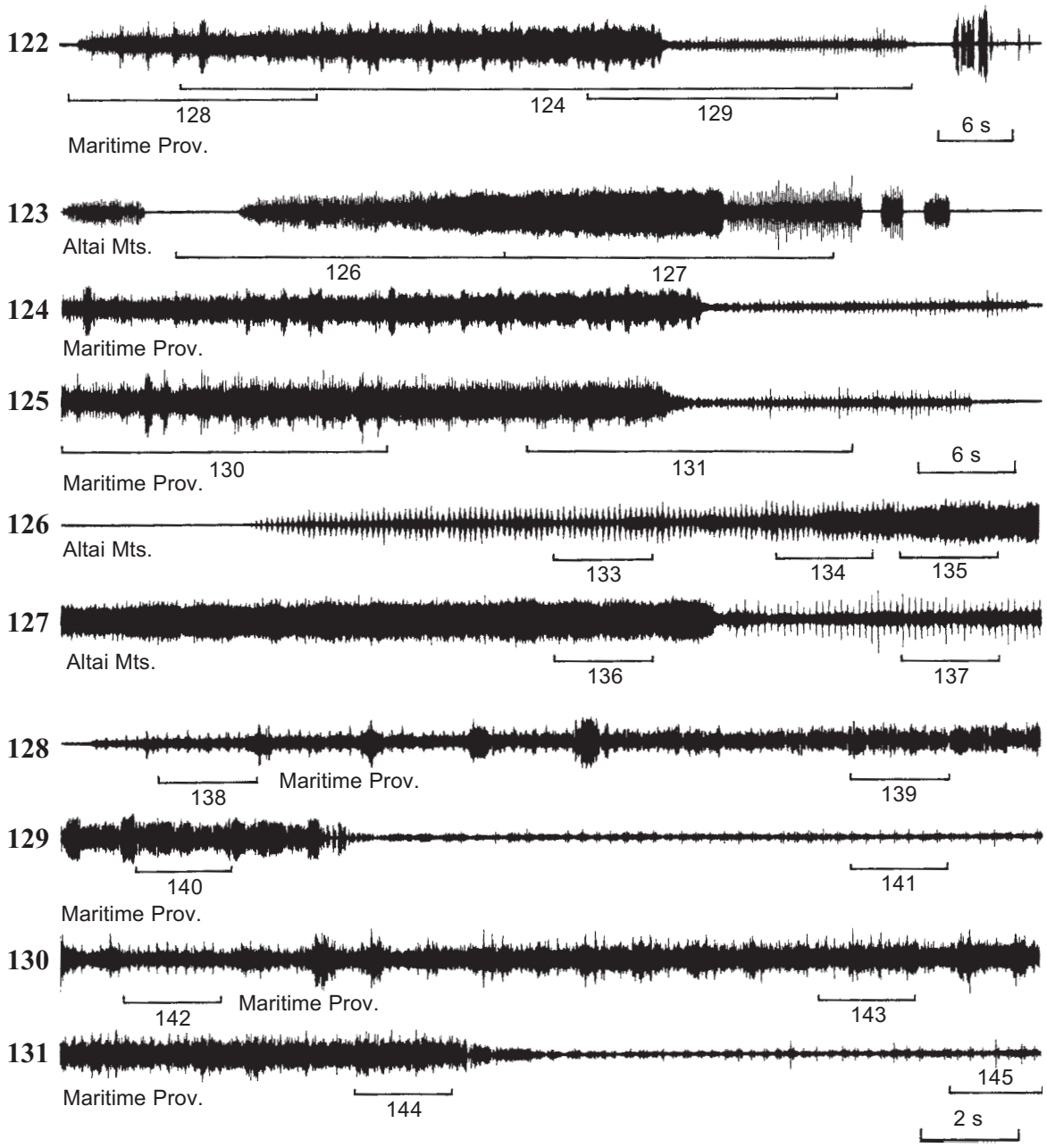
Figs. 91–106. Oscillograms of the songs of *Stenobothrus nigromaculatus* (H.-S.). Faster oscillograms of the parts of songs indicated as "96" and "98–106" are given on the oscillograms under the same numbers.

Рис. 91–106. Осциллограммы сигналов *Stenobothrus nigromaculatus* (H.-S.). Фрагменты сигнала, помеченные как "96" и "98–106", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.



Figs. 108–121. Oscillograms of the songs of *Stauroderus scalaris* (F.-W.). Faster oscillograms of the parts of songs indicated as "110" and "114–121" are given on the oscillograms under the same numbers.

Рис. 108–121. Осциллограммы сигналов *Stauroderus scalaris* (F.-W.). Фрагменты сигнала, помеченные как "110" и "114–121", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.



Figs. 122–131. Oscillograms of the second type songs of *Megaulacobothrus aetalinus aetalinus* (Zub.) (123 and 126–127) and *M. aetalinus kongausensis* Caudell (122, 124–125 and 128–131). Faster oscillograms of the parts of songs indicated as "124" and "126–131, 133–145" are given on the oscillograms under the same numbers.

Рис.. 122–131. Осциллограммы сигналов второго типа *Megaulacobothrus aetalinus aetalinus* (Zub.) (123 и 126–127) и *M. aetalinus kongausensis* Caudell (122, 124–125 и 128–131). Фрагменты сигнала, помеченные как as "124" и "126–131, 133–145", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.

11. *Ch. intermedius* (Bey-Bienko, 1926)

DISTRIBUTION. Almost all Siberia from Tomsk Area and Altai Mountains to Maritime Province and Sakhalin, China; southwards as far as Tibet.

LOCALITIES (Fig. 107).

1. Southern Tuva, environs of Erzin Village, damp meadow near Tes-Khem River. 6.VIII.1989. 1 ♂ recorded at 26°C.

2. Irkutsk Area, in the vicinity of Lake Baikal, the environs of Listvyanka. 26.VIII.1988. 1 ♂ recorded at 28°C.

3. Chita Area, Ononskiy District, near the Onon River 5 km west of Nizhniy Tsasuchey Village, meadow on the bank of the former river-bed. 17.VI.1995. 1 ♂ recorded at 32°C (shade).

4. Chita Area, Karymskiy District, Talacha River at the confluence with Ingoda River (15 km E of the Urul'ga Village). 27.VI.1995. 3 ♂♂ recorded in the field at 27°C (shade).

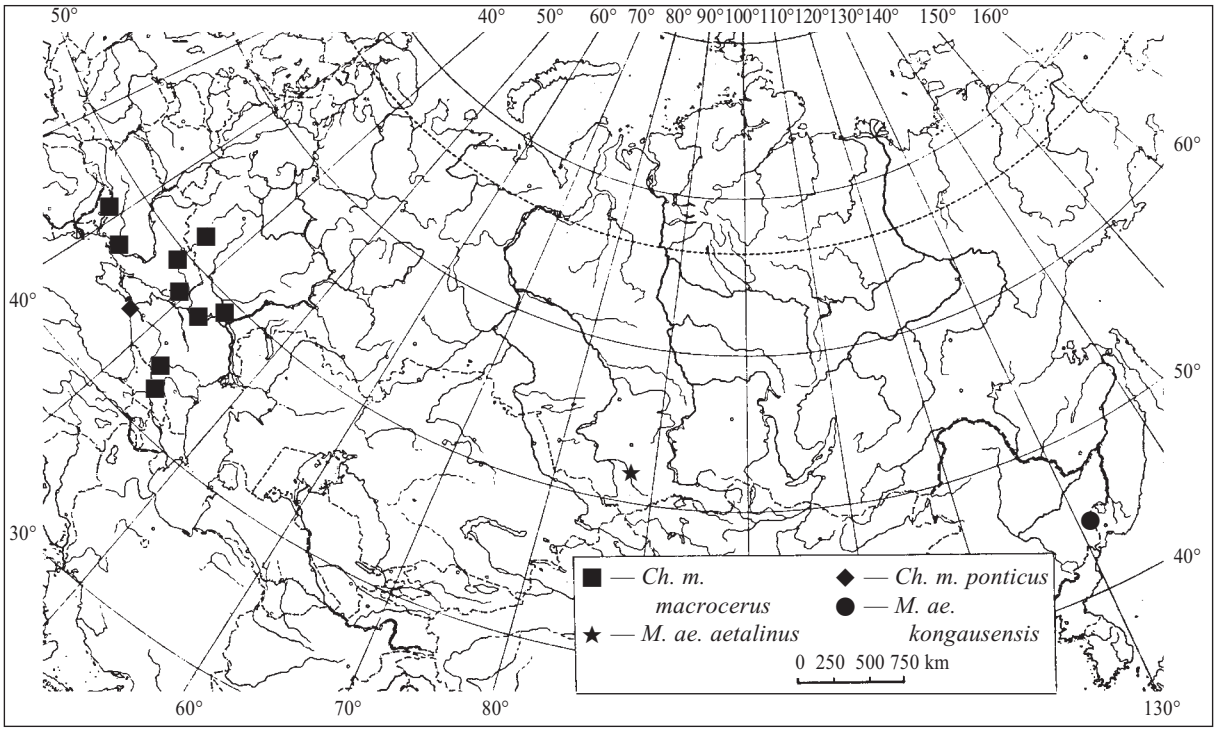


Fig. 132. Map of localities of *Megaulacobothrus aetalinus aetalinus* (Zub.), *M. aetalinus kongausensis* Caudell, *Chorthippus macrocerus purpuratus* (Vor.) and *Ch. macrocerus ponticus* Mistsh.

Рис. 132. Места сбора *Megaulacobothrus aetalinus aetalinus* (Zub.), *M. aetalinus kongausensis* Caudell, *Chorthippus macrocerus purpuratus* (Vor.) и *Ch. macrocerus ponticus* Mistsh.

REFERENCES TO SONG. Bukhvalova, Zhantiev, 1994.

SONG (Figs. 205–224). The calling song consists of a sequence of regularly repeated echemes, each lasting about 1–2 s. Each echeme is divided into two parts. Oscillographic analysis shows that the first part contains about 30–40 pulses separated by gaps; sometimes the high-amplitude pulses alternate with the low-amplitude ones. The second part contains 8–10 syllables which are not clearly distinguishable and audible as hissing sound. Sometimes the male does not produce the second part (Figs. 205–206, 209). Usually it produces either full or reduced signals, but the signals of both types may be rarely present in the same song (Figs. 207, 213, 217).

NOTES. In our previous publication [Bukhvalova, Zhantiev, 1994] the reduced form of the signal was only described.

12. *Ch. dichrous* (Eversmann, 1859)

DISTRIBUTION. South-east of Western Europe, Ukraine, southern regions of European Russia, Transcaucasia, Asia Minor, Iran, southern Kazakhstan, Middle Asia, steppe regions of western Siberia and Altai Mountains, Mongolia.

LOCALITIES (Fig. 107).

