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New data on calling signals of Gomphocerinae grasshoppers (Orthoptera: Acrididae) from South Siberia and the Russian Far East

Новые данные о призывных сигналах саранчовых подсемейства Gomphocerinae (Orthoptera: Acrididae) Южной Сибири и Дальнего Востока России

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

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

ABSTRACT. Oscillograms and descriptions of signals of 12 species of Gomphocerinae grasshoppers (Orthoptera: Acrididae) from 12 localities in Southern Siberia and the Russian Far East are presented. Within a subspecies or monotypical species no differences in temporal pattern of signals and acoustic behaviour between different populations were revealed. Songs of different subspecies sometimes differ clearly from each other, however. Signals of *Aeropedellus variegatus minutus* Mistshenko, 1951 are described for the first time, taxonomic status of this form is discussed.

РЕЗЮМЕ. Приведены осциллограммы и описания сигналов 12 видов саранчовых подсемейства Gomphocerinae (Orthoptera: Acrididae) из 12 местонахождений в Южной Сибири и на Дальнем Востоке России. В пределах подвида или монотипического вида различий во временном рисунке сигналов и акустическом поведении между разными популяциями выявлено не было. В то же время, сигналы разных подвидов иногда различаются довольно чётко. Впервые описаны сигналы *Aeropedellus variegatus minutus* Mistshenko, 1951; обсуждается таксономический статус этой формы.

Introduction

Grasshoppers of the subfamily Gomphocerinae are well-known for their elaborate and species-specific calling signals (songs). Temporal structure of songs is widely used as a taxonomic character for discrimination of closely related morphologically similar species and for elucidation of status of dubious forms. For this reason, in last decades extensive studies of sounds produced by Gomphocerinae grasshoppers were performed by a number of specialists.

At present, sounds of european representatives of the subfamily are described in literature quite adequately. Comprehensive data on signals of West-European Gomphocerinae can be found in the monograph by Ragge and Reynolds [1998]. Oscillograms of the songs of the most part of species from European Russia were recently published by Bukhvalova and Vedenina [Bukhvalova, 1993b, 1998; Bukhvalova & Vedenina, 1998; Vedenina & Bukhvalova, 2001] and Savitsky [Savitsky, 2000, 2002, 2005, 2007; Savitsky & Lekarev, 2007].

Information on signals of Gomphocerinae grasshoppers of Siberia and the Russian Far East is far less complete, however. Sounds of certain East-palaearctic forms and also, of a number of widespread species from the siberian and the far-eastern populations were described by Bukhvalova and Vedenina [Bukhvalova, 1993a, b, 1998; Bukhvalova & Vedenina, 1998; Vedenina & Bukhvalova, 2001]. Oscillograms of signals of siberian species of *Chorthippus* Fieber, 1852 (with the exception of species from Transbaikalia) are presented in Benediktov [2005].

Nowadays it is evident that investigation of acoustic signals of grasshoppers from different parts of the range allows revealing certain taxonomic inexactitudes, which are not so easy to discover relying on morphological characters only. Taxonomic changes in the *Glyptobothrus biguttulus* group [Bukhvalova, 1993b, 1998] and the establishment of species status of *Chorthippus caliginosus* Mistshenko, 1951 [Vedenina & Bukhvalova,

2001] can be mentioned as examples. For this reason, publication of oscillograms of widespread species from populations not studied before seems to be useful for taxonomic studies.

In the present paper oscillograms and descriptions of signals of 12 species of grasshoppers are presented. Seven of them are widespread european-siberian or even transpalaearctic forms, still, the songs of individuals from eastern parts of their ranges were not studied until now with the exception of *Aeropedellus variegatus variegatus* (Fisher von Waldheim, 1846). For four species oscillograms of signals of individuals from european populations are given for comparison.

The ranges of five other ones include only Siberia (mainly, within the limits of steppe and forest-steppe zones) and, in certain species, also the Russian Far East. For these species oscillograms of songs from only one population were published previously. Signals of *Aeropedellus variegatus minutus* Mistshenko, 1951 are described for the first time.

Matherial and methods

Recordings of songs were made under natural conditions from caged or freely-moving insects with microphone MD–382 (upper frequency limit 12.5 kHz) and cassette recorder "Elektronika–302–1" (upper frequency limit 10 kHz) or minidisk recorder "Sony Walkman MZ-NH900" (sampling frequency 44.1 kHz). In all cases manual mode of recording level control was used.

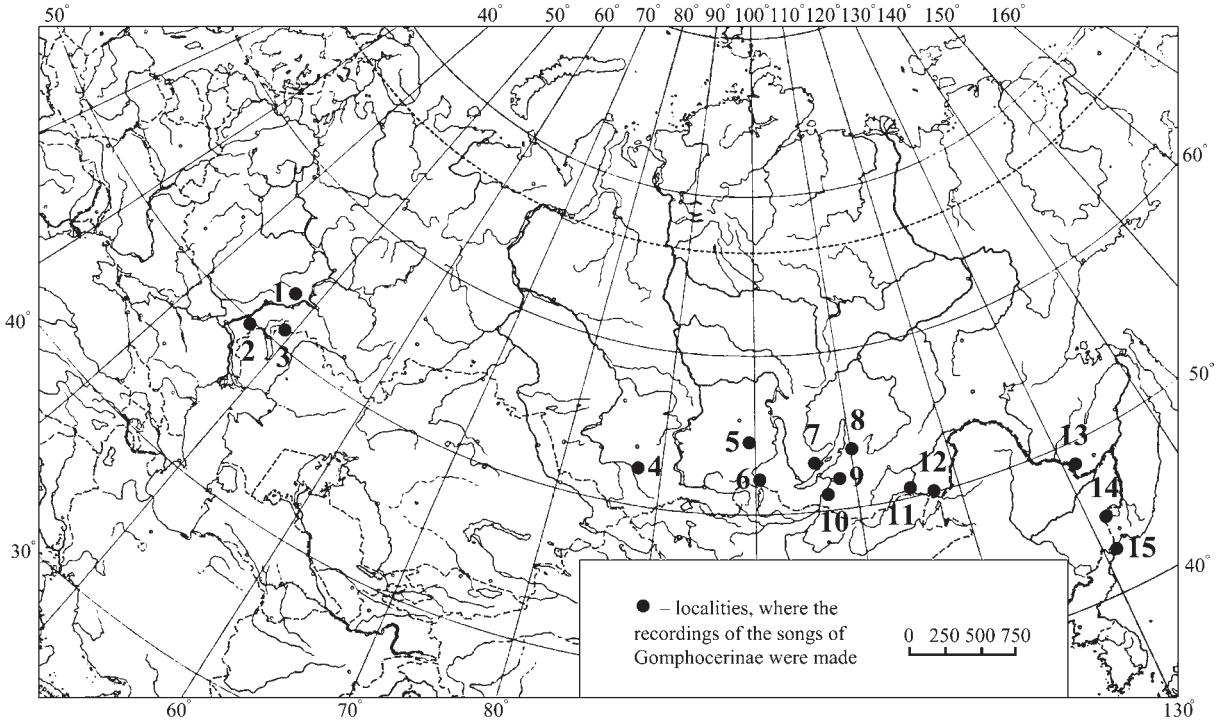


Fig. 1. Map of localities, where the recordings of the songs of Gomphocerinae were made: 1 — Northern part of Saratov Area, environs of Khvalynsk, near Ulyanino Village; 2 — Saratov Area, Krasnokutskiy Distr., Dyakovka Village; 3 — South-east of Saratov Area, environs of Ozinki Town; 4 — Altai Mountains, northern end of Teletskoe Lake, environs of Yaylyu Village; 5 — Irkutsk Area, Uda River near the mouth of Uk, about 30 km north-west of Nizhneudinsk (approx. 450 km north-west of Irkutsk); 6 — Buryatia, the valley of Irkut River in the environs of Mondy Village (about 80 km west of Kyren); 7 — Irkutsk Area, steppes about 30 km north-east of Elantsy along the road Elantsy–Ol'khon Island (approx. 180 km north-east of Irkutsk); 8 — Buryatia, Barguzin Depression, Ina River 3–4 km west from Ina Village (about 40 km north-east from Barguzin Town); 9 — Buryatia, 10 km east of Onokhoy (about 60 km east of Ulan-Ude), the valley of Bryanka Riv; 10 — Buryatia, the valley of Selenga River 5 km north from Novoselenginsk (20 km south-south-east from Gusinoozersk); 11 — South-east of Chita Area, the valley of Onon River 5–6 km west of Nizhniy Tsasuchey village; 12 — South-east of Chita Area, Klichkinskiy Mtn. Ridge at the crossing with Urulyunguy River (15 km west of Klichka Town); 13 — South-west of Khabarovsk Province, about 5 km north of Obluchye Town; 14 — Southern Maritime Province, Khankaiskiy District, 3–4 km north from Novokachalinsk Village, bank of Khanka Lake; 15 — Southern Maritime Province, Khasan Region, environs of Andreevka Village (about 35 km south-west from Slavyanka).

Рис. 1. Места сбора саранчовых подсемейства Gomphocerinae для записи звуковых сигналов: 1 — север Саратовской обл., окрестности Хвалынска, близ деревни Ульянино; 2 — Саратовская обл., Краснокутский район, село Дьяковка; 3 — юго-восток Саратовской обл., окрестности поселка Озинки; 4 — Алтай, северная оконечность Телецкого озера, окрестности поселка Яйлю; 5 — Иркутская обл., р. Уда близ устья р. Ук, около 30 км СЗ Нижнеудинска (приблизительно 450 км СЗ Иркутска); 6 — Бурятия, долина Иркута в окрестностях села Монды (около 80 км З Кырена); 7 — Иркутская обл., степи около 30 км СВ поселка Еланцы по дороге на о. Ольхон (около 180 км СВ Иркутска); 8 — Бурятия, Баргузинская котловина, р. Ина 3–4 км З одноименного села (около 40 км к СВ от поселка Баргузин); 9 — Бурятия, 10 км СВ Онохоя (около 60 км СВ Улан-Удэ), долина р. Брянки; 10 — Бурятия, долина Селенги, 5 км С Новоселенгинска (20 км ЮЮВ Гусиноозерска); 11 — Юго-восток Читинской обл., долина Онона 5–6 км З села Нижний Цасучей; 12 — Юго-восток Читинской обл., Кличкинский хребет при пересечении с р. Урулюнгуй (15 км З поселка Кличка); 13 — Юго-запад Хабаровского края, около 5 км С поселка Облучье; 14 — Южное Приморье, Ханкайский район, берег озера Ханка 3–4 км С Новокачалинска; 15 — Южное Приморье, Хасанский район, окрестности села Андреевка (около 35 км ЮЗ Славянки).

Air temperature was measured during or immediately after recording on the place where the singing insect was sitting.

The specimens whose signals were recorded have been taken for taxonomic identification. All the material studied is deposited in the collection of Zoological Museum of Moscow State University.

Geographical points where the recordings were made are shown on Fig. 1. The numbers of localities in the text (the first item in the description of signals of each species) correspond with these on the map.

In most species of singing insects calling male adopts a specific calling site (a tree trunk, thin twig, grass stem, etc.) and as a rule demonstrates specific behaviour during singing [e.g. Boulard, 2006]. Gomphocerinae are no exception. Data on acoustic behaviour for each species are provided after description of the calling song.

Song terminology used in the present paper is accepted after Ragge [e.g. Ragge, 1987]. Also, it is described in Bukhvalova and Vedenina [1998]. Data on distribution are given mainly after Bey-Bienko and Mistshenko [1951] and Storozhenko [1986]. For species whose songs were described by Ragge and Reynolds [1998] only references to the recent articles not mentioned in this book are given. References to earlier works can be found in the monograph cited above. The order of genera is accepted after Storozhenko [1986], the subdivision of *Chorthippus* sensu lato — after Storozhenko [2002].

Descriptions of songs

Myrmeleotettix palpalis (Zubowsky, 1899)

MATERIAL. 6. Buryatia, the valley of Irkut River in the environs of Mondy Village (about 80 km west of Kyren), 4.VII.2007. Signals of 3 ♂♂ are recorded at the temperature 30–35°C.

10. Buryatia, the valley of Selenga River 5 km north from Novoselenginsk (20 km south-south-east from Gusinoozersk), 7.VII.2007. Signals of 1 ♂ are recorded at the temperature 33°C.

12. South-east of Chita Area, Klichkinskiy Mtn. Ridge at the crossing with Urulyunguy River (15 km west of Klichka Town), 22.VII.2003. Signals of 1 ♂ are recorded at the temperature 28–30°C.

DISTRIBUTION. Southern Siberia from Altai to Transbaikalia, Southwest of Amur Area, Mongolia.

REFERENCES TO SONG. The only oscillogram of the recording of poor quality from southern Tyva is presented in Bukhvalova and Zhantiev [1994].

SONG AND ACOUSTIC BEHAVIOUR. The calling song is an echeme-sequence lasting for 7–12 s and consisting of 14–20 echemes (Figs 2–13). In the main part of the song echemes are separated by intervals of about 0.2–0.3 s. Pauses between echemes in the end of signal are somewhat longer and average 0.4–0.6 s in our recordings. Echeme duration averages 200–250 ms. The song begins quietly reaching maximum intensity after 4th-7th echeme. Each echeme consists of about 20–30 pulses (Figs 11–13). Signals of individuals from different localities are quite similar.

Male sings on the open bare places or on the soil among sparse vegetation every time moving to another place after producing a signal. Usually, it produces up to 4–5 signals after which stops singing. Pauses between signals average from 3–5 up to 15–20 s and more.

COMPARATIVE NOTES. In general, the song of this species is similar with this of *M. maculatus* (Thunberg, 1815) [see Ragge & Reynolds, 1998; Bukhvalova & Vedenina, 1998; Savitsky, 2005] and differs from it only in quantitative parameters. In *M. palpalis* echemes are shorter than in *M. maculatus*. Pauses between echemes in the former species are equal to or longer than echemes whereas in the latter one echemes exceed pauses in duration.

Omocestus haemorrhoidalis (Charpentier, 1825)

MATERIAL. 1. Northern part of Saratov Area, environs of Khvalynsk, near Ulyanino Village, 19.VII.2004. Signals of 1 ♂ are recorded at the temperature 34–36°C.