1. Ukraine, Odessa Area, Kiliiskiy District, environs of Vilkovo Town. 1.VII.1997. 1 ♂ recorded at 40°C.

2. Ukraine, Kherson Area, Chernomorskiy Nature Reserve. 29.VII.1995. 3 ♂♂ recorded at 34°C.

3. Ukraine, Poltava Area, Mirgorodskiy District, environs of Velikie Sorochintsy Village. The glades along the Psyol River. 17.VIII.1994. 3 ♂♂ recorded at 27, 31°C.

4. Ukraine, Dnepropetrovsk Area, Samarskiy Nature Reserve. 16.VII.1996.1 ♂ recorded at 33°C.

5. Ukraine, Lugansk Area, Luganskiy Nature Reserve, "Proval'skaya steppe". 21.VII.1995. 1 ♂ recorded at 30°C.

6. Rostov Area, Oblivskiy District, environs of Sosnovy (=Oporny) Village on Chir River. 12.VIII.1991, 5 ♂♂ recorded at 26°C. 11.VIII.1992, 2 ♂♂ recorded at 34°C.

7. Volgograd. 11.VIII.1992. 1 ♂ recorded at 29°C.

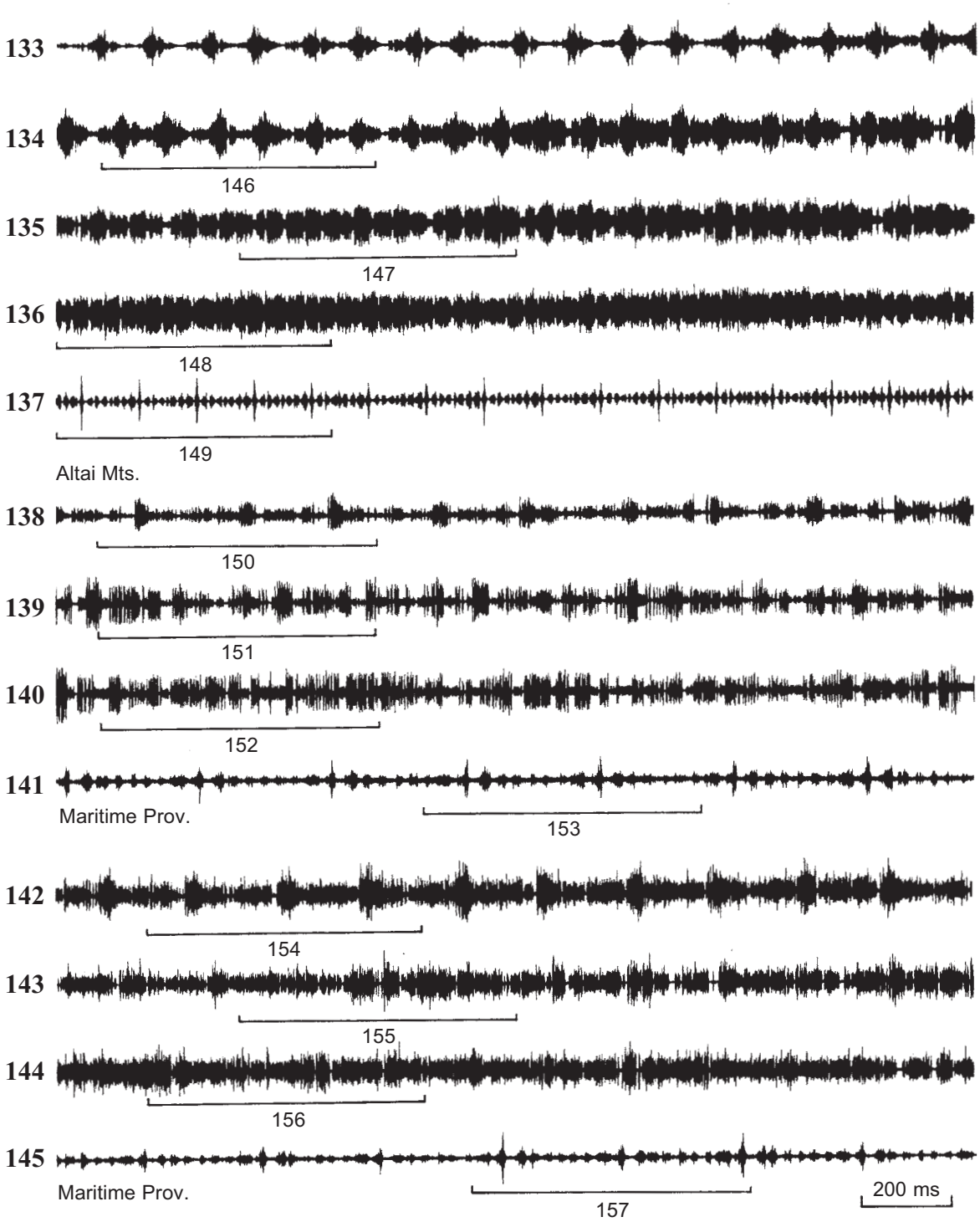
8. Environs of Orenburg, the bank of Kargalka River near Pokrovka Village. 26.VII.1999. Signals of 1 ♂ recorded at 30–32°C in the field.

REFERENCES TO SONG. Komarova, Dubrovin, 1973; Schmidt, Schach, 1978; Bukhvalova, Zhantiev, 1994; Stumpner, Helversen, 1994; Ragge, Reynolds, 1998.

SONG (Figs. 225–247). The calling song is a short echeme lasting about 0.4–0.8 s. Oscillographic analysis shows that the echeme begins with the short pulses which can be grouped sometimes into 1–3 syllables; then the syllables without visible pulses follow (Figs. 233–239). Stumpner and Helversen [1994] showed that the short pulses at the beginning of the echeme are produced as a result of synchronous movement of the hind legs, whereas the main part of the echeme that is audible as hissing sound is produced during asynchronously movement of the hind legs. Male usually produces several echemes one after another, then stops singing and moves to another place.

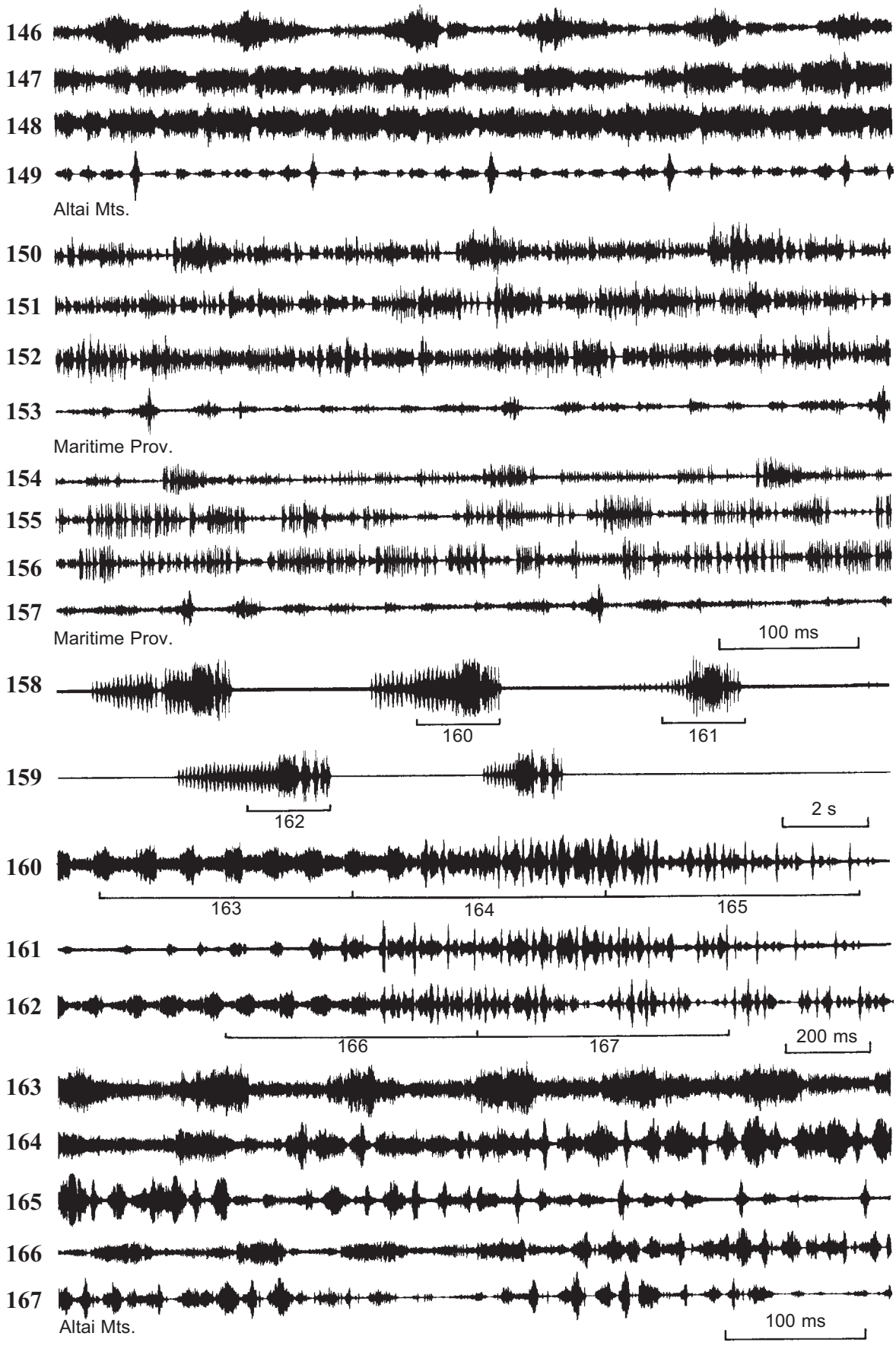
13. *Ch. albomarginatus* (De Geer, 1773)

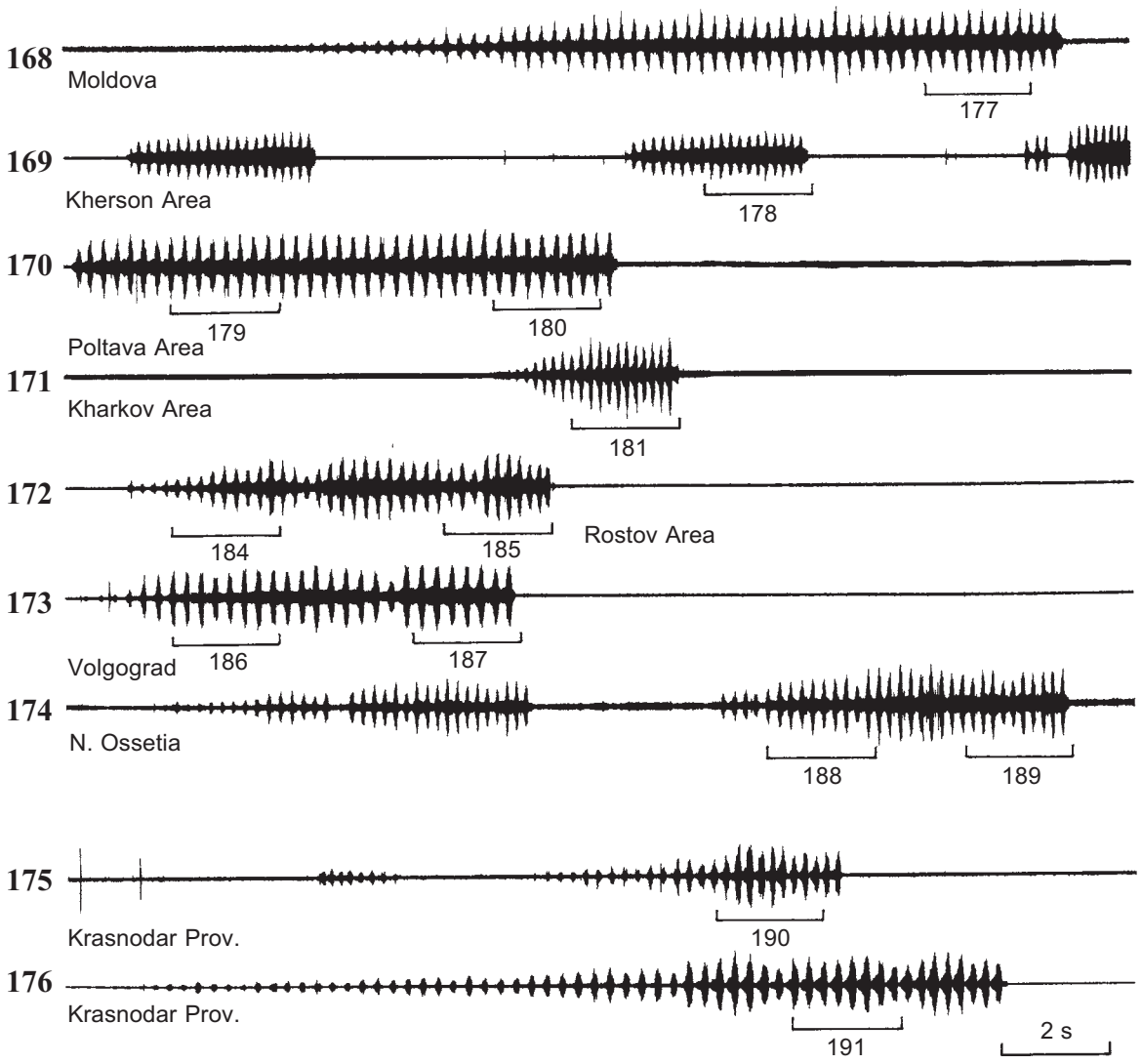
DISTRIBUTION. Western Europe, European part of the former Soviet Union except of the northern parts, Transcauca-



Figs. 133–145. Oscillograms of parts of the second type songs of *Megaulacobothrus aetalinus aetalinus* (Zub.) (133–137) and *M. aetalinus kongausensis* Caudell (138–145). Parts of three different signals are given (133–137, 138–141 and 142–145 respectively). Faster oscillograms of the parts of songs indicated as "146–157" are given on the oscillograms under the same numbers.

Рис. 133–145. Осциллограммы фрагментов сигналов второго типа *Megaulacobothrus aetalinus aetalinus* (Zub.) (133–137) и *M. aetalinus kongausensis* Caudell (138–145). Приведены фрагменты трех разных сигналов (133–137, 138–141 и 142–145 соответственно). Фрагменты сигнала, помеченные как "146–157", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.


146
147
148
149
Altai Mts.
150
151
152
153
Maritime Prov.
154
155
156
157
Maritime Prov.
100 ms
158
160
161
159
162
2 s
160
163
164
165
161
162
166
167
200 ms
163
164
165
166
167
Altai Mts.
100 ms



Figs. 168–176. Oscillograms of the songs of *Chorthippus macrocerus* (F.-W.). Faster oscillograms of the parts of songs indicated as "177–178", "180–182" and "185–192" are given on the oscillograms under the same numbers.

Рис. 168–176. Осциллограммы сигналов *Chorthippus macrocerus* (F.-W.). Фрагменты сигнала, помеченные как "177–178", "180–182" и "185–192", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.

sia, Asia Minor, Kazakhstan, Middle Asia, Iran, Afghanistan, western Siberia, Yakutia.

LOCALITIES (Fig. 248).

1. Border of Moldova and Vinnitsa Area of Ukraine, about 5 km W from Mogilev-Podol'skiy Town. 17.VII.1997. 1 ♂ recorded at 31°C.

2. Ukraine, Odessa Area, meadows along the Dnestrovskyi estuary, environs of Semjonovka and Krasnaja Kosa Villages. 29.VI.1997, 2.VII.1999. 6 ♂♂ recorded at 30-34°C.

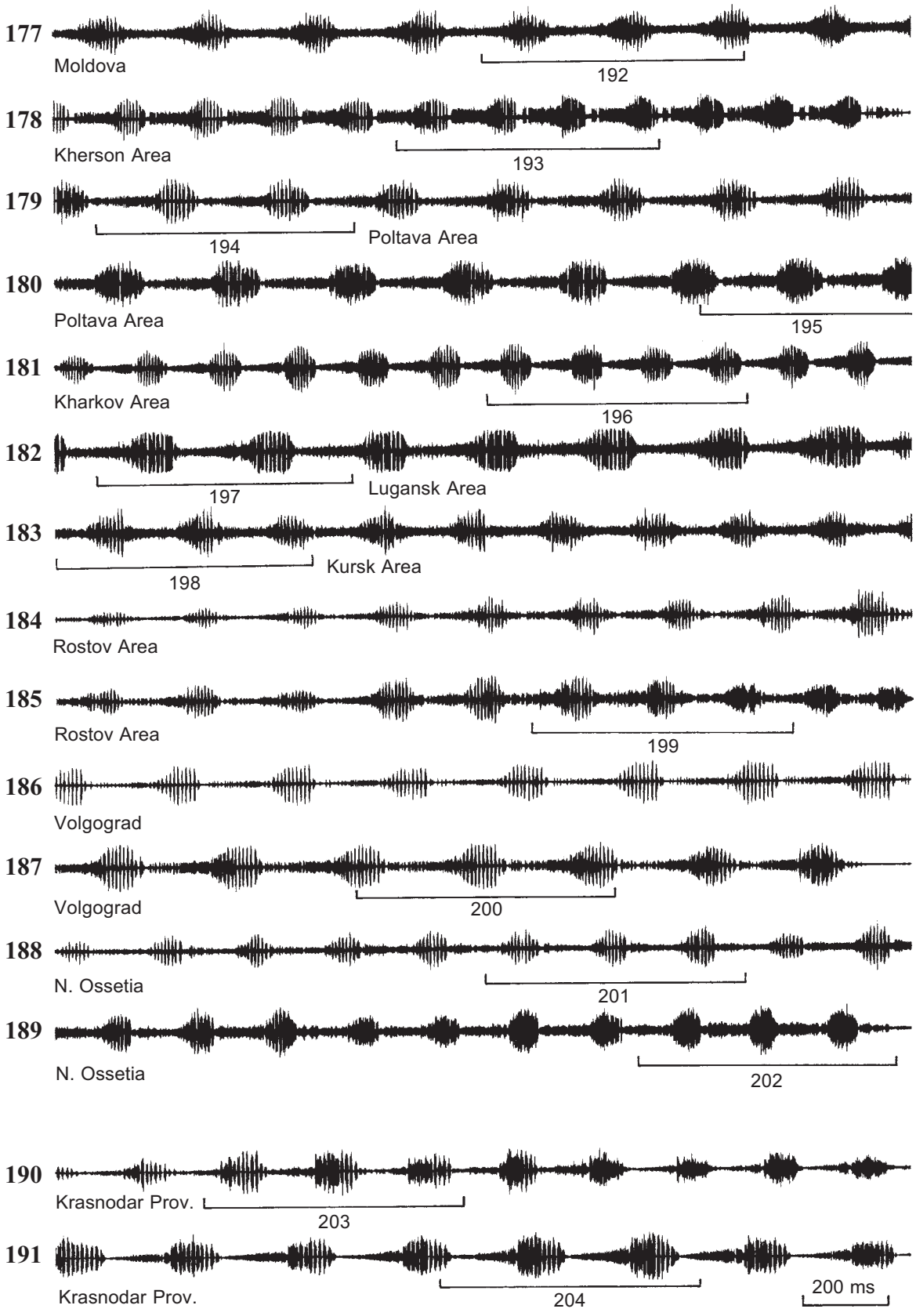
3. Ukraine, Cherkassy Area, Kanevskiy Nature Reserve. 19.VI.1996. 1 ♂ recorded at 24°C.

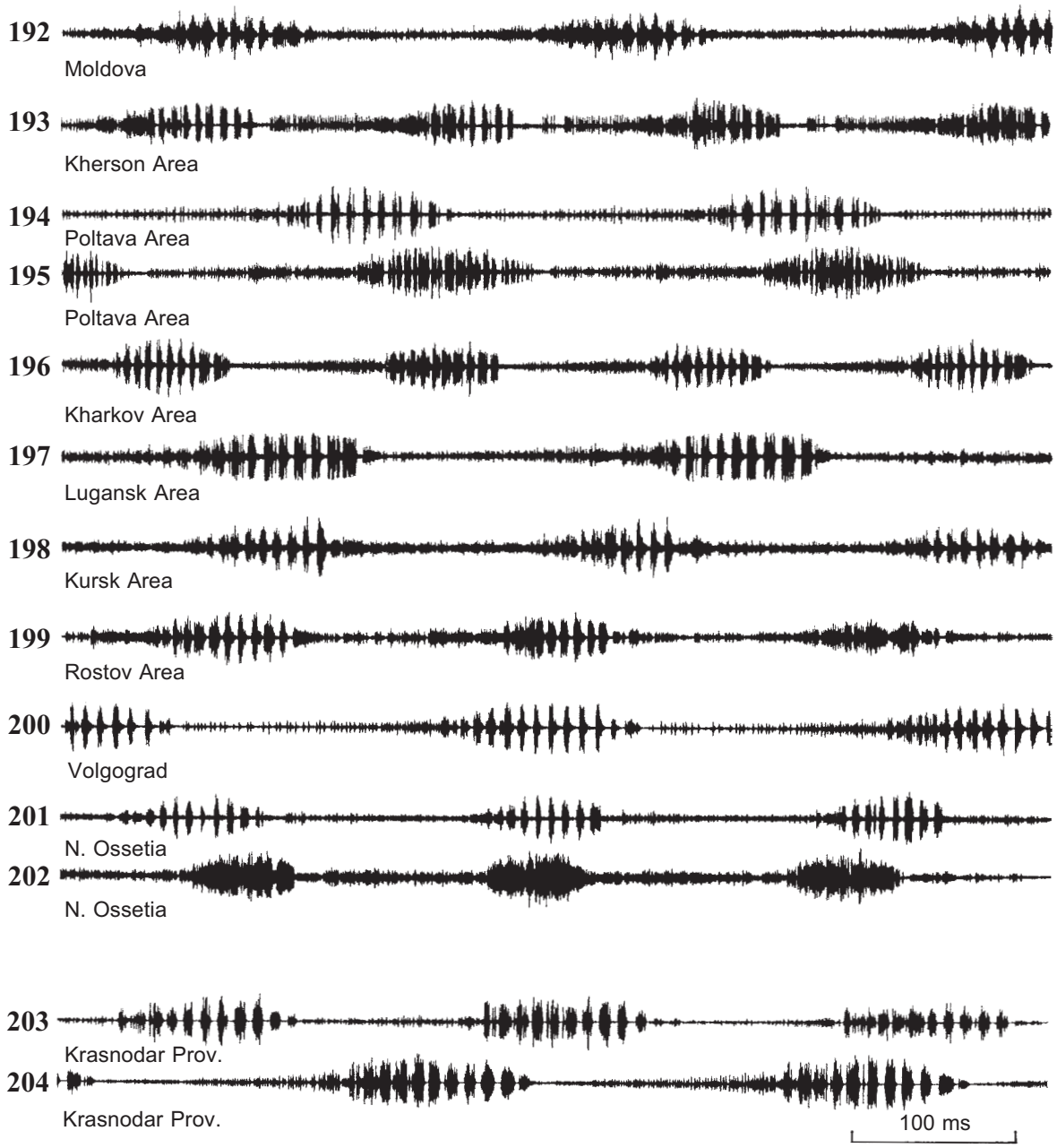
4. Ukraine, Poltava Area, Mirgorodskiy District, environs of Velikie Sorochintsy Village. 21.VII–23.VIII.1993, 20-29.VII.1994. 9 ♂♂ recorded at 24–31°C. Signal recorded at 28°C is presented on oscillogram (Figs. 251, 258, 268).