7. Irkutsk Area, steppes about 30 km north-east of Elantsy along the road Elantsy — Ol'khon Island (approx. 180 km north-east of Irkutsk), 15.VII.2003. Signals of 1 ♂ are recorded at the temperature 31°C.

12. South-east of Chita Area, Klichkinskiy Mtn. Ridge at the crossing with Urulyunguy River (15 km west of Klichka Town), 22.VII.2003. Signals of 1 ♂ are recorded at the temperature 30–31°C.

14. Southern Maritime Province, Khankaiskiy District, 3–4 km north from Novokachalinsk Village, bank of Khanka Lake, 21.VII.2006. Signals of 2 ♂♂ are recorded at the temperature 32–34°C.

DISTRIBUTION. Transpalaearctic.

REFERENCES TO SONG. Ragge and Reynolds [1998]: recordings from Western Europe; Savitsky [2005]: recordings from the Lower Volga Region.

SONG AND ACOUSTIC BEHAVIOUR. The calling song is an echeme lasting for about 2–5 s (Figs 14–25). It begins quietly and gradually increases in amplitude. Syllable repetition period becomes longer towards the end of the song and averages 30–75 ms for the echeme as a whole.

Male as a rule sings on the soil among sparse vegetation. Usually, it produces signals with irregular intervals from 0.5 up to several minutes. Occasionally, 4–5 and more echemes follow with short breaks lasting from 10–15 up to 40–50 s.

COMPARATIVE NOTES. *O. haemorrhoidalis* is a widespread species, still until now only signals of individuals from european populations were described in literature. The only exception is the article by Bukhvalova and Zhantiev [1994], where the description of signals of this species from Southern Tyva (Central Siberia) is given.

Presently, only signals of nominotypical subspecies are investigated. In general structure the songs of individuals from european, siberian and the far-eastern populations are almost indistinguishable (e.g. see Figs 14, 18, 22 and 15–17, 19–21, 23–25). Temporal parameters of signals in our recordings are in good agreement with data of Savitsky [2005] for populations from the Lower Volga Region. Unfortunately, it is impossible to compare our results with data in Ragge and Reynolds [1998] for the reason of considerable difference of temperatures during recordings (21–22 and 26°C for recordings from Western Europe).

Omocestus viridulus (Linnaeus, 1758)

MATERIAL. 4. Altai Mountains, northern end of Teletskoe Lake, environs of Yaylyu Village, 5.VII.1999. Signals of 1 ♂ are recorded at the temperature 27–30°C.

5. Irkutsk Area, Uda River near the mouth of Uk, about 30 km north-west of Nizhneudinsk (approx. 450 km north-west of Irkutsk), 4.VII.2003. Signals of 1 ♂ are recorded at the temperature 30–31°C.

DISTRIBUTION. Transpalaearctic.

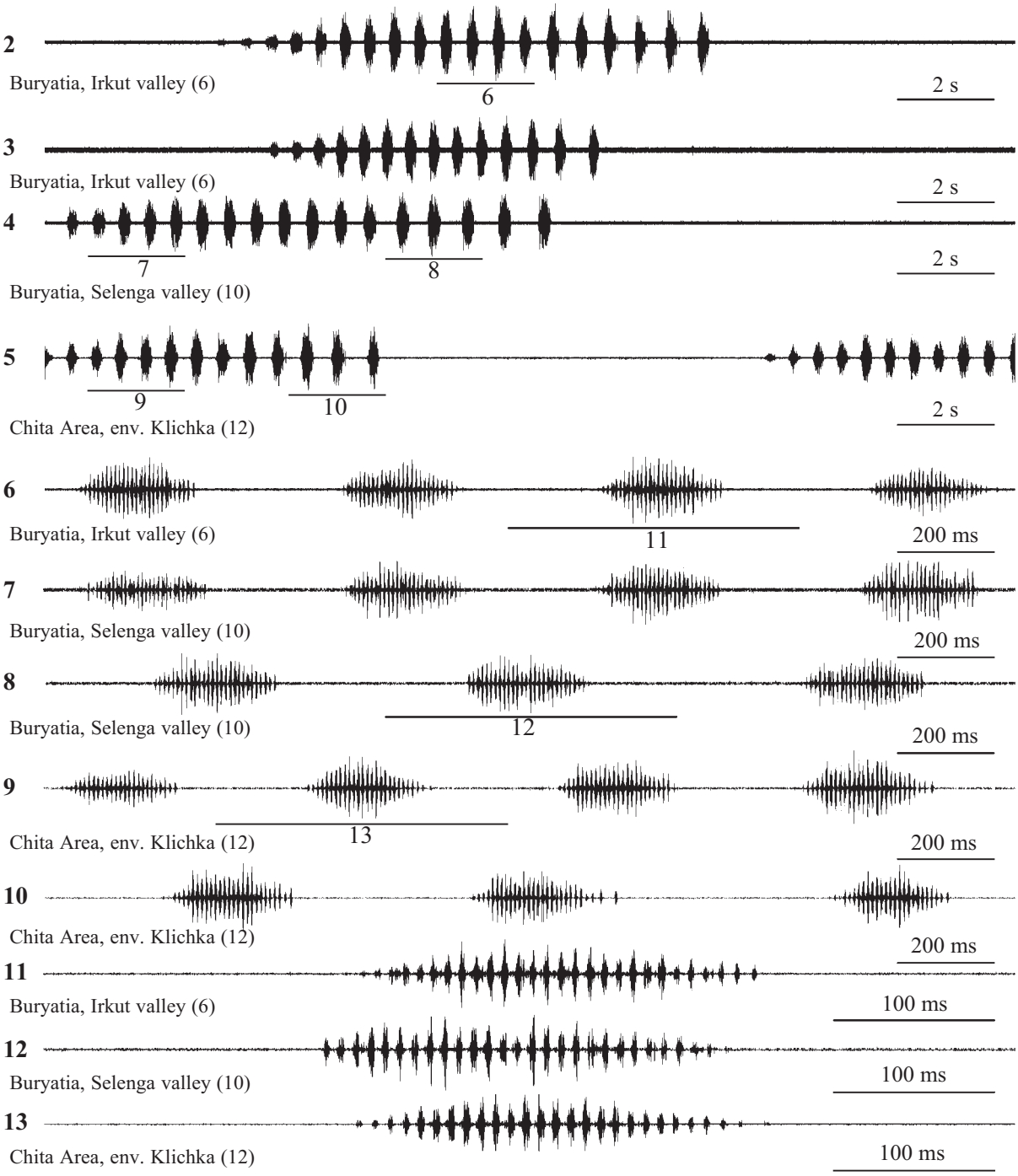
REFERENCES TO SONG. Ragge and Reynolds [1998]: recordings from Western Europe; Savitsky [2005]: recordings from Western Caucasus.

SONG AND ACOUSTIC BEHAVIOUR. The calling song is a prolonged echeme varying in duration from 15–20 up to 30–40 s in our recordings (Figs 26–32). Syllable

repetition period gradually increases towards the end of the signal and changes from 55–90 ms in the first half of echeme to 90–110 ms in the end of a song.

Male usually sings among dense vegetation sitting on the grass stem. Signals follow each other with rather long irregular intervals about 1–2 minutes.

COMPARATIVE NOTES. General structure of the song in our recordings is the same as in individuals from european populations. Temporal parameters (echeme duration and syllable repetition period) are in general agreement with data for populations from Western Europe [Ragge, 1986] and North Caucasus (Adygeya) [Savitsky, 2005]. The range of variability of parameters in individuals from the latter locality is wider, which is evidently, a result of larger sample studied.



Figs 2–13. Oscillograms of calling signals of *Myrmeleotettix palpalis* (Zubowsky, 1899) from different localities (No. of the locality on the map is given in brackets). Faster oscillograms of the parts of songs indicated as "6–13" are given under the same numbers.

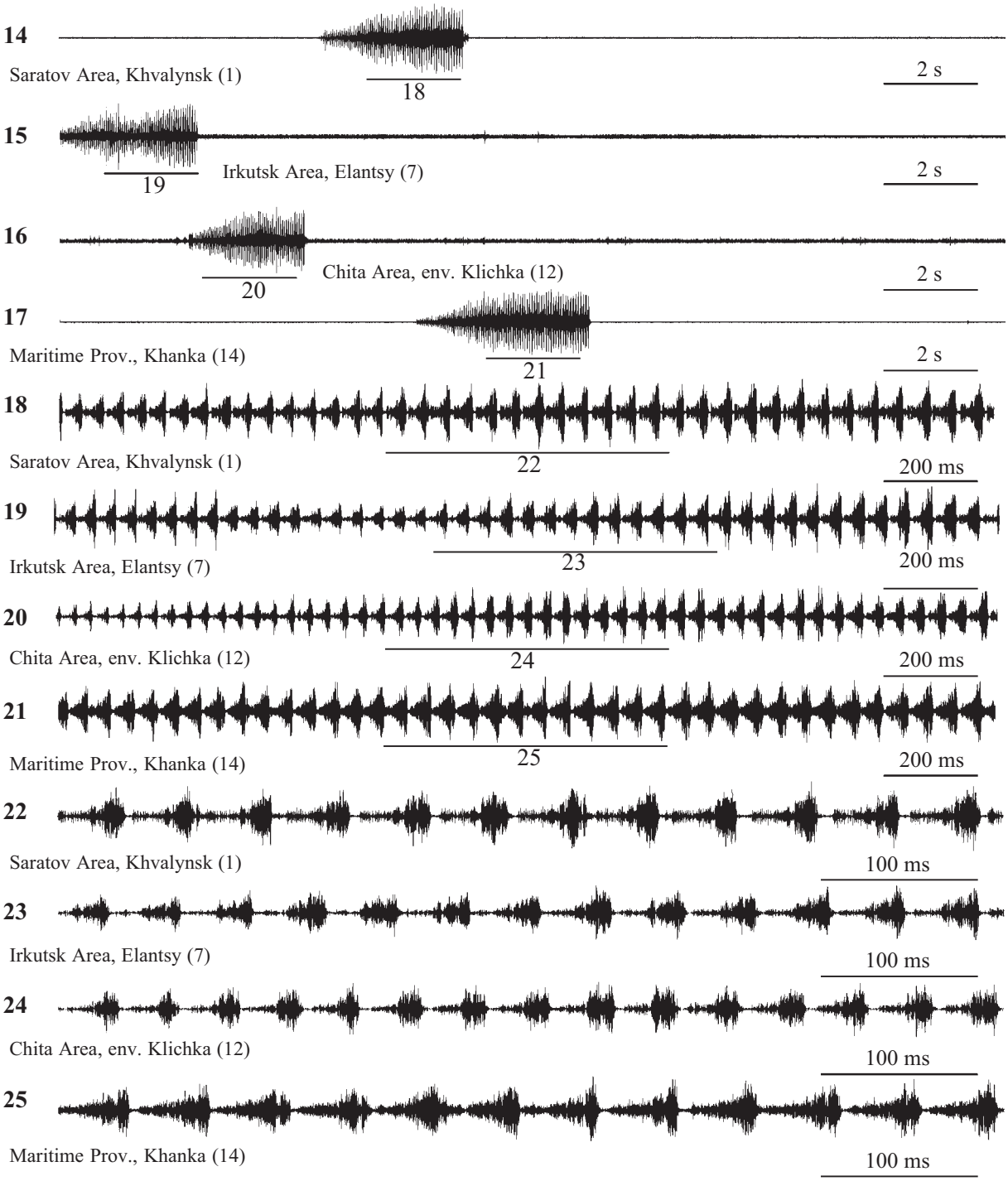
Рис. 2–13. Осциллограммы призывных сигналов *Myrmeleotettix palpalis* (Zubowsky, 1899) из разных географических точек (в скобках указан номер точки на карте). Фрагменты сигналов, помеченные цифрами "6–13", представлены при большей скорости развертки на осциллограммах под такими же номерами.

Stenobothrus nigromaculatus
(Herrich-Schäffer, 1840)

MATERIAL. 7. Irkutsk Area, steppes about 30 km north-east of Elantsy along the road Elantsy — Ol'khon Island (approx. 180 km north-east of Irkutsk), 15.VII.2003. Signals of 3 ♂♂ are recorded at the temperature 33°C.

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

REFERENCES TO SONG. Ragge and Reynolds [1998]: recordings from Western Europe; Vedenina and Bukhvalova [2001]: recordings from Ukraine, North Caucasus, European Russia (Rostov Area) and South Urals (Orenburg Area).



Figs 14–25. Oscillograms of calling signals of *Omocestus haemorrhoidalis* (Charpentier, 1825) from different localities (No. of the locality on the map is given in brackets). Faster oscillograms of the parts of songs indicated as "18–25" are given under the same numbers.

Рис. 14–25. Осциллограммы призывных *Omocestus haemorrhoidalis* (Charpentier, 1825) из разных географических точек (в скобках указан номер точки на карте). Фрагменты сигналов, помеченные цифрами "18–25", представлены при большей скорости развертки на осциллограммах под такими же номерами.

SONG AND ACOUSTIC BEHAVIOUR. The calling song is a series of echemes following each other with intervals about 1–3 s (Figs 33–35). The echeme lasts about 1–2 s. It begins quietly and reaches maximum towards the end. Syllable repetition period averages 10–15 ms in our recordings. Male sings sitting on the ground. Usually, it produces 2–5 echemes and then stops singing for several minutes.

When courting female, male can sing ceaselessly for about ten minutes and more producing a signal of quite another kind consisting of two different phases (Figs 36–43). The first phase of courtship song is a succession of low-amplitude echemes having a duration about 200–400 ms and repeating with a period 0.9–1.4 s (Fig. 37). Syllable repetition period in the echemes is almost the same as in the calling song. This part can last for several minutes. Then the male abruptly starts producing the second phase (Figs 38–43). It includes 4–8 echemes consisting of two parts each. Syllable repetition period in the first part averages 20–30 ms, whereas in the second part it is half as long. Overall duration of echeme is about 0.9–1.2 s.

COMPARATIVE NOTES. Only signals of nominotypical subspecies were studied until now. Temporal pattern of calling song of individuals from Irkutsk Area is the same as in european populations [Ragge, 1987; Vedenina & Bukhvalova, 2001].