5. Eastern part of Saratov Area, 15 km NE of Ozinki Town. Steppe places with gramineous vegetation near the pool. 22.VI.1996. 1 ♂ recorded at 28°C (shade).

Figs. 146–167. Oscillograms of the songs of *Megaulacobothrus aetalinus aetalinus* (Zub.) (146–149 and 158–167) and *M. aetalinus kongausensis* Caudell (150–157). 146–157 — parts of the second type song, 158–167 — first type song. Faster oscillograms of the parts of songs indicated as "160–167" are given on the oscillograms under the same numbers.

Рис. 146–167. Осциллограммы сигналов *Megaulacobothrus aetalinus aetalinus* (Zub.) (146–149 и 158–167) и *M. aetalinus kongausensis* Caudell (150–157). 146–157 — фрагменты сигналов второго типа, 158–167 — сигналы первого типа. Фрагменты сигнала, помеченные как "160–167", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.


177
Moldova
192
178
Kherson Area
193
179
194
Poltava Area
180
Poltava Area
195
181
Kharkov Area
196
182
197
Lugansk Area
183
198
Kursk Area
184
Rostov Area
185
Rostov Area
199
186
Volgograd
187
Volgograd
200
188
N. Ossetia
201
189
N. Ossetia
202
190
Krasnodar Prov.
203
191
Krasnodar Prov.
204
200 ms



Figs. 192–204. Oscillograms of the parts of songs of *Chorthippus macrocerus* (F.-W.).
Рис. 192–204. Осциллограммы фрагментов сигналов *Chorthippus macrocerus* (F.-W.).

6. Altai Mountains, northern end of Teletskoe Lake, environs of Yaylyu Village. 5.VII.1999. Signals of 1 ♂ recorded at 30–32°C.

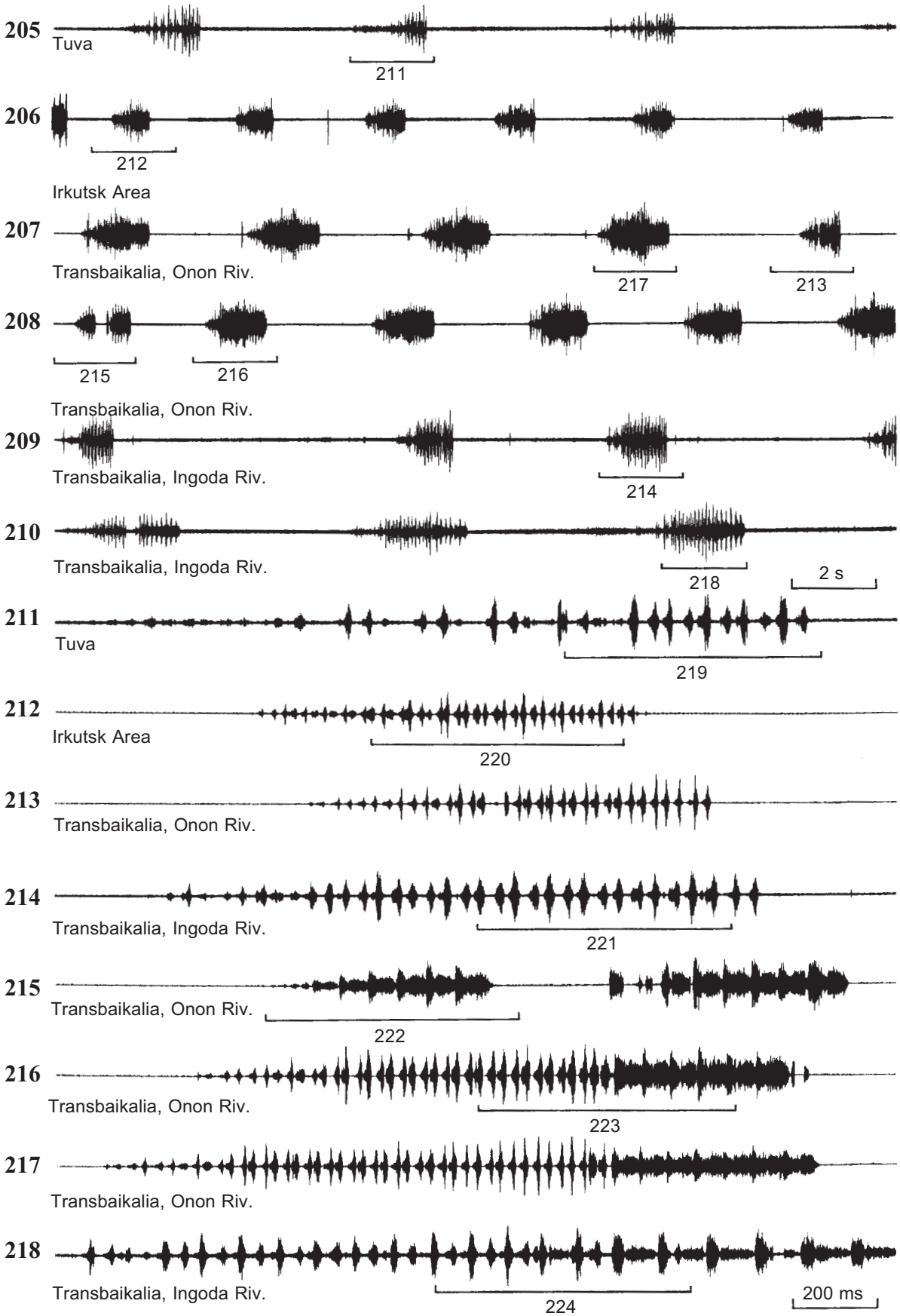
7. Southern Tuva, environs of Erzin Village, boggy places near Tes-Khem River. 30.VII.1989. 7 ♂♂ recorded at 30°C.

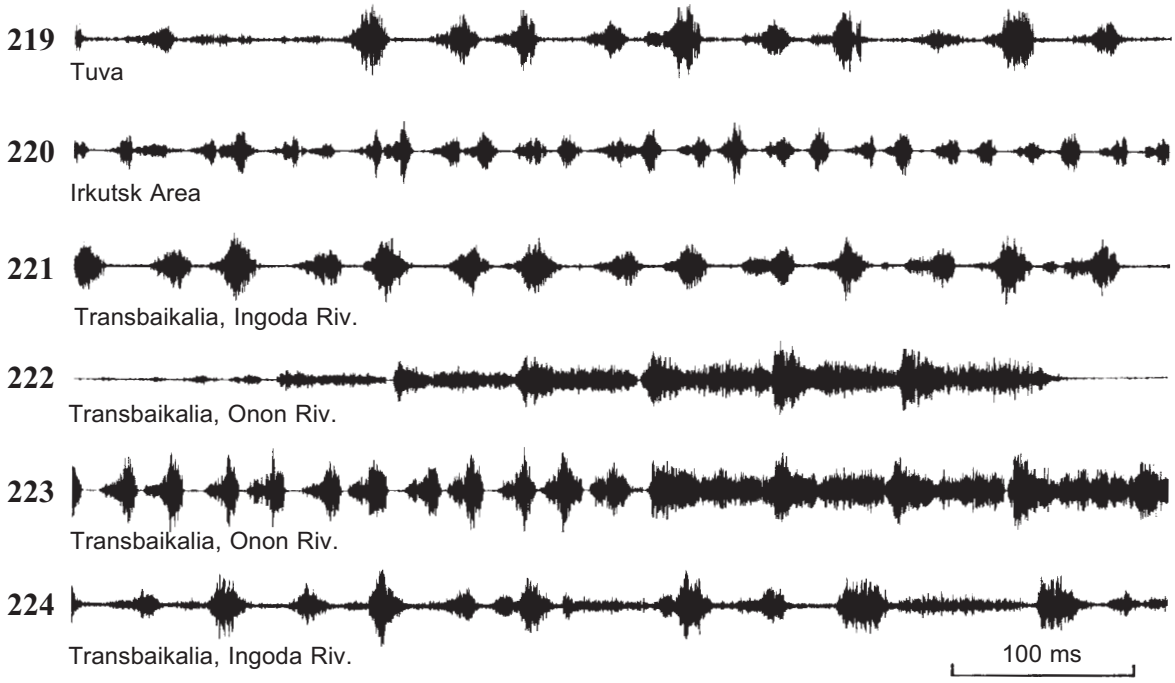
REFERENCES TO SONG. Holst, 1970, 1986 (cited after Ragge, Reynolds, 1998); Schmidt, Schach, 1978; Elsner, 1983; Helversen, 1986; Xi et al., 1992 (cited after Ragge, Reynolds, 1998); Bukhvalova, Zhantiev, 1994; Kleukers et al., 1997; Ragge, Reynolds, 1998;

SONG (Figs. 249–274). Signal is a short echeme lasting about 0.4–0.8 s and consisting of about 30–50 pulses. In the oscillograms the pulses are of variable amplitude, sometimes the high-amplitude pulses alternate with the low-amplitude ones. In most of the recordings, the pulses are separated by distinct gaps. However, in the songs recorded from Odessa

Figs. 177–191. Oscillograms of the parts of songs of *Chorthippus macrocerus* (F.-W.). Faster oscillograms of the parts of songs indicated as "192–204" are given on the oscillograms under the same numbers.