Courtship signals in our recordings differ slightly from these described by Ragge [1987]. In west-european individuals short additional echemes present between longer ones in the second phase of courtship signal. In our recordings these echemes are hardly distinguishable (Fig. 38, in the beginning of the oscillogram) or almost entirely reduced (Figs 39–40). Temporal parameters of courtship signals in our recordings are similar with these given in Ragge [1987].

Staurodérus scalaris (Fischer von Waldheim, 1846)

MATERIAL. 1. Northern part of Saratov Area, environs of Khvalynsk, near Ulyanino Village, 19.VII.2004. Signals of 1 ♂ are recorded at the temperature 32–33°C.

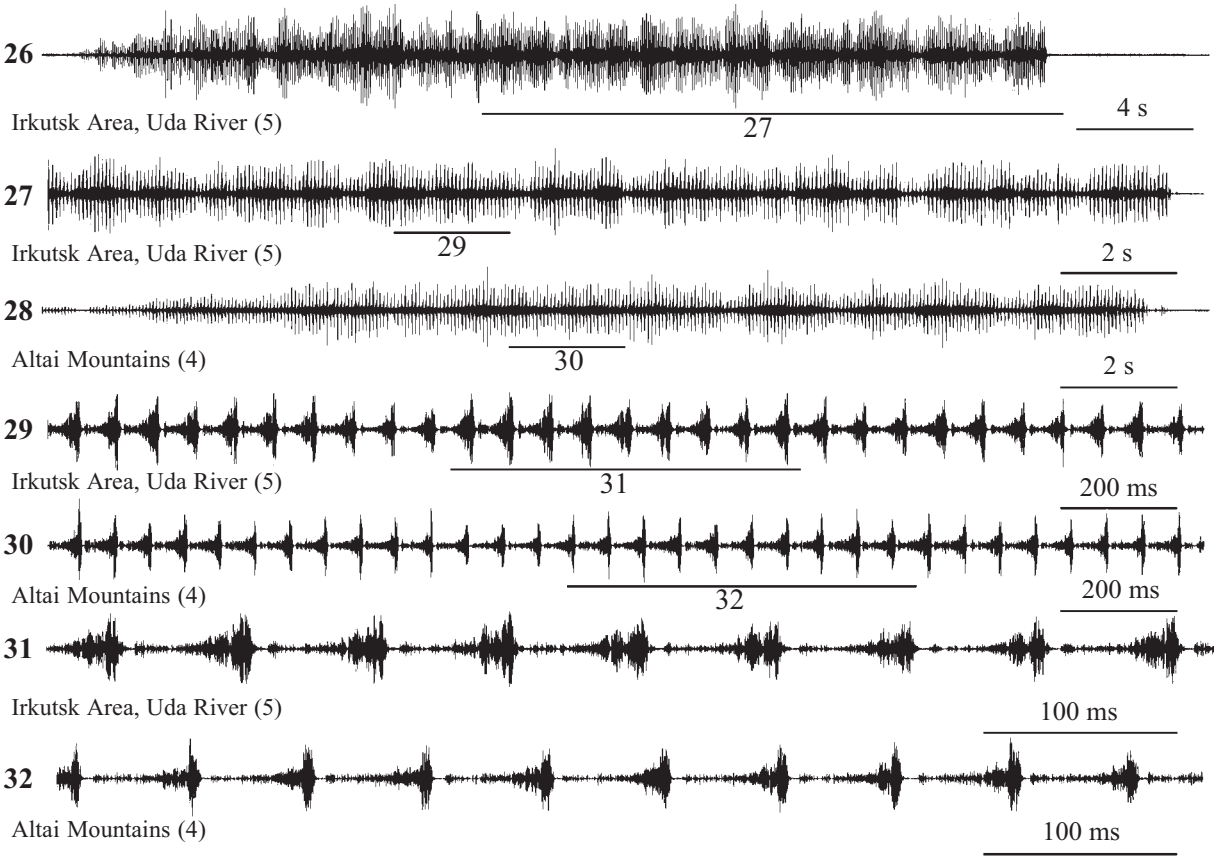
5. Irkutsk Area, Uda River near the mouth of Uk, about 30 km north-west of Nizhneudinsk (approx. 450 km north-west of Irkutsk), 1.VII.2003. Signals of 1 ♂ are recorded at the temperature 30–31°C.

9. Buryatia, 10 km east of Onokhoy (about 60 km east of Ulan-Ude), the valley of Bryanka Riv., 1.VII.2006. Signals of 1 ♂ are recorded at the temperature 36°C.

DISTRIBUTION. Europe, Caucasus, Kazakhstan, mountains of Middle Asia, Southern Siberia from Urals to Buryatia, Mongolia, Northern China.

REFERENCES TO SONG. Ragge and Reynolds [1998]: recordings from Western Europe; Vedenina and Bukhvalova [2001]: recordings from Greece, North Caucasus, Southern Kazakhstan and Altai Mountains.

SONG AND ACOUSTIC BEHAVIOUR. The main part of the calling song is an echeme-sequence lasting for 10–30 s (Figs 44–47, 50–52 and 55–57). It consists of 20–40 echemes repeating with a period of 450–750 ms. Each echeme consists



Figs 26–32. Oscillograms of calling signals of *Omocestus viridulus* (Linnaeus, 1758) from different localities (No. of the locality on the map is given in brackets). Faster oscillograms of the parts of songs indicated as "27" and "29–32" are given under the same numbers.

Рис. 26–32. Осциллограммы призывных сигналов *Omocestus viridulus* (Linnaeus, 1758) из разных географических точек (в скобках указан номер точки на карте). Фрагменты сигналов, помеченные цифрами "27" и "29–32", представлены при большей скорости развертки на осциллограммах под такими же номерами.

of two parts including 8–14 longer syllables and 7–12 shorter ones respectively.

Occasionally, male produce a long train of short echemes preceding the main part of signal (Figs 44–45, 47). In certain cases such a prelude lasts for 20–30 s and more. Echeme repetition period in it varies greatly (Figs 44–45, 47–49), each echeme consists of 4–8 syllables (Figs 48–49, 53–54).

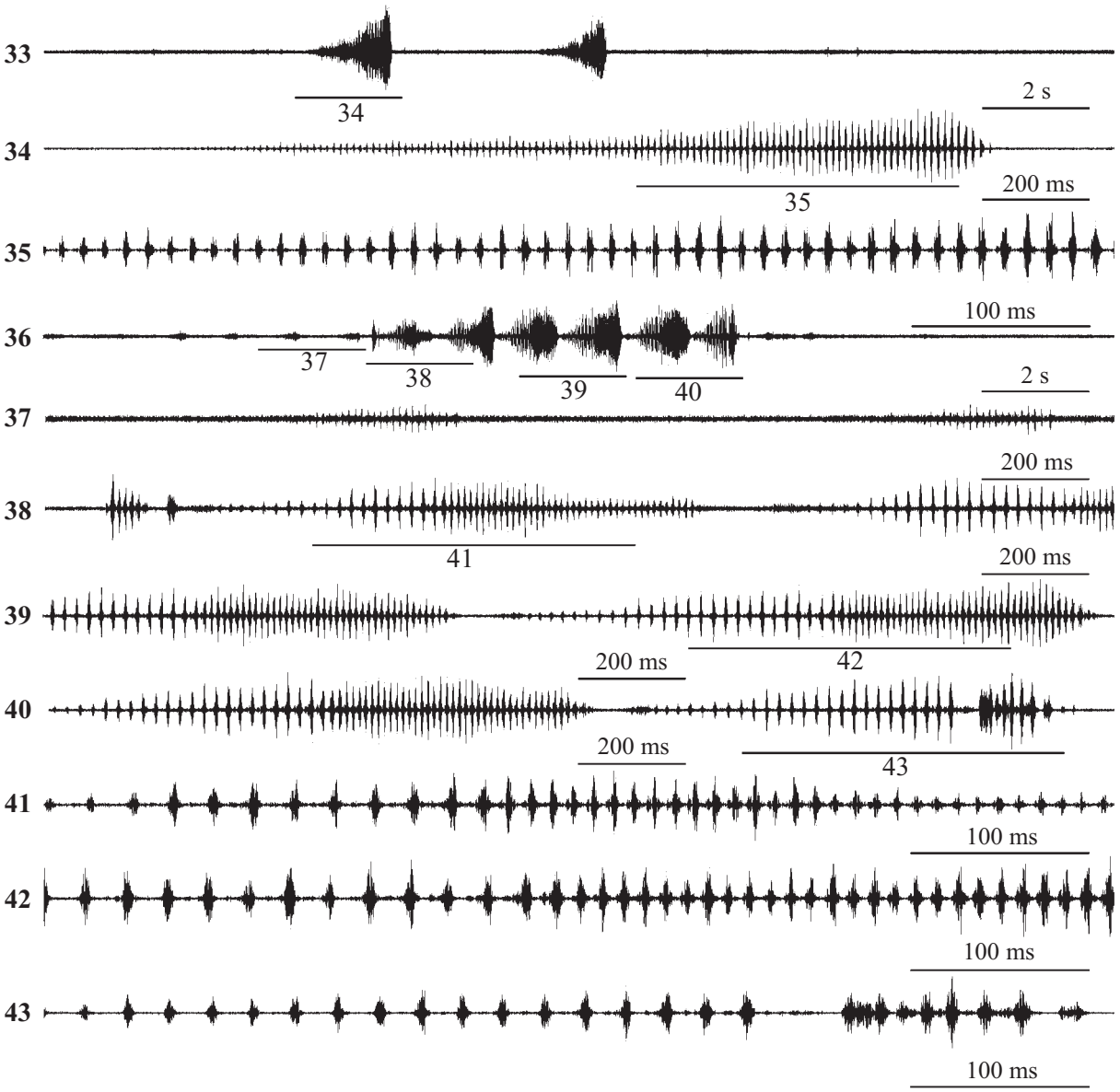
Male prefers places with rather high dense vegetation and sings sitting on the grass stem. Usually, after the end of the song it leaves the stem and flies for a distance of several meters. Quite often it starts singing anew immediately after landing. In actively singing male pauses between signals average 10–20 s.

COMPARATIVE NOTES. All populations studied belong to nominotypical subspecies. Temporal parameters, the pattern of calling song and acoustic behaviour in individuals from Eastern Siberia are the same as in populations from Europe (Figs 44–45, 48, 50, 53, 55 — male from Saratov Area, Figs 46–47, 49, 51–52, 54, 56–57 — males from Irkutsk Area and Transbaikalia).

Glyptobothrus maritimus (Mistshenko, 1951)

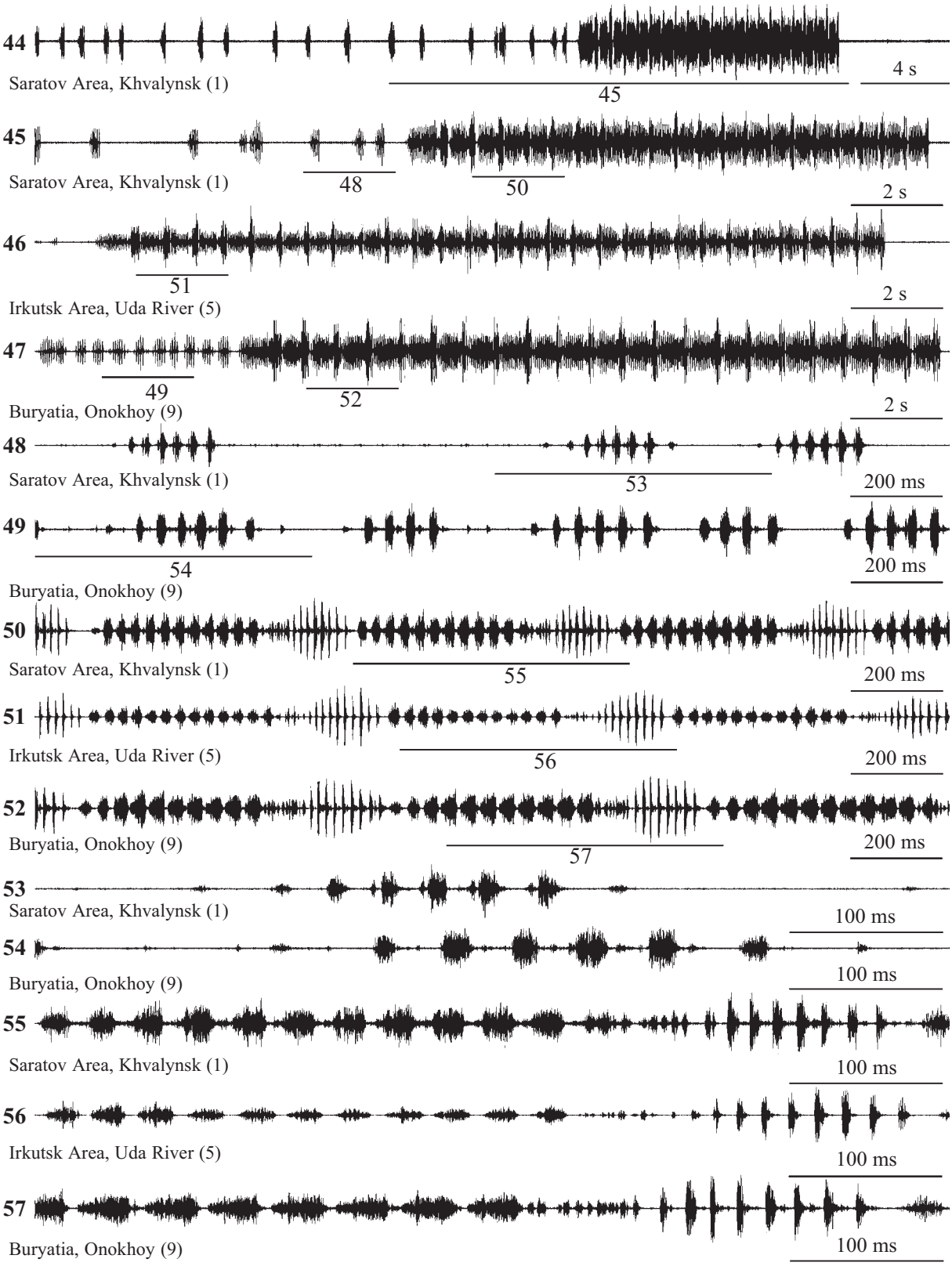
MATERIAL. 2. Saratov Area, Krasnokutskiy District, Dyakovka Village, 18.VII.2004. Signals of 3 ♂♂ are recorded at the temperature 30°C.

7. Irkutsk Area, steppes about 30 km north-east of Elantsy along the road Elantsy — Ol'khon Island (approx. 180 km north-east of



Figs 33–43. Oscillograms of signals of *Stenobothrus nigromaculatus* (Herrich-Schäffer, 1840) from steppes about 30 km north-east of Elantsy, Irkutsk Area (No. 7 on the map). 33–35 — calling song, 36–43 — courtship song. Faster oscillograms of the parts of songs indicated as "34–35" and "37–43" are given under the same numbers.

Рис. 33–43. Осциллограммы сигналов *Stenobothrus nigromaculatus* (Herrich-Schäffer, 1840) из степей около 30 км СВ поселка Еланцы, Иркутская обл. (точка № 7 на карте). 33–35 — призывный сигнал, 36–43 — сигнал ухаживания. Фрагменты сигналов, помеченные цифрами "34–35" и "37–43", представлены при большей скорости развертки на осциллограммах под такими же номерами.



Figs 44–57. Oscillograms of calling signals of *Stauroderus scalaris* (Fischer-Waldheim, 1846) from different localities (No. of the locality on the map is given in brackets). Faster oscillograms of the parts of songs indicated as "45" and "48–57" are given under the same numbers.

Рис. 44–57. Осциллограммы призывных *Stauroderus scalaris* (Fischer-Waldheim, 1846) из разных географических точек (в скобках указан номер точки на карте). Фрагменты сигналов, помеченные цифрами "45" и "48–57", представлены при большей скорости развертки на осциллограммах под такими же номерами.

Irkutsk), 15.VII.2003. Signals of 4 ♂♂ are recorded at the temperature 31°C

8. Buryatia, Barguzin Depression, Ina River 3–4 km west from Ina Village (about 40 km North-East from Barguzin Town), 17, 18.VII.2007. Signals of 3 ♂♂ are recorded at the temperature 20 and 25–27°C.

12. South-east of Chita Area, Klichkinskiy Mtn. Ridge at the crossing with Urulyunguy River (15 km west of Klichka Town), 22.VII.2003. Signals of 2 ♂♂ are recorded at the temperature 38–40°C.

14. Southern Maritime Province, Khankaiskiy District, 3–4 km north from Novokachalinsk Village, bank of Khanka Lake, 21.VII.2003. Signals of 3 ♂♂ are recorded at the temperature 33–34°C.

DISTRIBUTION. Crimea, southern part of European Russia, North Caucasus up to subalpine zone (2000–2300 m above sea level), Kazakhstan including North Tien-Shan, Turkmenistan (Kopet-Dagh Mtn. Ridge), Irkutsk Area, Transbaikalia, southern regions of the Russian Far East [Bukhvalova, 1998]. Until now was not found in Western Siberia (Altai, Tyva). Western boundary of the range is obscure.

REFERENCES TO SONG. Bukhvalova [1993b, 1998], Bukhvalova and Zhantiev [1994]: recordings from Crimea, southern regions of European Russia, North Caucasus, southern Turkmenistan, southern Kazakhstan, Amur Area and the Southern Maritime Province; Benediktov [2005]: recording from Irkutsk Area; Savitsky and Lekarev [2007]: recordings from the eastern parts of the Lower Volga Region.

SONG AND ACOUSTIC BEHAVIOUR. Similarly with other species of *Glyptobothrus* Chopard, 1951 from *biguttulus*-group, males of *G. maritimus* prefer to produce their songs sitting on the open places or on the ground among grass stems. This is one of the most actively-singing species of Gomphocerinae. Males readily sing in reply to each other so that at times their songs sound as an unceasing chorus. In a single male pauses between songs usually average 1–3 minutes and more. In males from the siberian and the far-eastern populations spontaneously produced signal as a rule consists of initial echeme having duration about 3.5–8 s after which 1–2 shorter ones (approximately 2.5–3 s each) follow (Figs 58–62). As an exception signal consisting of seven echemes once was registered in the male from Barguzin Depression. If the male produces his song in reply to another one, duration of the first echeme usually does not exceeds 3–4 s.

Each syllable consists of one low-amplitude rather long fragment followed by 3–5 high-amplitude ones usually separated by more or less distinct gaps (Figs 63–74). The structure of syllables is rather variable and occasionally has distinct differences even in the males from the same locality (Figs 67, 73 and 68, 74). Syllable repetition period averages 100–150 ms in our recordings.

COMPARATIVE NOTES. Comparative investigation of songs of this species from different localities was performed by Bukhvalova [1998]. Oscillograms of signals of individuals from Crimea, North Caucasus, southern part of European Russia, Turkmenistan, Kazakhstan and the Russian Far East are given in her paper. Two oscillograms of the only signal from Irkutsk are presented in the article by Benediktov [2005], descriptions of songs of *G. maritimus* from Transbaikalia were absent in literature.

As it was shown by Bukhvalova [1998], certain forms of *G. maritimus* from North Caucasus (*G. maritimus tsejensis* (Bukhvalova, 1993)), Turkmenistan (*G. maritimus karakalensis* (Sytshev et Woznessenskij, 1996)) and Southern Kazakhstan differ from european and the far-eastern ones. They usually produce single echemes of greater duration (10–20 s); in males from Caucasus and Turkmenistan gaps in syllables are more distinct, than in individuals from steppes of European Russia.

Males from European Russia and Eastern Siberia are quite similar with representatives of nominotypical (far-eastern) subspecies both in general pattern and in temporal parameters of signals (Figs 58, 63, 69 — male from Saratov Area and 59–62, 64–68, 70–74 — males from the eastern regions of Russia).

Chorthippus hammarstroemi (Miram, 1907)

MATERIAL. 10. Buryatia, the valley of Selenga River 5 km north from Novoselenginsk (20 km south-south-east from Gusinoozersk), 8, 9.VII.2007. Signals of 2 ♂♂ are recorded at the temperature 26 and 31–32°C.

12. South-east of Chita Area, Klichkinskiy Mtn. Ridge at the crossing with Urulyunguy River (15 km west of Klichka Town), 22.VII.2003. Signals of 2 ♂♂ are recorded at the temperature 30–31°C.

14. Southern Maritime Province, Khankaiskiy District, 3–4 km north from Novokachalinsk Village, bank of Khanka Lake, 17.VII.2002 and 21.VII.2006. Signals of 3 ♂♂ are recorded at the temperature 23–25 and 27–28°C.

15. Southern Maritime Province, Khasan Region, environs of Andreevka Village (about 35 km south-west from Slavyanka), 14.VII.2006. Signals of 1 ♂ are recorded at the temperature 23–25°C.

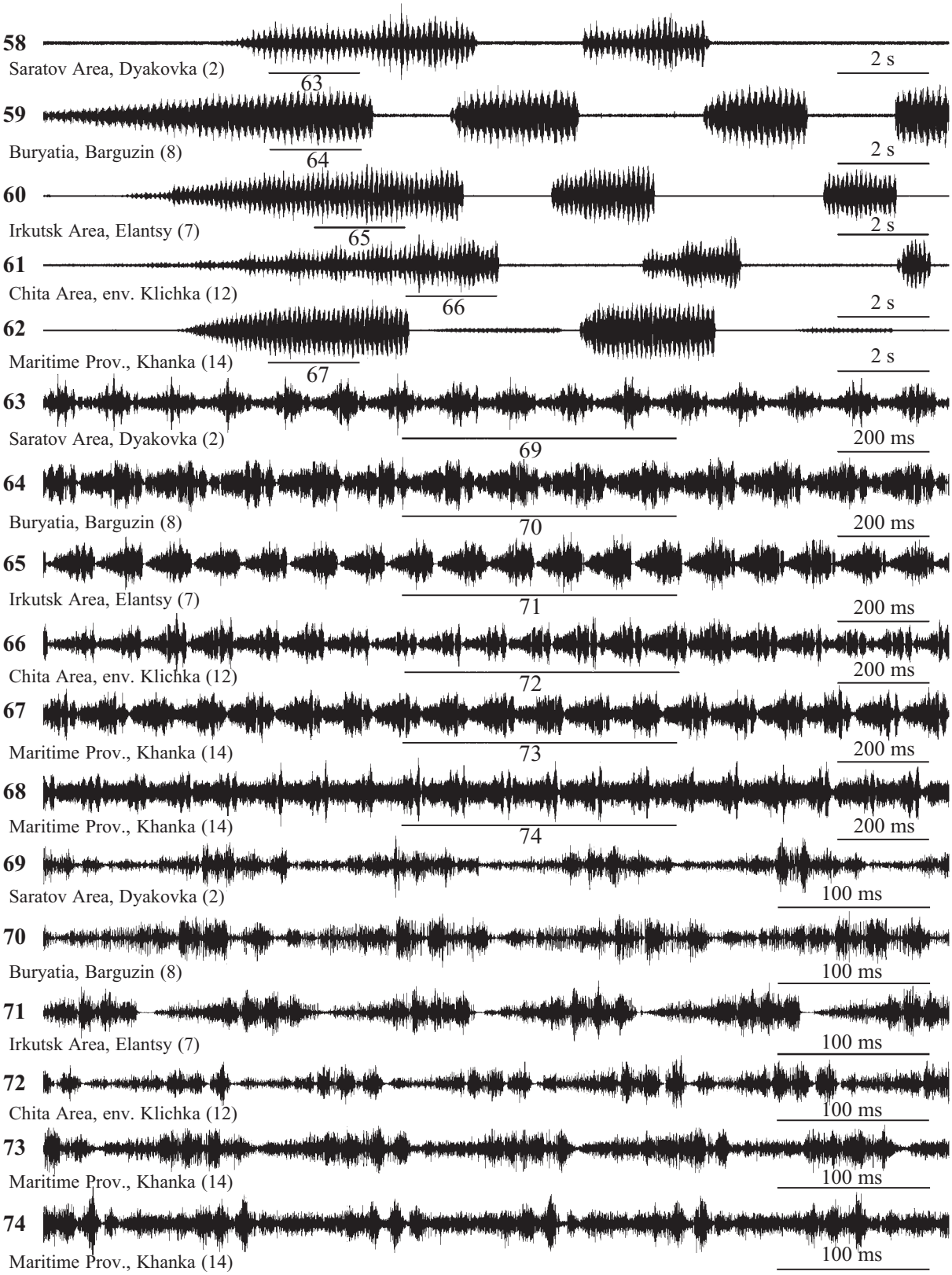
DISTRIBUTION. Southern Siberia from Altai to Transbaikalia (northwards as far as Yakutia), southern part of the Russian Far East, Mongolia, south-east of China.

REFERENCES TO SONG. Benediktov [2005]: recordings from Tyva.

SONG AND ACOUSTIC BEHAVIOUR. The calling song of a single individual is an echeme lasting for 10–20 s (Figs 75–78). In actively singing male 5–10 and more echemes can follow each other with short breaks about 2–10 s. Syllable repetition period averages 200–300 ms at the temperature 27–31°C and 300–500 ms at 23–25°C. Sometimes it becomes slightly longer towards the end of the echeme. The echeme begins quietly reaching maximum intensity in 5–10 s. Each syllable includes low- and high-amplitude parts (Figs 79–102). In the syllables from the beginning of the song the former part is almost indistinguishable, whereas the latter one includes 5–7 short pulses separated by distinct gaps (Figs 79, 82, 85, 88, 91, 94, 97, 100). Towards the end of the signal low-amplitude part gradually becomes more distinct, whereas the gaps in the high-amplitude one disappear partly or entirely (Figs 80–81, 83–84, 86–87, 89–90, 92–93, 95–96, 98–99, 101–102). As a rule, male sings sitting on the grass, usually preferring the place in the middle or in the lower half of the stem.

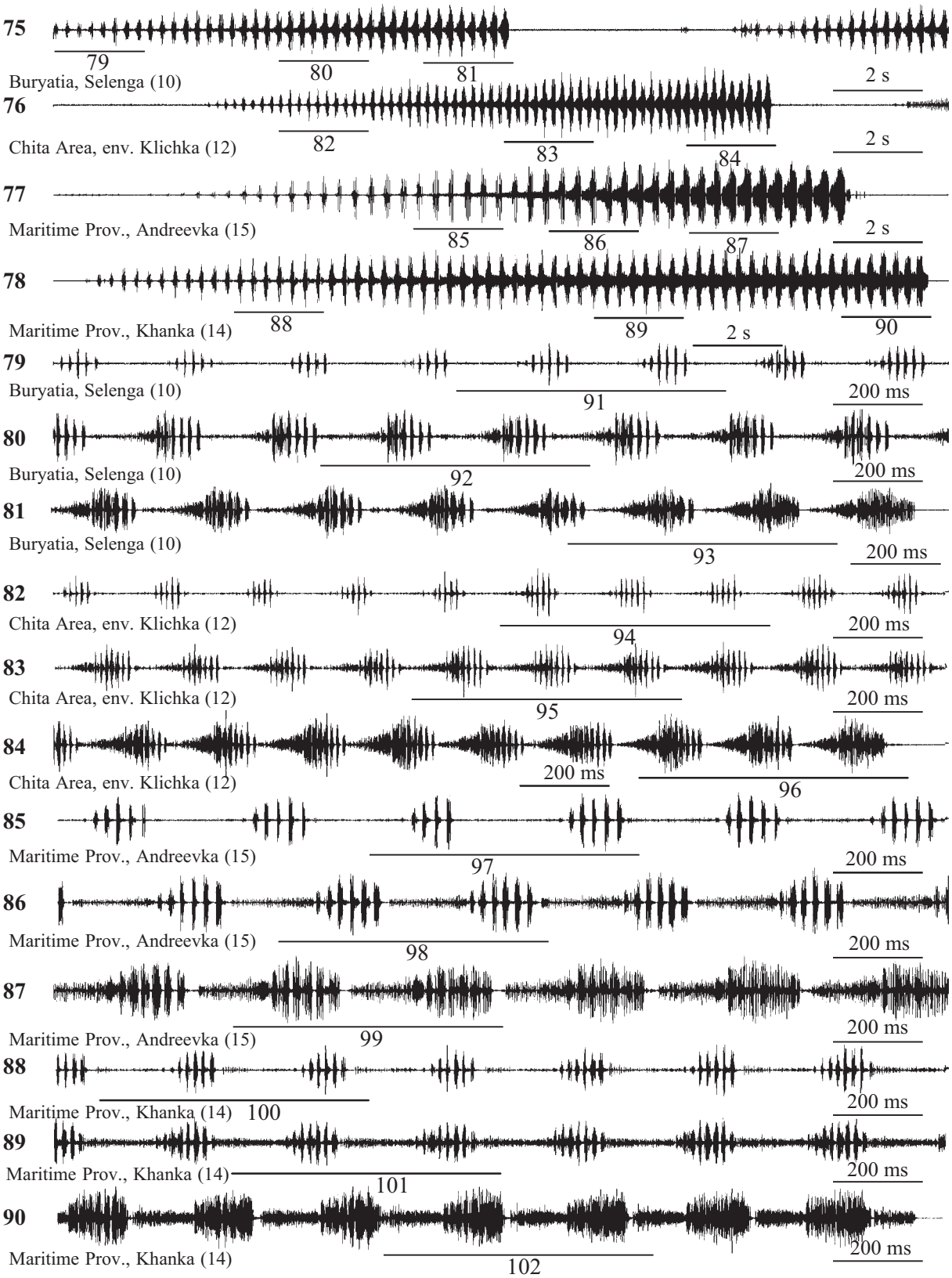
Male courting female produce the same signal, but the duration of echemes became more variable and averages from 5–8 up to 38–40 s (Figs 103–109). Syllable shape and repetition period remain the same as in the calling song (Figs 110–112). Quite often the male sitting next to female sings ceaselessly for about 10 minutes and more. In this situation it produces echemes more regularly with shorter intervals up to 4–5 s (Figs 103–105). Then the male suddenly stops singing and makes an attempt of copulation. It produces a succession of syllables of variable structure at this moment (Figs 113–116). Duration of syllables averages 200–250 ms and their repetition period is about 250–700 ms in our recordings. Occasionally, these syllables alternate with short successions of discrete pulses similar with these in syllables from the beginning of calling (Figs 114–115).