Рис. 177–191. Осциллограммы фрагментов сигналов *Chorthippus macrocerus* (F.-W.). Фрагменты сигнала, помеченные как "192–204", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.


205
Tuva
211
206
212
Irkutsk Area
207
Transbaikalia, Onon Riv.
217
213
208
215
216
Transbaikalia, Onon Riv.
209
Transbaikalia, Ingoda Riv.
214
210
Transbaikalia, Ingoda Riv.
218
2 s
211
Tuva
219
212
Irkutsk Area
220
213
Transbaikalia, Onon Riv.
214
Transbaikalia, Ingoda Riv.
221
215
Transbaikalia, Onon Riv.
222
216
Transbaikalia, Onon Riv.
223
217
Transbaikalia, Onon Riv.
218
Transbaikalia, Ingoda Riv.
224
200 ms



Figs. 219–224. Oscillograms of the parts of songs of *Chorthippus intermedius* (B.-Bien.).
Рис. 219–224. Осциллограммы фрагментов сигналов *Chorthippus intermedius* (B.-Bien.).

Area, the pulses follow without gaps and with higher rate (Figs. 257, 267). In the recordings from the eastern localities, at the beginning of the echeme, one pulse is usually louder than the others (Figs. 253–255, 261–265, 270–274). In the recordings from Moldova and Ukraine (Figs. 249–252, 256–260, 266–269), one pulse in the echeme's beginning is also loud, however, the echeme reaches its maximum intensity after about half of its duration.

Male, if not disturbed, usually produces sequence of echemes with constant intervals.

NOTES. According to Bei-Bienko and Mistshenko [1951], there are three subspecies on the territory of the former Soviet Union: *Ch. albomarginatus albomarginatus*, *Ch. albomarginatus karelini* (Uvarov, 1910) and *Ch. albomarginatus caliginosus* Mistshenko, 1951. The nominal subspecies was supposed to inhabit all localities mentioned above except of the locality No. 5 (Saratov Area); the latter one lays into the range of *Ch. a. karelini*. Helversen [1986] described the courtship songs in *Ch. albomarginatus*–group from different localities of Western Europe, Balkans and Turkey; on the base of the courtship songs, *Ch. oschei* was described as a new species of this group from Balkans and *Ch. a. karelini* from Turkey was regarded as a separate species. We do not present the recordings of the courtship songs at this study, however, according to unpublished data of Vedenina, the specimens from Odessa Area (the locality No. 2) could be attributed to *Ch. oschei,* and according to Benediktov [1997] the specimens from Tuva (the locality No. 7) and very likely from Altai Mountains (the locality No. 6) should be regarded as *Ch. a. karelini*.

A slight difference in the temporal structure of the calling songs recorded in different localities as well as insignificant morphological differences are the evidences that the forms mentioned above are rather good subspecies than separate species. However, taking into account very different courtship songs in these forms, the *Ch. albomarginatus*–group requires further investigations.

14. *Ch. caliginosus* Mistshenko, 1951, **stat.n.**

=*Ch. albomarginatus caliginosus* Mistsh., 1951.

DISTRIBUTION. Transbaikalia, China: Northern Alashan, Northern Manchuria.

LOCALITIES (Fig. 248).

1. Chita Area, Ononskiy District, Onon River 5 km W of Nizhniy Tsasuchey Village. 17.VI.1995. 1 ♂ recorded at 32°C.

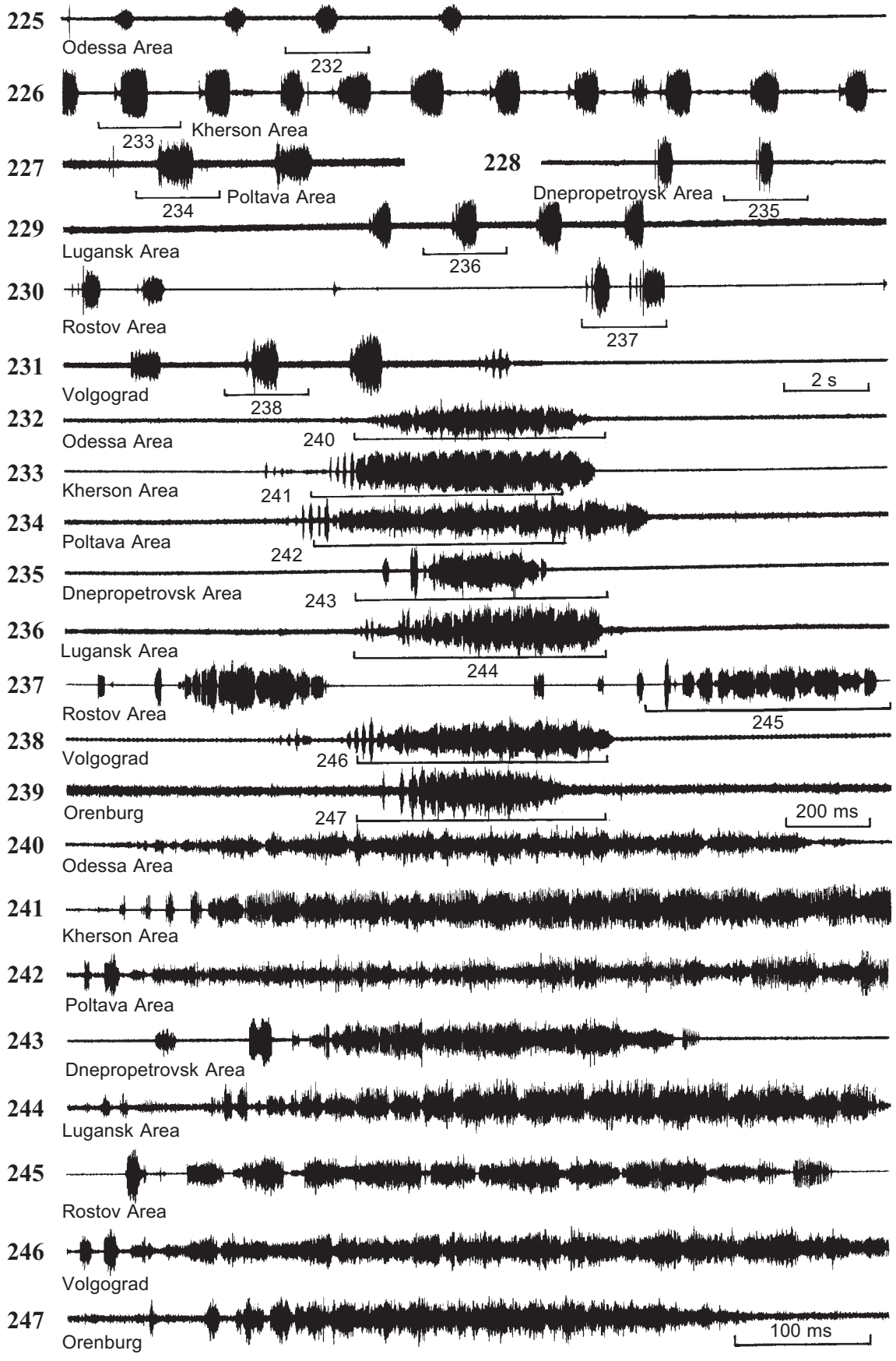
2. Chita Area, Karymskiy District, Talacha River at the confluence with Ingoda River (15 km E of Urul'ga Village). 2.VII.1995. 2 ♂♂ recorded at 27°C.

REFERENCES TO SONG. Unknown.

SONG (Figs. 275–289). The calling signal lasts about 0.8 s and consists of two short echemes with slightly different temporal pattern. At the beginning of the first echeme, one high-amplitude pulse usually presents. Sometimes the similar pulse also presents in the beginning of the second echeme, however, these high-amplitude pulses may be absent in both ones. The second echeme is similar to the song of *Ch. a. albomarginatus* in temporal structure. Singing male, if not disturbed, usually produces a sequence of 5–10 signals. Sometimes initial signals in the

Figs. 205–218. Oscillograms of the songs of *Chorthippus intermedius* (B.-Bien.). Faster oscillograms of the parts of songs indicated as "211–224" are given on the oscillograms under the same numbers.

Рис. 205–218. Осциллограммы сигналов *Chorthippus intermedius* (B.-Bien.). Фрагменты сигнала, помеченные как "211–224", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.


225
Odessa Area
232
226
233
Kherson Area
227
228
234
Poltava Area
Dnepropetrovsk Area
235
229
Lugansk Area
236
230
Rostov Area
237
231
Volgograd
2 s
238
232
Odessa Area
240
233
Kherson Area
241
234
Poltava Area
242
235
Dnepropetrovsk Area
243
236
Lugansk Area
244
237
Rostov Area
245
238
Volgograd
246
239
Orenburg
247
200 ms
240
Odessa Area
241
Kherson Area
242
Poltava Area
243
Dnepropetrovsk Area
244
Lugansk Area
245
Rostov Area
246
Volgograd
247
Orenburg
100 ms

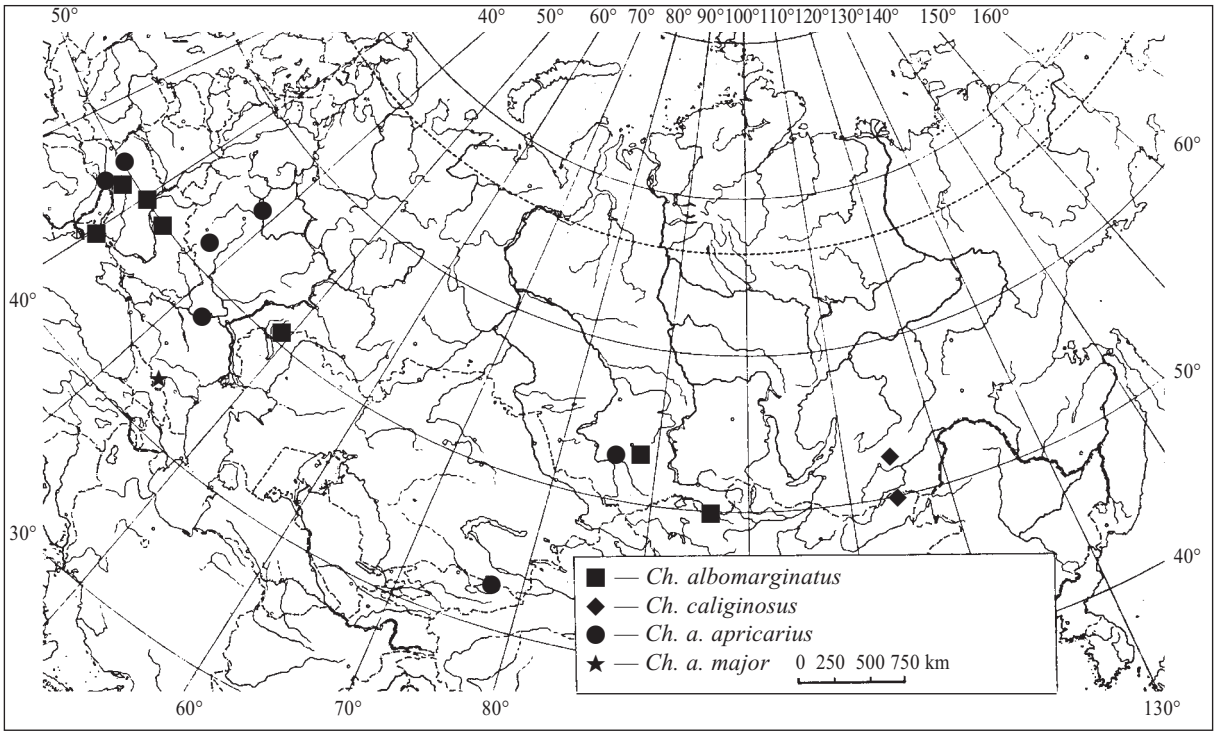


Fig. 248. Map of localities of *Chorthippus albomarginatus* (De Geer), *Ch. caliginosus* Mistsh., *Ch. apricarius apricarius* (L.) and *Ch. apricarius major* (Pyln.).