COMPARATIVE NOTES. Only oscillogram of one calling signal of male from Tyva (Kyzyl) exists in literature [Benediktov, 2005]. Both general pattern and temporal parameters of signals of males from different populations are quite similar. It should be noted, that all the material studied belongs to nominotypical subspecies.



Figs 58–74. Oscillograms of calling signals of *Glyptobothrus maritimus* (Mistshenko, 1951) from different localities (No. of the locality on the map is given in brackets). Faster oscillograms of the parts of songs indicated as "63–67" and "69–74" are given under the same numbers.

Рис. 58–74. Осциллограммы призывных сигналов *Glyptobothrus maritimus* (Mistshenko, 1951) из разных географических точек (в скобках указан номер точки на карте). Фрагменты сигналов, помеченные цифрами "63–67" и "69–74", представлены при большей скорости развертки на осциллограммах под такими же номерами.



Figs 75–90. Oscillograms of calling signals of *Chorthippus hammarstroemi* (Miram, 1907) from different localities (No. of the locality on the map is given in brackets). Faster oscillograms of the parts of songs indicated as "79–102" are given under the same numbers.

Рис. 75–90. Осциллограммы призывных *Chorthippus hammarstroemi* (Miram, 1907) из разных географических точек (в скобках указан номер точки на карте). Фрагменты сигналов, помеченные цифрами "79–102", представлены при большей скорости развертки на осциллограммах под такими же номерами.

Chorthippus caliginosus Mistshenko, 1951

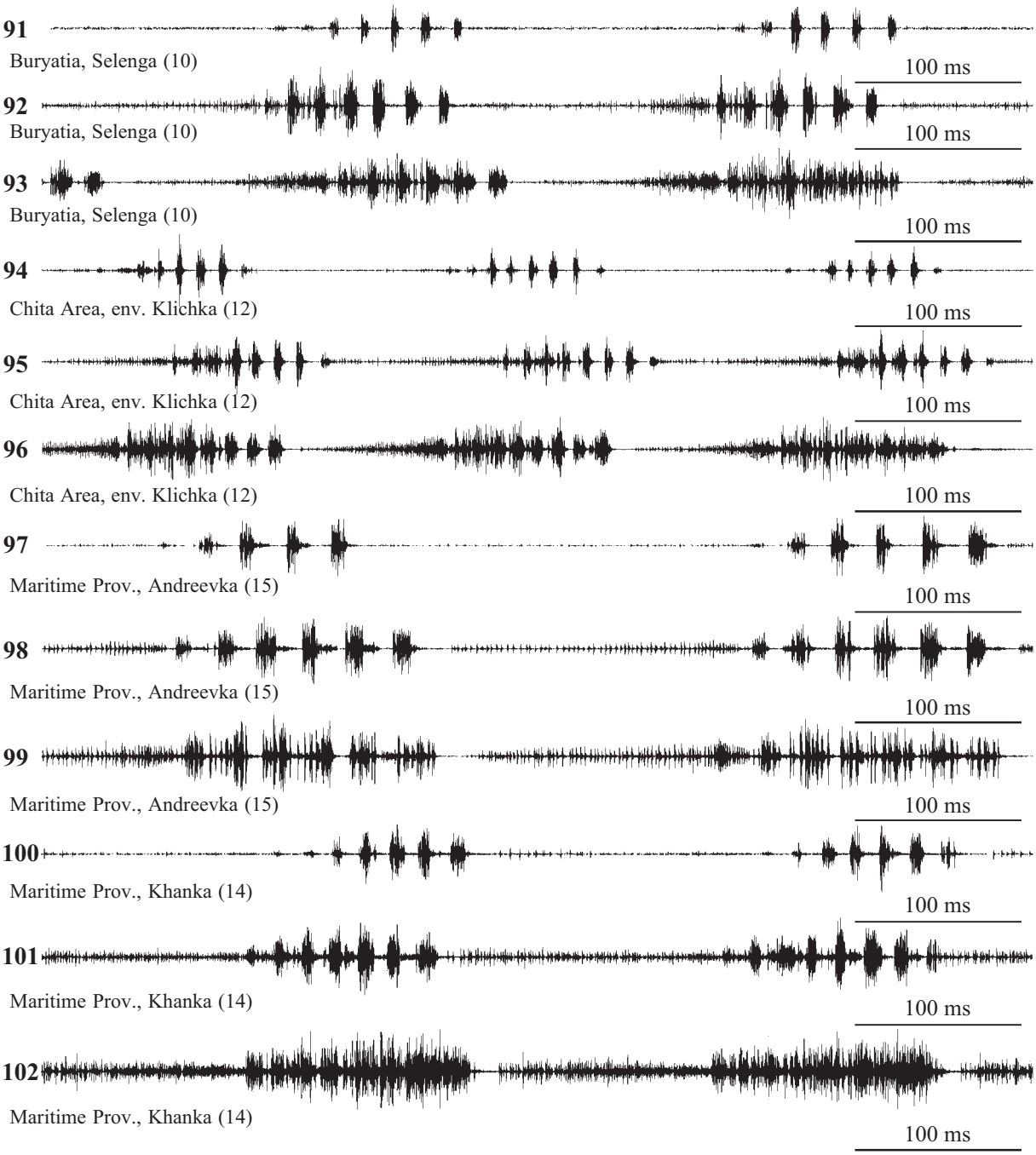
MATERIAL. 10. Buryatia, the valley of Selenga River 5 km north from Novoselenginsk (20 km south-south-east from Gusinoozersk), 8.VII.2007. Signals of 2 ♂♂ are recorded at the temperature 31–32°C.

DISTRIBUTION. Southern regions of Transbaikalia, Amur Area and Khabarovsk Region, also, south-east of China.

REFERENCES TO SONG. Vedenina and Bukhvalova [2001]: recordings from two localities in Chita Area.

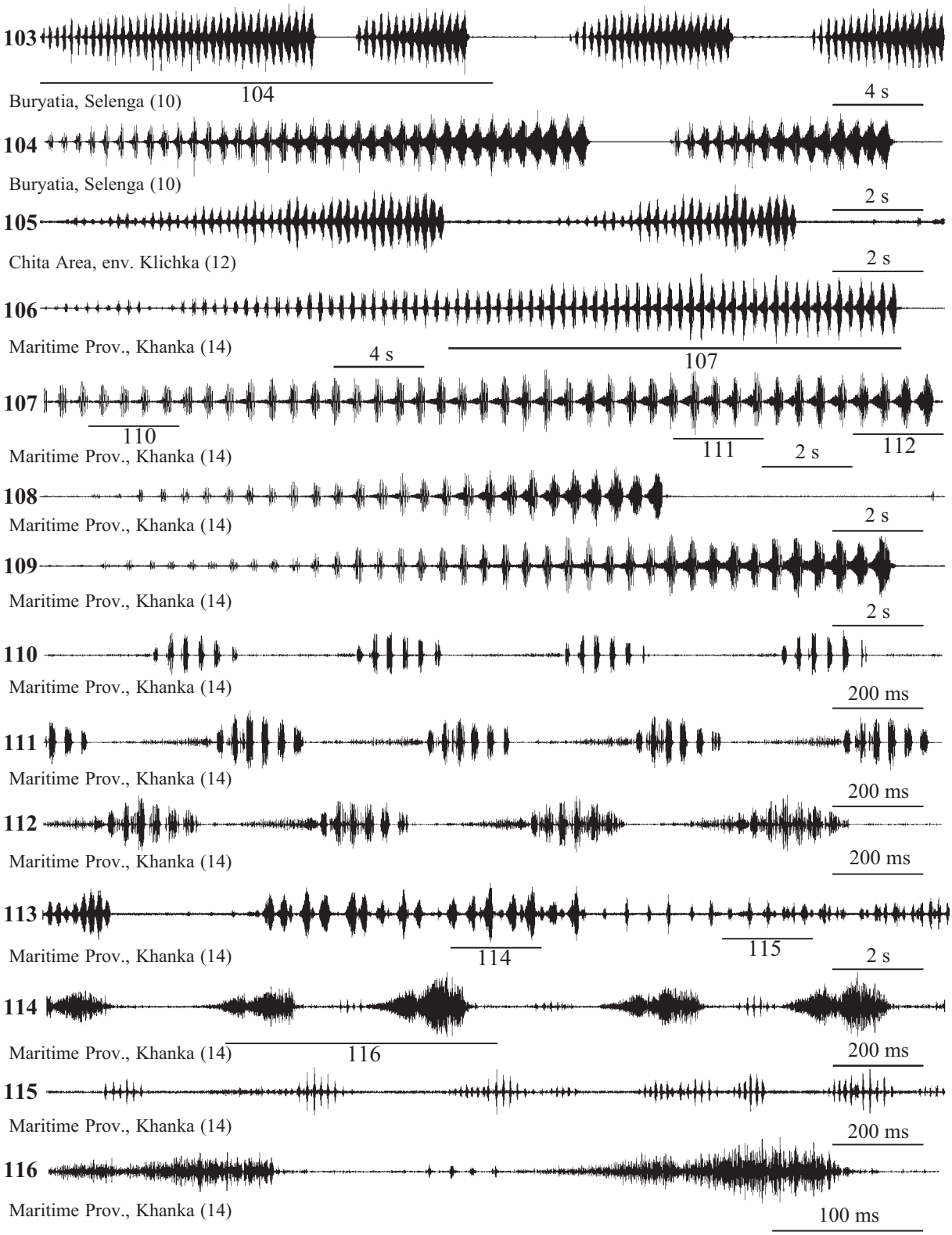
SONG AND ACOUSTIC BEHAVIOUR. Calling song is a succession of short fragments consisting of two echemes each (Figs 117–121). If male is not disturbed, the signal can last up to 20–30 s and more. Occasionally, the amplitude of the song slightly increases towards its end. Fragments in it repeat with the period about 2–3 s, duration of each fragment averages 0.8–1.0 s. Syllables repetition period in echemes is about 10–15 ms. Usually (but not always), initial syllable in the echeme has higher amplitude than succeeding ones.

Male sings sitting on the grass among dense vegetation. Sometimes, two or three neighbouring individuals sing in turn, so that their echemes alternate.



Figs 91–102. Oscillograms of the parts of calling signals of *Chorthippus hammarstroemi* (Miram, 1907) from different localities (also, see Figs 75–90, No. of the locality on the map is given in brackets).

Рис. 91–102. Осциллограммы фрагментов призывных сигналов *Chorthippus hammarstroemi* (Miram, 1907) из разных географических точек (см. также рис. 75–90, в скобках указан номер точки на карте).



Figs 103–116. Oscillograms of signals of *Chorthippus hammarstroemi* (Miram, 1907) from different localities (No. of the locality on the map is given in brackets). 103–112 — courtship song, 113–116 — precopulatory song. Faster oscillograms of the parts of songs indicated as "104", "107", "110–112" and "114–116" are given under the same numbers.

Рис. 103–116. Осциллограммы сигналов *Chorthippus hammarstroemi* (Miram, 1907) из разных географических точек (в скобках указан номер точки на карте). 103–112 — сигнал ухаживания, 113–116 — прекопуляционный сигнал. Фрагменты сигналов, помеченные цифрами "104", "107", "110–112" и "114–116", представлены при большей скорости развертки на осциллограммах под такими же номерами.

COMPARATIVE NOTES. Only signals of *Ch. caliginosus* from two localities in Chita Area were described in literature [Vedenina & Bukhvalova, 2001]. Songs of males from Buryatia and Chita Area have no significant differences.

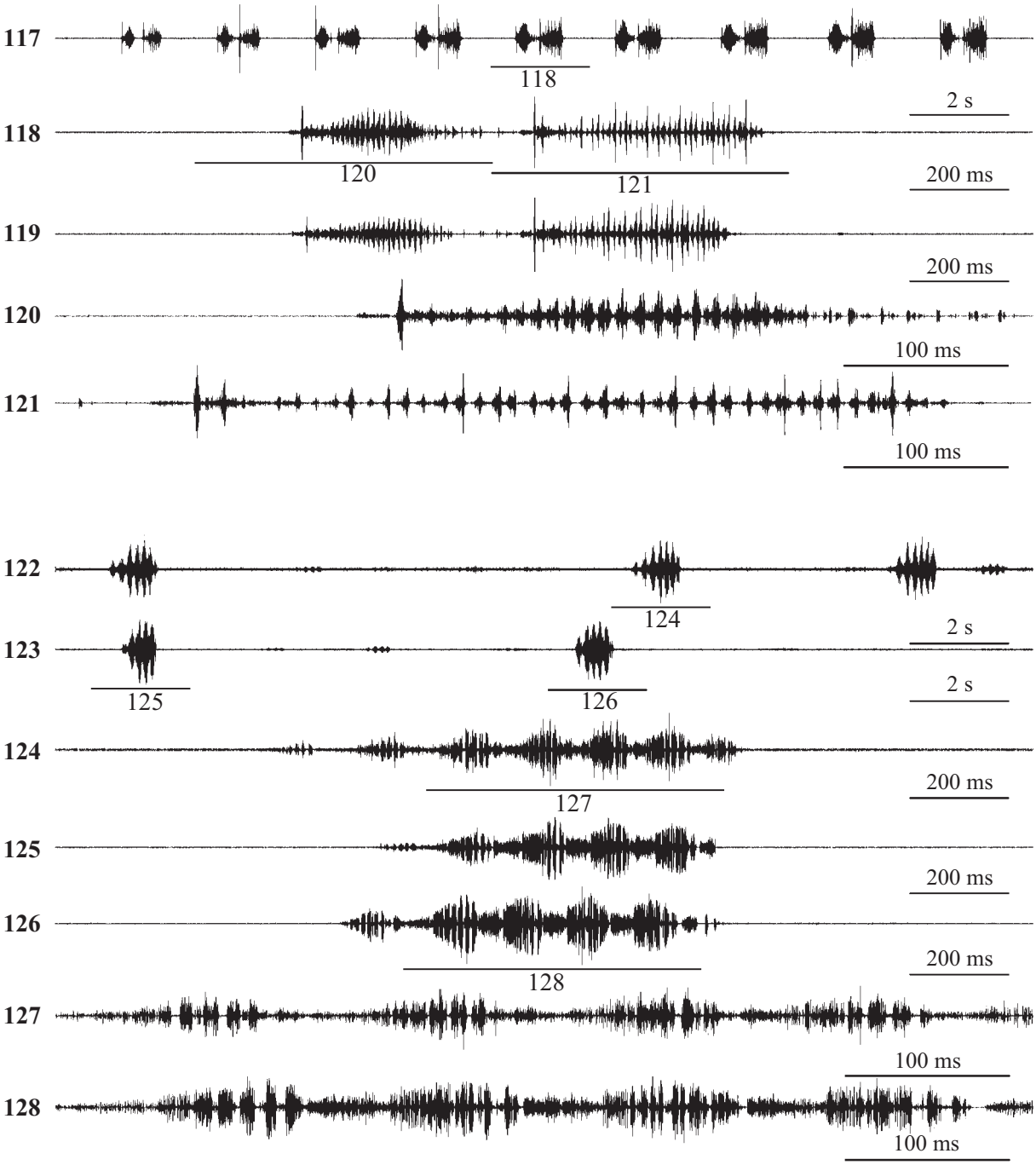
Schmidtiacris schmidti (Ikonnikov, 1913)

MATERIAL. 10. Buryatia, the valley of Selenga River 5 km north from Novoselenginsk (20 km south-south-east from Gusinoozersk), 7.VII.2007. Signals of 1 ♂ are recorded at the temperature 30–32°C.

DISTRIBUTION. Tyva, Southern Transbaikalia, southern regions of the Russian Far East, Korea.

REFERENCES TO SONG. Bukhvalova and Vedenina [1998]: recording from Amur Area (as *Chorthippus schmidti*).

SONG AND ACOUSTIC BEHAVIOUR. Calling song consists of single or irregularly repeated short echemes hav-



Figs 117–128. Oscillograms of calling signals of *Chorthippus caliginosus* Mistshenko, 1951 (117–121) and *Schmidtiacris schmidti* (Ikonnikov, 1913) (122–128) from Selenga valley, Buryatia (No. 10 on the map). Faster oscillograms of the parts of songs indicated as "118", "120–121" and "124–128" are given under the same numbers.

Рис. 117–128. Осциллограммы *Chorthippus caliginosus* Mistshenko, 1951 (117–121) и *Schmidtiacris schmidti* (Ikonnikov, 1913) (122–128) из долины Селенги, Бурятия (точка № 10 на карте). Фрагменты сигналов, помеченные цифрами "118", "120–121" и "124–128", представлены при большей скорости развертки на осциллограммах под такими же номерами.

ing duration about 0.6–1 s and including 5–7 syllables each (Figs 122–128). Syllable repetition period averages 120–150 ms in our recordings.

Usually, singing males form aggregations in wet places with high dense grass (e.g. on gramineous vegetation on river banks). Calling males sit on the tall grass stems about 0.5–1 m above the ground. Neighbouring individuals produce signals with irregular intervals from 4–6 s up to one minute and more so that echemes of different males alternate.

COMPARATIVE NOTES. Presently, oscillograms of the only signal of individual from Amur Area were published. Our recordings are quite similar with this presented in Bukhvalova and Vedenina [1998].

Schmidtiacris Storozhenko, 2002 differs from *Chorthippus* s. str. both in morphological and karyological characters [Sergeev & Bugrov, 1988; Storozhenko, 2002]. Nonetheless, temporal pattern of syllables in this species is quite similar with this in certain species from other genera, including *Chorthippus* and *Glyptobothrus* (Figs 127–128 and 69–74, 87). This fact is in a good agreement with the opinion of other authors [Ragge & Reynolds, 1998; Savitsky, 2005] that bioacoustic characters in taxonomy of Gomphocerinae are of little or no value on superspecies level.

Aeropedellus variegatus variegatus (Fisher von Waldheim, 1846)

MATERIAL. 3. East of Saratov Region, 10 km east of Ozinki town, 25.VI.1996. Signals of 3 ♂♂ are recorded at the temperature 27–30°C.

11. South-east of Chita Area, the valley of Onon River 5–6 km west of Nizhniy Tsasuchey village, 19.VI.1995. Signals of 3 ♂♂ are recorded at the temperature 29°C.

DISTRIBUTION. Mountains of Western Europe, European Russia, North Caucasus, South-eastern Kazakhstan, Siberia (northwards as far as Yakutia).

REFERENCES TO SONG. Bukhvalova and Vedenina [1998]: recordings from two localities listed above.

SONG AND ACOUSTIC BEHAVIOUR. The calling song is a series of several echemes (2–6 in our recordings) repeated with intervals of 2.5–5 s (Figs 129–133). The echeme lasts for 1.8–3 s (mean value 2.4±0.10 s) reaching maximum in the second half or in the end of its duration. The echeme consists of short simple syllables following each other at a rate 70–80/s (recording at 27°C from Saratov Area) or 85–90/s (recording at 29°C from Chita Area) almost without gaps (Figs 134–143).

Male usually produce his song sitting on the soil or on the grass close to the ground.

COMPARATIVE NOTES. A description of calling song of this species illustrated by three oscillograms of the recording from Chita Area is given in Bukhvalova and Vedenina [1998]. More comprehensive description is provided here for comparison with the song of the next subspecies.

Aeropedellus variegatus minutus Mistshenko, 1951

MATERIAL. 7. Irkutsk Area, steppes about 30 km north-east of Elantsy along the road Elantsy — Ol'khon Island (approx. 180 km north-east of Irkutsk), 15.VII.2003. Signals of 4 ♂♂ are recorded at the temperature 27 and 33°C.

DISTRIBUTION. Steppes of Irkutsk Area.

REFERENCES TO SONG. Unknown.

SONG AND ACOUSTIC BEHAVIOUR. In general structure the calling song is similar with this of nominotypical subspecies, but differs from it in longer echemes averaging 3.6–6.5 s (mean value 4.7±0.15 s) (Figs 144–152). Usually, wave-like changes of amplitude present in the echemes (Figs 146, 149–152), but this character can vary even in the song of the same male (on Figs 144–146 three parts of one song are presented). Syllable repetition rate is almost the same as in *Ae. variegatus variegatus* and averages 60–70 syllables/s at the temperature 27°C and 80 syllables/s at 33°C (Figs 153–162). Occasionally, syllables are grouped in pairs and separated by distinct gaps, but their repetition rate remains the same (Figs 157, 162). We emphasize that such signal was registered from the intact male with two hind legs.

Singing male usually sits on the ground and walks from one place to another during pauses between echemes. If it starts singing when moving, amplitude distortions present in the beginning of the echeme (e.g. Fig. 147, the last echeme).

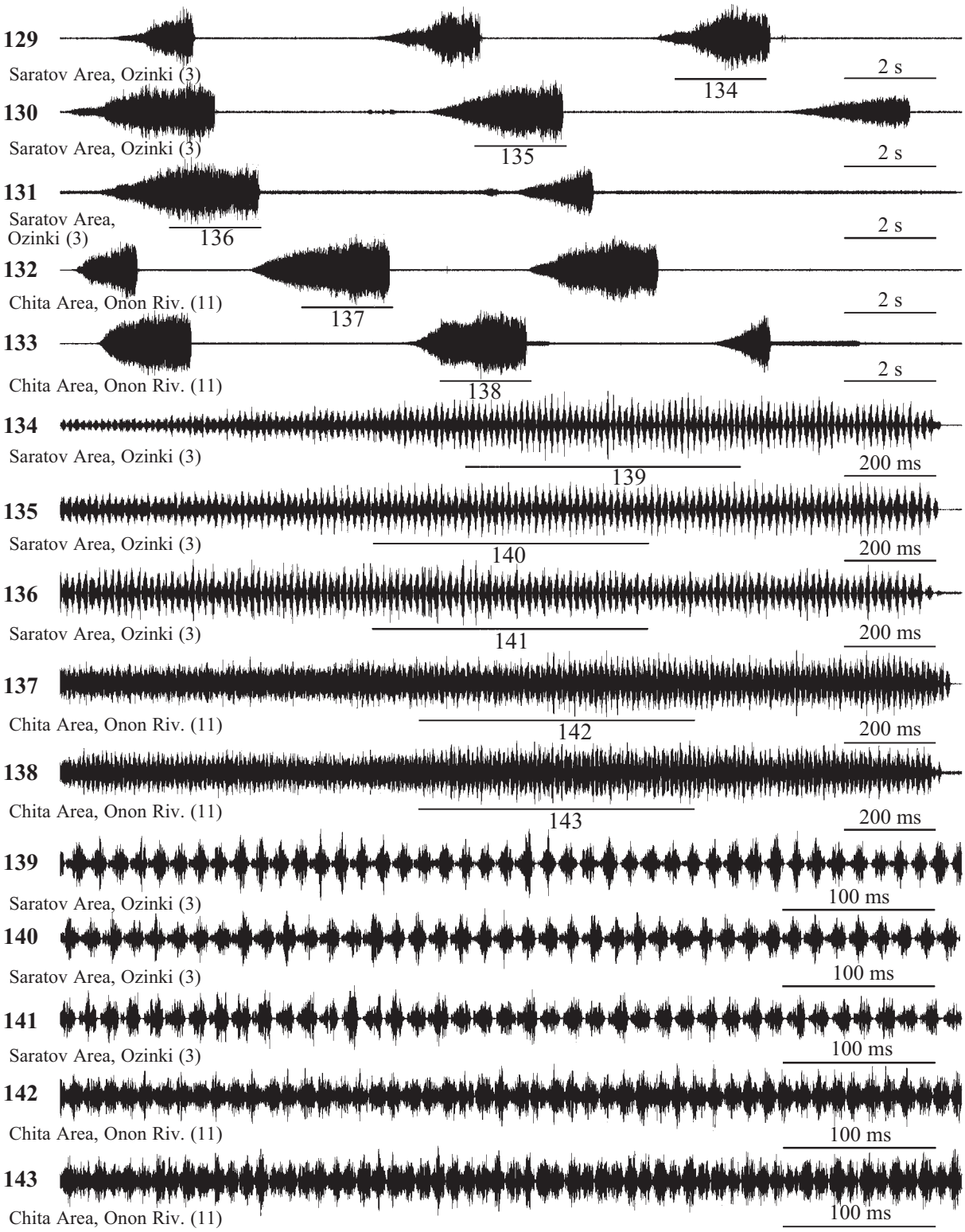
In the region of our observations *Ae. variegatus minutus* inhabited steppes, preferring wet moderately salted meadows with gramineous vegetation on the shores of shallow salted lakes.

COMPARATIVE NOTES. There is no consensus of opinion among authors as to the taxonomic status of certain siberian forms in the genus *Aeropedellus* Hebard, 1935. The form with swelled fore tibiae from Minusinsk Depression and Irkutsk Area was described almost contemporaneously by Miram [1906–1907] as *Ae. reuteri* (Miram, 1907) and Ikonnikov [1911] under the name *Ae. simillimus* (Ikonnikov, 1911). Later it was treated as a synonym of *Ae. variegatus* by Tarbinskiy [1931]. Mistshenko subdivided *Ae. variegatus* s. str. into five subspecies, among them *Ae. variegatus minutus* from steppes of Irkutsk Area [Bey-Bienko & Mistshenko 1951]. Also, he considered *Ae. reuteri* as a separate species; this opinion was accepted by Ivanova [1967] and Sergeev [1986]. On the other hand, Berezhkov [1956] in his comprehensive work on grasshoppers of Western Siberia points out that he has never collected this form in the region under investigation. In other articles on grasshoppers of Siberia for the most part the name *Ae. variegatus* is used without specifying the subspecies. *Ae. variegatus minutus* was only mentioned in the catalogue of Orthoptera of Northern Asia in the monograph by Sergeev [1986].

It should be pointed out that morphological characters in *Aeropedellus* are rather variable. For this reason differences between certain forms sometimes are obscure. Fore tibiae in our specimens from Irkutsk Area (Fig. 180) are slightly wider than in *Ae. variegatus variegatus* from Saratov (Figs 173–174) and Chita Areas (Figs 176–177), but are not so swelled as in *Ae. reuteri* (Figs 183–184; topotypes of *Ae. simillimus* with the label "Minusinsk, P.P. Sushkin, 10.VI.1902"). In the form of lateral carinae of pronotum and in width ratio of claw and arolium males from Irkutsk Area fall into *Ae. variegatus minutus* (Fig. 181–182), however among *Ae. variegatus variegatus* specimens with wide arolium also can be found (Fig. 178).