Рис. 248. Места сбора *Chorthippus albomarginatus* (De Geer), *Ch. caliginosus* Mistsh., *Ch. apricarius apricarius* (L.) и *Ch. apricarius major* (Pyln.).

sequence have somewhat atypical structure, for instance, they may include one echeme only or consist of one full echeme and another reduced one (Figs. 275, 277).

NOTES. In contrast to *Ch. albomarginatus albomarginatus* and *Ch. albomarginatus karelini* which are sometimes regarded as separate species, but produce similar calling signals, *Ch. caliginosus* is clearly different in this respect from the other forms of *Ch. albomarginatus* sensu lato and is certainly a separate species. Moreover, specimens of *Ch. caliginosus* and *Ch. albomarginatus* also differ distinctly from each other in morphological characters [Bei-Bienko, Mistshenko, 1951].

15. *Ch. apricarius* (Linnaeus, 1758)

DISTRIBUTION.

Ch. apricarius apricarius (Linnaeus, 1758): Western Europe, Asia Minor (?), Moldova, Ukraine, almost all European Russia, Kazakhstan, southern Siberia, northern Mongolia, China: Manchuria (?).

Ch. apricarius major (Pylnov, 1914): almost all Caucasus including southern part of Krasnodar Area, eastern part of Asia Minor.

LOCALITIES (Fig. 248).

Ch. apricarius apricarius:

1. Border of Moldova and Vinnitsa Area of Ukraine, about 5 km W from Mogilev-Podol'skiy Town. 17.VII.1997. 1 ♂ recorded at 31°C.

2. Ukraine, Khmel'nitskiy Area, about 15 km S from Khmel'nitskiy Town, Pravdivka Village. 15.VIII.1996. 1 ♂ recorded at 32°C.

3. Moscow Area, Voskresensk District, environs of Beloozerskiy Town. 8–10.VII.1992. 5 ♂♂ recorded at 22–27°C. Signal recorded at 25°C is presented on oscillogram (Figs. 292, 300, 310).

4. Kursk Area, Tsentral'no-Chernozemnyi Nature Reserve, Streletskaya steppe. VIII.1985. 3 ♂♂ recorded at 25–30°C.

5. Rostov Area, Oblivskiy District, environs of Sosnovy (=Oporny) Village on Chir River. 17–18.VIII.1991. 3 ♂♂ recorded at 26°C. 16.VIII.1992. 2 ♂♂ recorded at 26–29°C.

6. Southern Kazakhstan, Almaty. 2.VII.1994. 1 ♂ recorded at 32–33°C.

7. Altai Mountains, northern end of Teletskoe Lake, Artybash Village. 3.VII.1999. 2 ♂♂ recorded at 30–32°C in the field.

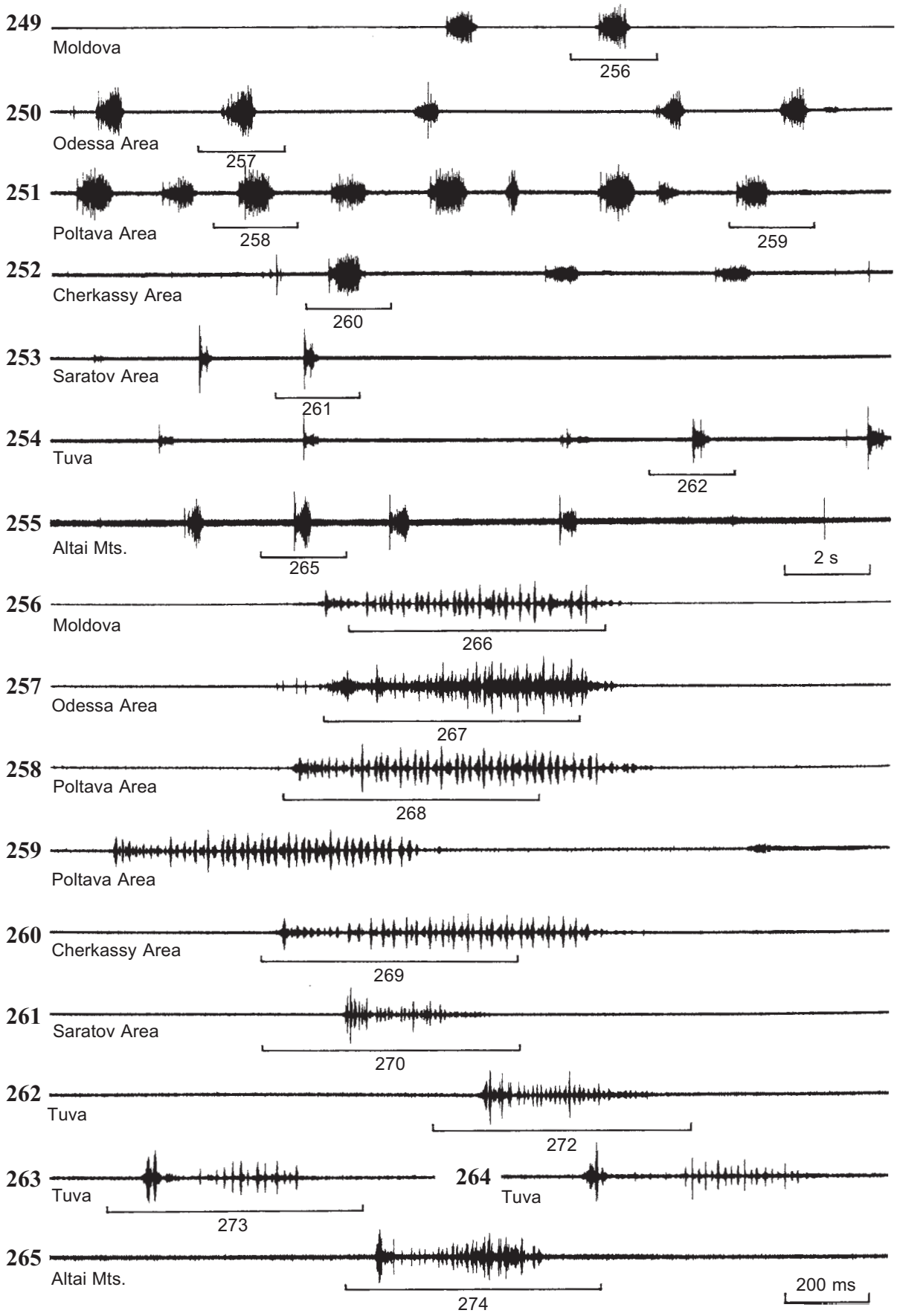
Ch. apricarius major: Northern Caucasus, North Ossetia, Ardon River basin, Tsey Canyon, environs of Nizhniy Tsey Village, 1700–1800 m above sea level. 27–30.VII.1990. 5 ♂♂ recorded at 22 and 26–30°C.

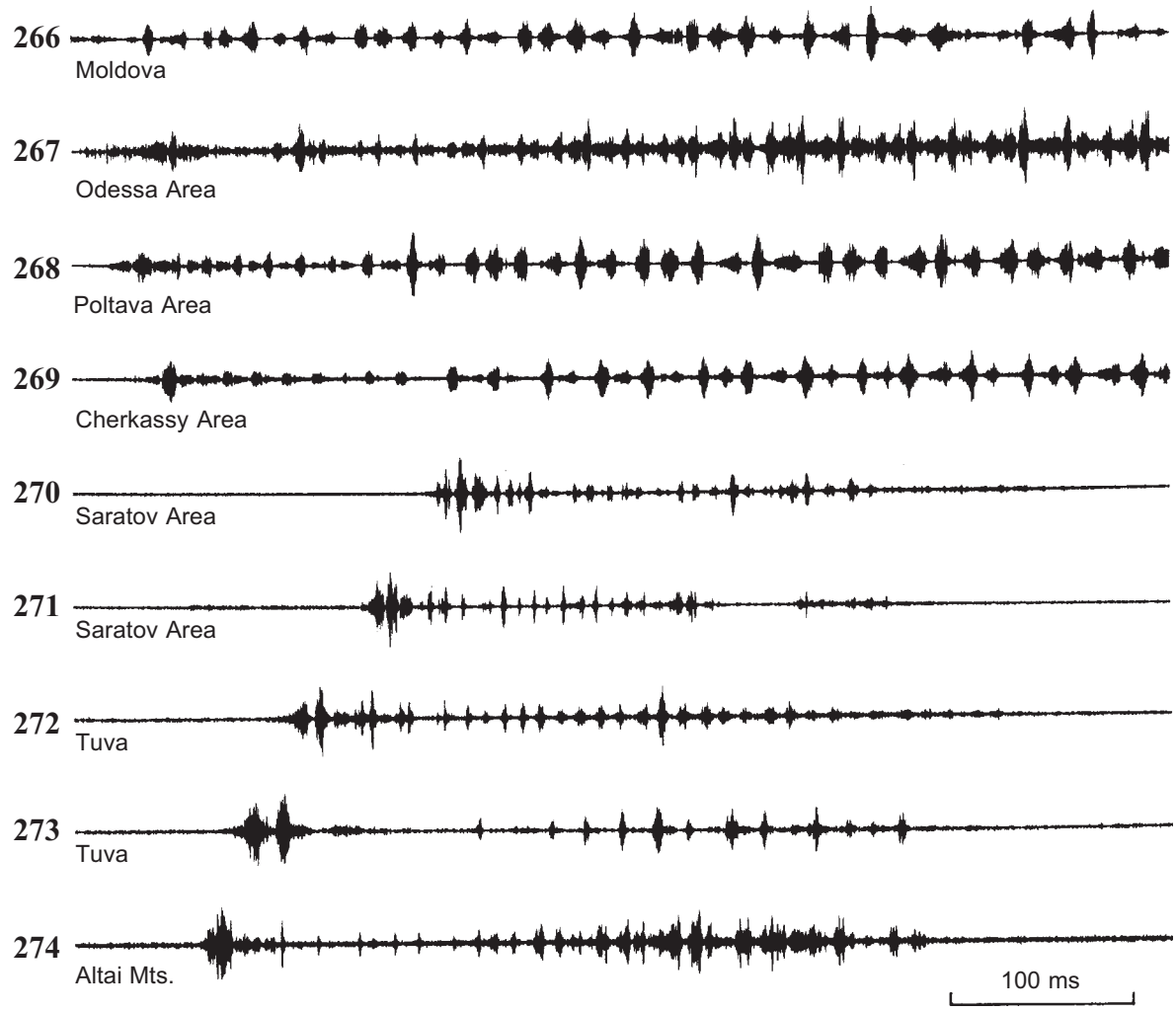
REFERENCES TO SONG.