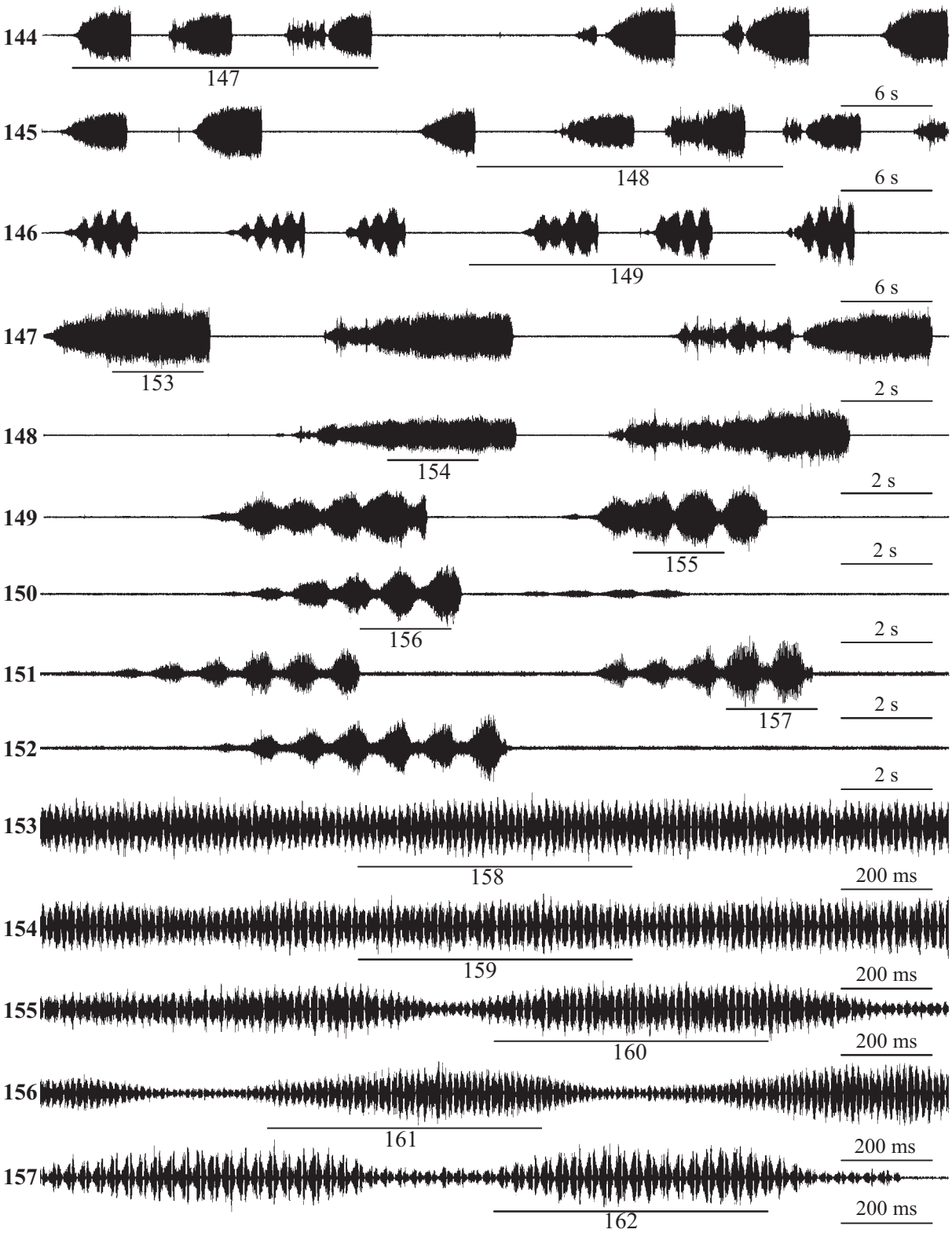
The specimens from Chita Area are somewhat larger than the ones from Saratov Area, still, according to the key in Bey-Bienko and Mistshenko [1951], the material from both localities belongs to nominotypical subspecies. It is worth noting that *Ae. variegatus variegatus* was recorded from South-Eastern Transbaikalia by Popov [1964].

Echemes in *Ae. variegatus minutus* are about twice as long as in *Ae. variegatus variegatus*, moreover, the ranges of variability of this parameter do not overlap. Also, in the echemes of *Ae. variegatus minutus* wave-shaped changes of amplitude usually (but not always!) present, whereas for signals of *Ae. variegatus variegatus* as a rule rather monotonous increasing of amplitude along echeme is intrinsic. On the other hand, both temporal pattern and repetition rate of syllables in two subspecies are almost identical. Thus, these two forms differ distinctly from each other only in echeme



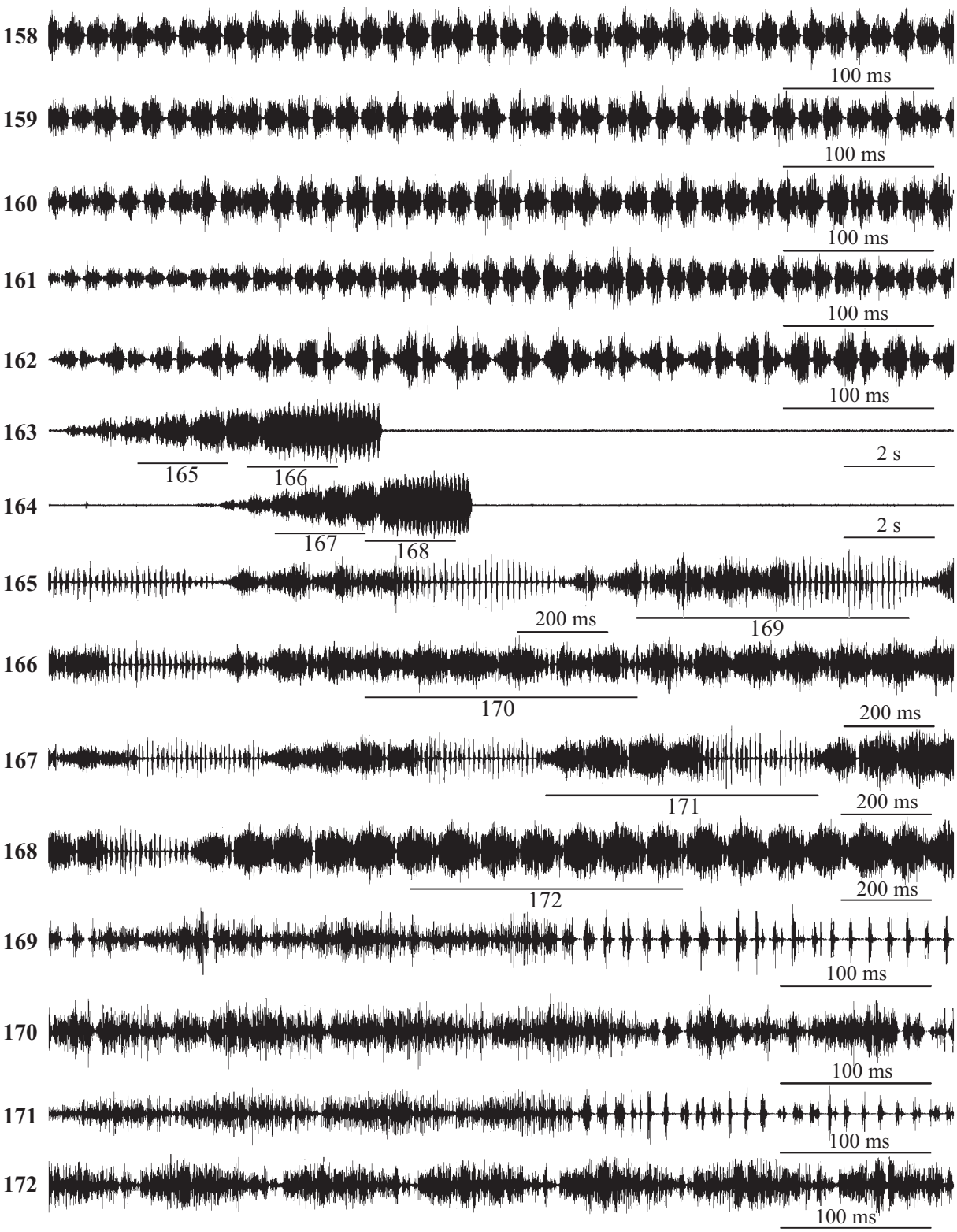
Figs 129–143. Oscillograms of calling signals of *Aeropedellus variegatus variegatus* (Fisher-Waldheim, 1846) from different localities (No. of the locality on the map is given in brackets). Faster oscillograms of the parts of songs indicated as "134–143" are given under the same numbers. 129, 134 and 139 — male No.1, 130, 135 and 140– male No.2, 131, 136 and 141 — male No.3, 132, 137 and 142 — male No.4, 133, 138 and 143 — male No.5.

Рис. 129–143. Осциллограммы призывных сигналов *Aeropedellus variegatus variegatus* (Fisher-Waldheim, 1846) из разных географических точек (в скобках указан номер точки на карте). Фрагменты сигналов, помеченные цифрами "134–143", представлены при большей скорости развертки на осциллограммах под такими же номерами. 129, 134 и 139 — самец № 1, 130, 135 и 140– самец № 2, 131, 136 и 141 — самец № 3, 132, 137 и 142 — самец № 4, 133, 138 и 143 — самец № 5.



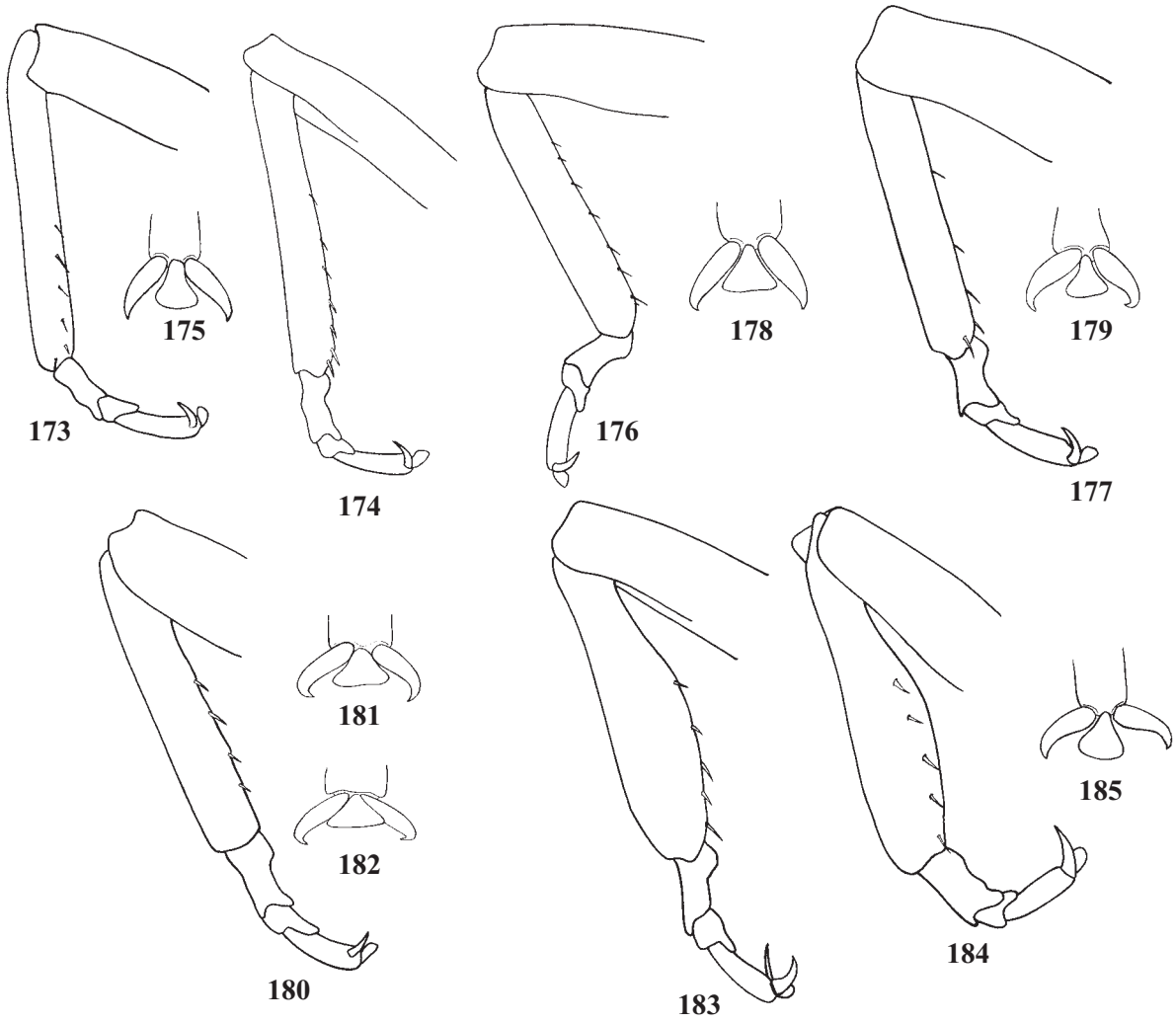
Figs 144–157. Oscillograms of calling signals of *Aeropedellus variegatus minutus* Mistshenko, 1951 from steppes about 30 km north-east of Elantsy, Irkutsk Area (No. 7 on the map). Faster oscillograms of the parts of songs indicated as "147–149" and "153–162" are given under the same numbers. 144–149 and 153–155 — male No.1, 150 and 156– male No.2, 151 and 157 — male No.3, 152 — male No.4.

Рис. 144–157. Осциллограммы призывных сигналов *Aeropedellus variegatus minutus* Mistshenko, 1951 из степей около 30 км СВ поселка Еланцы, Иркутская обл. (точка № 7 на карте). Фрагменты сигналов, помеченные цифрами "147–149" и "153–162", представлены при большей скорости развертки на осциллограммах под такими же номерами. 144–149 и 153–155 — самец № 1, 150 и 156 — самец № 2, 151 и 157 — самец № 3, 152 — самец № 4.