Ch. apricarius apricarius: Holst, 1970, 1986 (cited after Ragge, Reynolds, 1998); Zhantiev, 1981; Vedenina, Zhantiev, 1990; Xi et al., 1992 (cited after Ragge, Reynolds, 1998); Bukhvalova, Zhantiev, 1994; Kleukers et al., 1997; Ragge, Reynolds, 1998.

Figs. 225–247. Oscillograms of the songs of *Ch. dichrous* (Ev.). Faster oscillograms of the parts of songs indicated as "232–238" and "240–247" are given on the oscillograms under the same numbers.

Рис. 225–247. Осциллограммы сигналов *Ch. dichrous* (Ev.). Фрагменты сигнала, помеченные как "232–238" и "240–247", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.


249
Moldova
256
250
Odessa Area
257
251
Poltava Area
258
259
252
Cherkassy Area
260
253
Saratov Area
261
254
Tuva
262
255
Altai Mts.
265
2 s
256
Moldova
266
257
Odessa Area
267
258
Poltava Area
268
259
Poltava Area
260
Cherkassy Area
269
261
Saratov Area
270
262
Tuva
272
263
Tuva
273
264
Tuva
265
Altai Mts.
274
200 ms



Figs. 266–274. Oscillograms of the songs of *Chorthippus albomarginatus* (De Geer).
Рис. 266–274. Осциллограммы сигналов *Chorthippus albomarginatus* (De Geer).

Ch. apricarius major: Bukhvalova, Zhantiev, 1994.

SONG (Figs. 290–317). The male calling song is a long echeme-sequence, beginning quietly and reaching maximum intensity after about half of its duration. The song usually lasts 15–30 s. The echeme repetition rate is about 200-350 ms in average. In nominal subspecies, each echeme consists of two low-amplitude somewhat merging syllables and one short high-amplitude component, sounding like an abrupt tick (Figs. 298–304, 308–314). In *Ch. apricarius major,* the low-amplitude syllables have more complex and variable structure and usually consist of several discrete components (Figs. 305-307, 315–317).

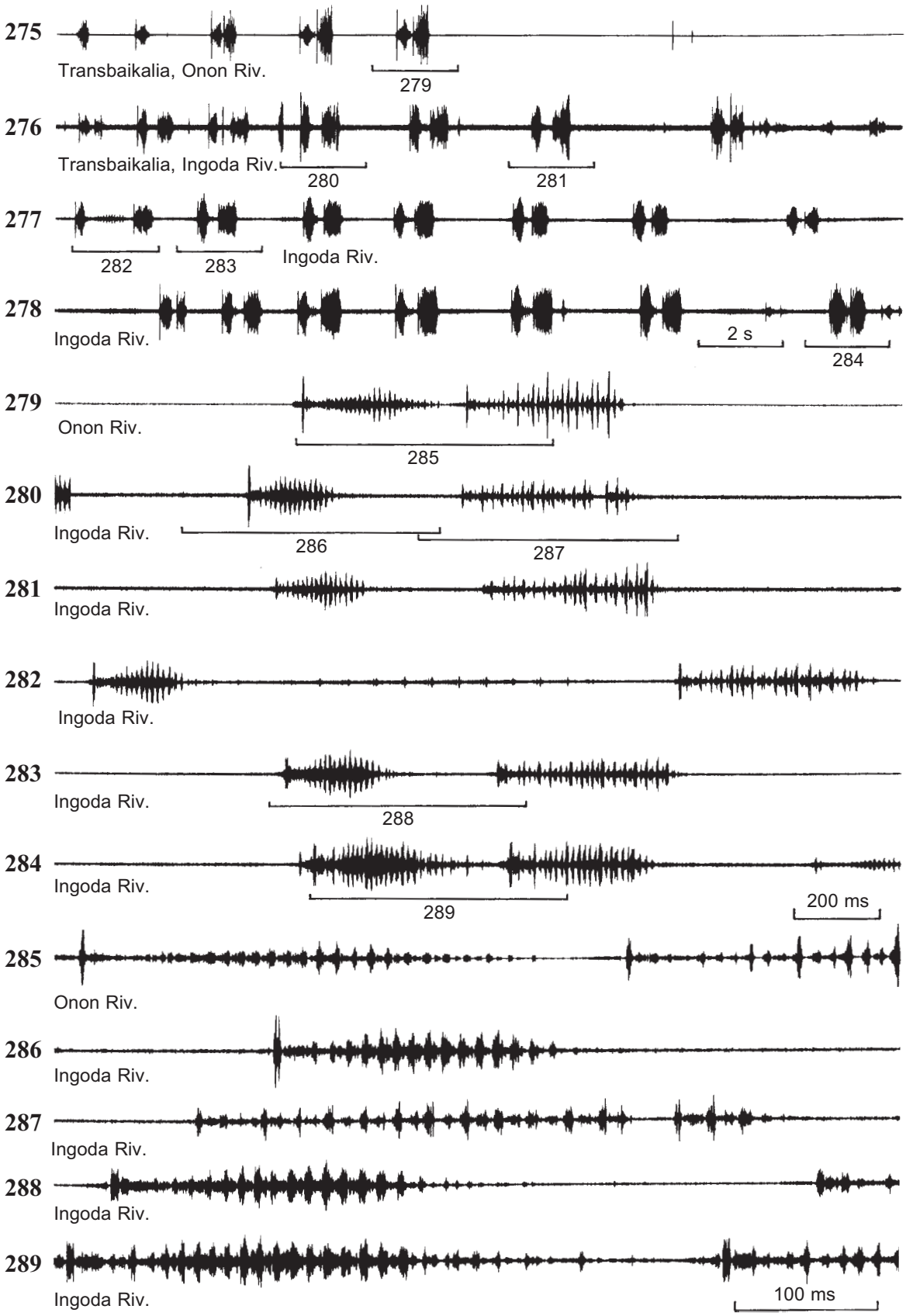
NOTES. The signals of *Ch. apricarius apricarius* specimens from different localities remote from each other show no significant difference. On the other hand, the songs of two subspecies studied differ quite distinctly.

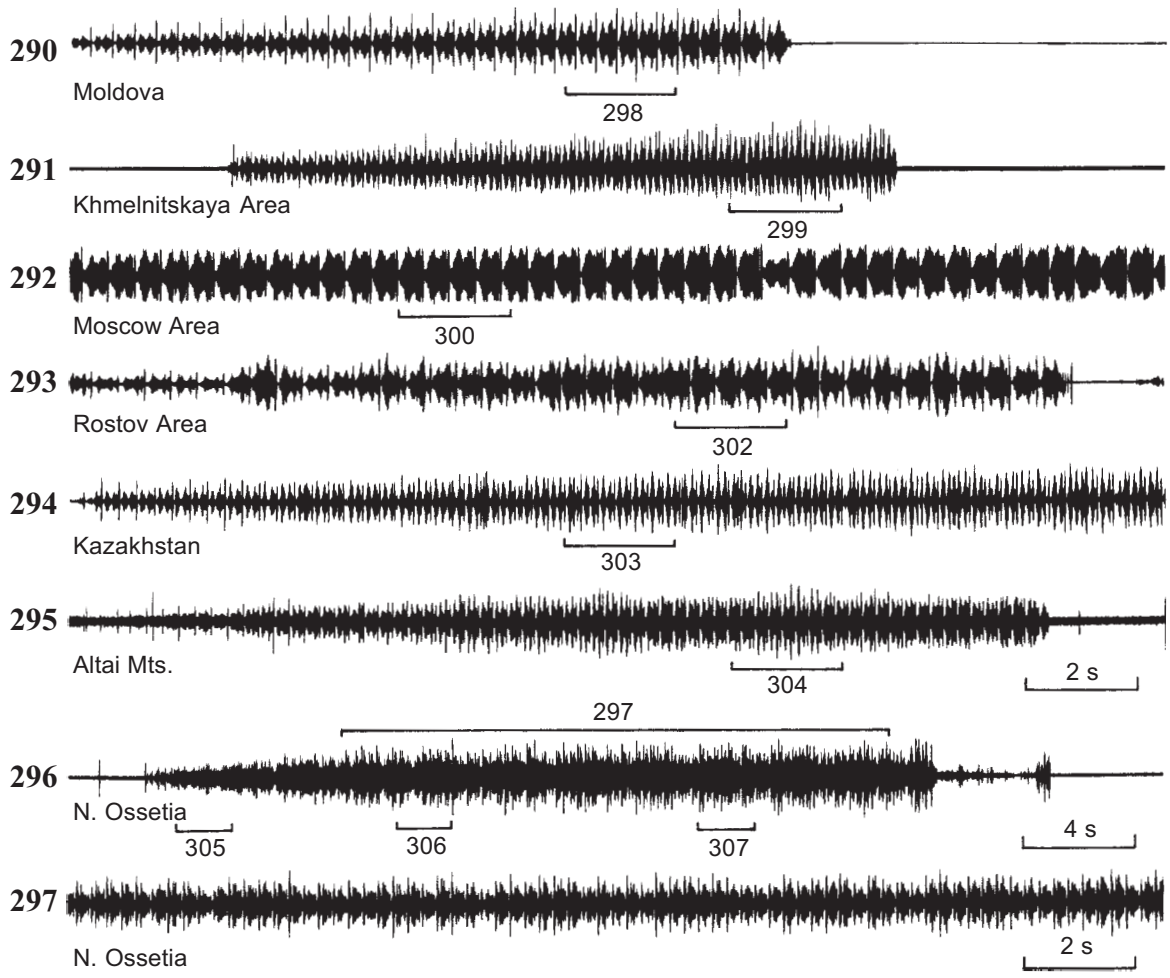
ACKNOWLEDGEMENTS

We are greatly indebted to our colleague D.Yu. Tishechkin (Department of Entomology, Biological Faculty of Moscow State University), who made a considerable part of songs recordings used in this study and helped us with signals analysis and manuscript preparation. We are grateful to O.V. Dudkin (Kiev, Zoological Institute) and D.V. Shubertov (Moscow, Institute for Information Transmission Problems) for invaluable help in our field-work in Ukraine and to K.-G. Heller (Germany, Erlangen Zoological Institute) for organising the field-work in Greece. Also, our

Figs. 249–265. Oscillograms of the songs of *Chorthippus albomarginatus* (De Geer). Faster oscillograms of the parts of songs indicated as "256–262", "265–270" and "272–274" are given on the oscillograms under the same numbers.

Рис. 249–265. Осциллограммы сигналов *Chorthippus albomarginatus* (De Geer). Фрагменты сигнала, помеченные как "256–262", "265–270" и "272–274", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.


275
Transbaikalia, Onon Riv.
279
276
Transbaikalia, Ingoda Riv.
280
281
277
282
283
Ingoda Riv.
278
Ingoda Riv.
2 s
284
279
Onon Riv.
285
280
Ingoda Riv.
286
287
281
Ingoda Riv.
282
Ingoda Riv.
283
Ingoda Riv.
288
284
Ingoda Riv.
289
200 ms
285
Onon Riv.
286
Ingoda Riv.
287
Ingoda Riv.
288
Ingoda Riv.
289
Ingoda Riv.
100 ms



Figs. 290–297. Oscillograms of the songs of *Chorthippus apricarius apricarius* (L.) (290–295) and *Ch. apricarius major* (Pyln.) (296–297). Faster oscillograms of the parts of songs indicated as "297–300" and "302–307" are given on the oscillograms under the same numbers.

Рис. 290–297. Осциллограммы сигналов *Chorthippus apricarius apricarius* (L.) (290–295) и *Ch. apricarius major* (Pyln.) (296–297). Фрагменты сигнала, помеченные как "297–300" и "302–-307", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.

thanks are due to Prof. R.D. Zhantiev (Department of Entomology, Biological Faculty of Moscow State University) for critical reading of the manuscript.

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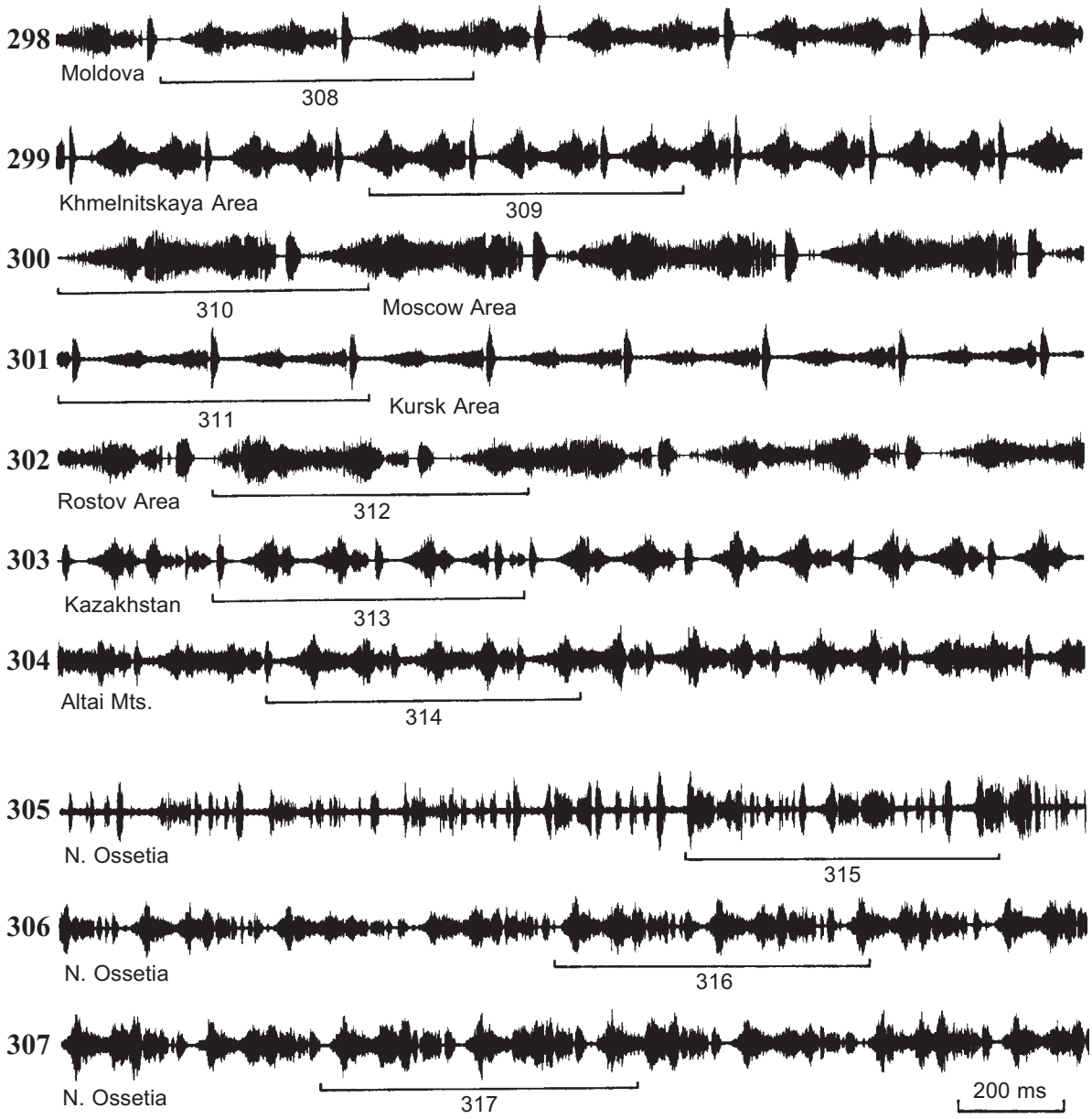
Figs. 275–289. Oscillograms of the songs of *Chorthippus caliginosus* Mistsh. Faster oscillograms of the parts of songs indicated as "279–289" are given on the oscillograms under the same numbers.

Рис. 275–289. Осциллограммы сигналов *Chorthippus caliginosus* Mistsh. Фрагменты сигнала, помеченные как "279–289", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.



Figs. 298–307. Oscillograms of the songs of *Chorthippus apricarius apricarius* (L.) (298–304) and *Ch. apricarius major* (Pyln.) (305–307). Faster oscillograms of the parts of songs indicated as "308–317" are given on the oscillograms under the same numbers.

Рис. 298–307. Осциллограммы сигналов *Chorthippus apricarius apricarius* (L.) (298–304) и *Ch. apricarius major* (Pyln.) (305–307). Фрагменты сигнала, помеченные как "308–317", представлены при большей скорости развертки на осциллограммах под соответствующими номерами.

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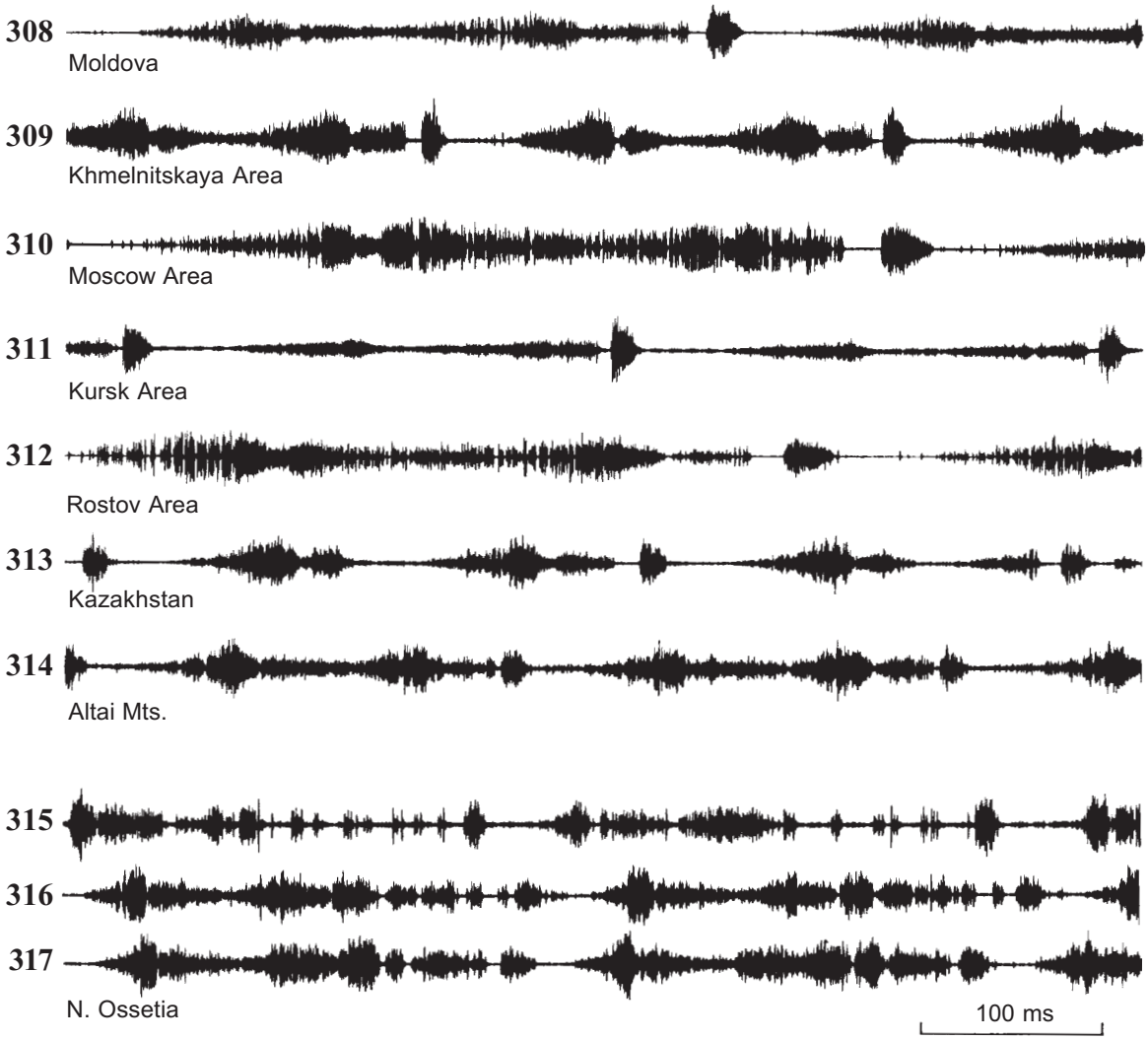
[1] This paper was originally published in Zoologichesky Zhurnal, Vol.72, No.9, where in several figures the oscillograms were turned upside-down. For this reason we give reference to English translation of the article in Entomological Review, where those misprints were corrected.



Figs. 308–317. Oscillograms of the songs of *Chorthippus apricarius apricarius* (L.) (308–314) and *Ch. apricarius major* (Pyln.) (315–317).
Рис. 308–317. Осциллограммы сигналов *Chorthippus apricarius apricarius* (L.) (308–314) и *Ch. apricarius major* (Pyln.) (315–317).

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