Figs 158–172. 158–162 — oscillograms of the parts of calling signals of *Aeropedellus variegatus minutus* Mistshenko, 1951 from steppes about 30 km north-east of Elantsy, Irkutsk Area, No. 7 on the map (also, see Figs 144–157). 163–172 — oscillograms of calling signals of *Dasyhippus barbipes* (Fischer-Waldheim, 1846) from the environs of Onokhoy, Buryatia, No. 9 on the map. Faster oscillograms of the parts of songs indicated as "165–172" are given under the same numbers.

Рис. 158–172. 158–162 — осциллограммы фрагментов призывных сигналов *Aeropedellus variegatus minutus* Mistshenko, 1951 из степей около 30 км СВ поселка Еланцы, Иркутская обл., точка № 7 на карте (см. также Рис. 144–157). 163–172 — осциллограммы призывных сигналов *Dasyhippus barbipes* (Fischer-Waldheim, 1846) из окрестностей Онохоя, Бурятия, точка № 9 на карте. Фрагменты сигналов, помеченные цифрами "165–172", представлены при большей скорости развертки на осциллограммах под такими же номерами.



Figs 173–185. Fore leg (173–174, 176–177, 180, 183–184) and claws and arolium of middle tarsus (175, 178–179, 181–182, 185) of *Aeropedellus* spp.: 173–175 — *Ae. variegatus variegatus* from Ozinki, Saratov Area (No. 3 on the map); 176–179 — same from Chita Area (No. 11 on the map); 180–182 — *Ae. variegatus minutus* Mistshenko, 1951 from Irkutsk Area (No. 7 on the map); 183–185 — *Ae. reuteri* (Miram, 1907) from Minusinsk.

Рис. 172–184. Передняя нога (173–174, 176–177, 180, 183–184) и коготки и присоска средних лапок (175, 178–179, 181–182, 185) видов *Aeropedellus*: 173–175 — *Ae. variegatus variegatus* из Озинок Саратовской обл. (точка № 3 на карте); 176–179 — то же из Читинской обл. (точка № 11 на карте); 180–182 — *Ae. variegatus minutus* Mistshenko, 1951 из Иркутской обл. (точка № 7 на карте); 183–185 — *Ae. reuteri* (Miram, 1907) из Минусинска.

duration. On the contrary, populations of *Ae. variegatus variegatus* from Saratov and Chita Areas do not differ significantly in this character (probability of identity P=0.38 by Wilcoxon test), consequently, this is a very constant parameter of the signal within a subspecies. This give good reason to believe that *Ae. variegatus minutus* is a separate subspecies. Differences of the same level (different duration of echemes, but identical syllable structure and repetition rate) were also described between subspecies of *Mongolotettix japonicus* (I. Bolivar, 1898) and *G. maritimus* [Bukhvalova, 1998; Vedenina & Bukhvalova, 2001].

Dasyhippus barbipes (Fischer-Waldheim, 1846)

MATERIAL. 9. Buryatia, 10 km east of Onokhoy (about 60 km east of Ulan-Ude), the valley of Bryanka Riv., 1.VII.2006. Signals of 1 ♂ are recorded at the temperature 36°C.

DISTRIBUTION. Transbaikalia, Mongolia, northern China.

REFERENCES TO SONG. Bukhvalova and Vedenina [1998]: recordings from Chita Area.

SONG AND ACOUSTIC BEHAVIOUR. The calling song is an echeme lasting for about 4.5–7.5 s (Figs 163–164). Its main part consists of 4–6 complex fragments each including 15–30 short discrete pulses followed by 4–6 syllables (Figs 165, 167, 169, 171). Pulses repeat at a rate 80–110/s, syllable repetition period averages approximately 80–130 ms. The main part lasts for about 2.8–4.5 s in our recordings. The song ends with a succession of 15–30 syllables of the same structure as in the main part (Figs 166, 168, 170, 172).

Male produces signals with prolonged irregular intervals averaging several minutes. It chooses for singing the places with bare ground among sparse vegetation.

COMPARATIVE NOTES. Signals of individuals from Buryatia and Chita Area are quite similar both in temporal pattern and in quantitative parameters.

Chrysochraon dispar major Uvarov, 1925

MATERIAL. 13. South-west of Khabarovsk Province, about 5 km north of Obluchye Town, 5–6.VII.2002. Signals of 3 ♂♂ are recorded at the temperature 29–30 and 34–35°C.

DISTRIBUTION. Eastern part of North Caucasus (Dagestan), Georgia, South-eastern Kazakhstan, Kyrgyzstan, Eastern and North-eastern Uzbekistan, Transbaikalia, Amur Area, south of Khabarovsk Province, Maritime Province, Western China [Mistshenko, 1986].

REFERENCES TO SONG. *Ch. dispar dispar* (Germar, 1831): Ragge and Reynolds [1998] (recordings from Western Europe); Vedenina and Bukhvalova [2001] (recordings from Ukraine and European Russia).

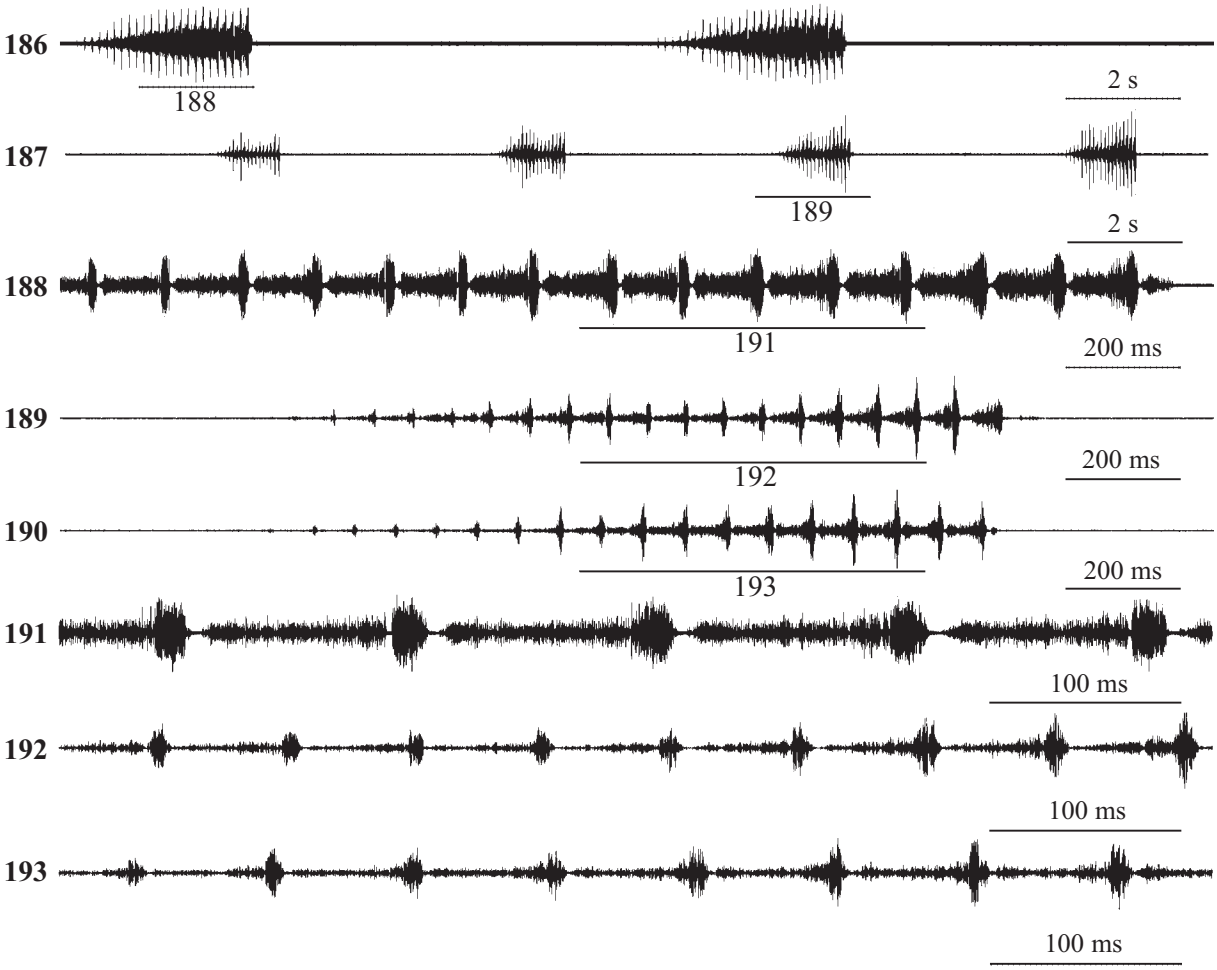
Ch. dispar major: Vedenina and Bukhvalova [2001] (recordings from southern Kazakhstan; subdivision into subspecies is not given in the paper).

SONG AND ACOUSTIC BEHAVIOUR. The calling song is a sequence of echemes, each lasting from 1.2–1.5 s (includes 18–20 syllables; recording at 34–35°C, Figs 187, 189–190, 192–193) up to 3–3.5 s (includes 23–26 syllables; recording at 29–30°C, Figs 186, 188, 191). Syllables repetition period in these two cases averages 65–85 and 110–130 ms respectively. Evidently, such differences result not only from different temperatures during recording, but also from individual variability. Male produce signals sitting on the stem among dense vegetation. If not disturbed, it can sing unceasingly for several minutes.

COMPARATIVE NOTES. Calling songs of *Ch. dispar dispar* (Germar, 1831) from many localities in Western Europe, Ukraine and European Russia were described in literature. Temporal pattern of signals of individuals from different populations are quite similar and do not differ from these of *Ch. dispar major*. Temporal parameters of songs within each subspecies as well as in different subspecies overlap to a large extent (Table).

Discussion

Presently, a great body of information on acoustic signals of palaearctic Gomphocerinae exists in literature. For the most part of species descriptions of calling songs from different populations were studied. However, such investigations usually were conducted within the boundaries of Western Europe or European Russia. The only exception is the article by Vedenina and



Figs 186–193. Oscillograms of calling signals of *Chrysochraon dispar major* Uvarov, 1925 from the environs of Obluchye, Khabarovsk Province (No. 13 on the map). Faster oscillograms of the parts of songs indicated as "188–189" and "191–193" are given under the same numbers.

Рис. 186–193. Осциллограммы призывных сигналов *Chrysochraon dispar major* Uvarov, 1925 из окрестностей поселка Облучье, Хабаровский край (точка № 13 на карте). Фрагменты сигналов, помеченные цифрами "188–189" и "191–193", представлены при большей скорости развертки на осциллограммах под такими же номерами.

Table. Temporal parameters of calling songs of two subspecies of *Chrysochraon dispar*
Таблица. Временные параметры призывного сигнала двух подвидов *Chrysochraon dispar*

Subspecies	Source	Temperature during recording, °C	Echeme duration, s	Syllable repetition period, ms
Ch. dispar dispar	Ragge & Reynolds, 1998	23–28	0.5–2.0	50–100
	Vedenina & Zhantiev, 1990	28–30	1.5	82±2
Ch. dispar major	Vedenina & Bukhvalova, 2001	30–31	2.0	100–110
	Original data	29–30	3.0–3.5	110–130
	-----"-----	34–35	1.2–1.5	65–85

Bukhvalova [2001], where the oscillograms of songs of widespread species from different localities in Ukraine, European Russia, Southern Siberia and the Russian Far East are published. In the present paper the results of farther investigations of geographical variability of the songs of Gomphocerinae are provided.

As is seen from the oscillograms presented, in Gomphocerinae grasshoppers, temporal pattern of calling signals is one of the most constant taxonomic characters. Within a subspecies or monotypical species it retains all its parameters over many hundreds or even thousands of kilometres of the range. As a rule, no significant differences in the structure of calling songs between populations studied can be found. The songs of *O. haemorrhoidalis* (Figs 14–25), *S. scalaris* (Figs 44–57), *G. maritimus* (Figs 58–74) and *Ch. hammarstroemi* (Figs 75–102) can be mentioned as examples. Only between courtship signals of *S. nigromaculatus* from Irkutsk Area and european populations certain minor differences were found.

Songs of different subspecies sometimes differ clearly from each other. In *Chorthippus apricarius apricarius* (Linnaeus, 1758) and *Ch. apricarius major* (Pylnov, 1914), *Mongolotettix japonicus japonicus* (I. Bolivar, 1898) and *M. japonicus vittatus* (Uvarov, 1914) and in different subspecies of *G. maritimus* this is the case [Bukhvalova, 1998; Vedenina & Bukhvalova, 2001]. On the other hand, no differences in song pattern were found between *Chorthippus macrocerus purpuratus* (Vorontsovsky, 1928) and *Ch. macrocerus ponticus* (Mistshenko, 1951) [Vedenina & Bukhvalova, 2001]. Similar situation takes place in two subspecies of *Chrysochraon dispar*. Signals of *Ch. dispar major* do not differ from these of nominotypical form neither in general pattern (Figs 186–193) nor in quantitative parameters (Table).

Comparative analysis of songs from different geographical points provides a way of estimating the range of intraspecific variability of signal pattern and, consequently, of correct interpretation of differences observed.

Thus, differences between signals of *Ae. variegatus variegatus* and *Ae. variegatus minutus* are not very great (Figs 129–143 and 144–162). They are most stable, however, because signals of the former subspecies from two localities situated about 4500 km apart from each other are indistinguishable (Figs 129–131, 134–136, 139–141 and 132–133, 137–138, 142–143). This fact gives good reason to believe that in the case under consideration these differences provide a reliable taxonomic character, and the forms under investigation actually have subspecies status.

As it was shown by Bukhvalova [2006], partitioning of acoustic transmission channels in grasshopper communities is based on differences in syllable repetition period to a great extent. For this reason, the results of more detailed investigation of the variability of this parameter will be considered in another paper.

The preferences of calling site and position are no less constant ethological characters than signal structure. Data on acoustic behaviour of widespread species in european populations [Ragge & Reynolds, 1998; Savitsky, 2005; Savitsky & Lekarev, 2007] are in good agreement with our observations in Siberia and the Russian Far East. Possibly, ethological characters in certain cases also can be used for solving of taxonomic problems in Gomphocerinae.

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