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Does *Tadarida teniotis* really occur in Crimea? (Chiroptera: Molossidae)

Vyskytuje sa *Tadarida teniotis* skutočne na Kryme? (Chiroptera: Molossidae)

Marcel UHRIN[1,4], Suren GAZARYAN[2] & Petr BENDA[3,4]

[1] Slovak Bat Conservation Society, B. Němcovej 141/5, SK–050 01 Revúca, Slovakia; marcel.uhrin@gmail.com
[2] Institute of Ecology of Mountain Territories, Kabardino-Balkarian Scientific Center of the Russian Academy of Science, Nalchik 360000, Russia; s-gazaryan@yandex.ru
[3] Department of Zoology, National Museum (Natural History), Václavské nám. 68, CZ–115 79 Praha 1, Czech Republic; petr.benda@nm.cz
[4] Department of Zoology, Faculty of Science, Charles University in Prague, Viničná 7, CZ–128 44 Praha 2, Czech Republic

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Abstract. Echolocation calls identified as searching calls of *Tadarida teniotis* were recorded at two sites in the forested mountainous part of the Crimean Peninsula, Ukraine, in September 2009. Description of the records is given and possible occurrence of *T. teniotis* in Crimea is discussed.

Key words. *Tadarida*, echolocation, distribution, Crimea, Ukraine.

INTRODUCTION

The European free-tailed bat, *Tadarida teniotis* (Rafinesque, 1814), is a true Mediterranean bat species and the only representative of the family Molossidae Gervais, 1856 in Europe as well as in the Mediterranean parts of Africa and the Middle East (Corbet 1978, Horáček et al. 2000).

Whereas the southern margin of distribution range of *T. teniotis* in the western Palaearctic is clearly limited by severe arid habitats of the Sahara and Arabian deserts (Aellen 1966, Harrison & Bates 1991, Ibáñez & Pérez-Jordá 2004), the northern margin of its range seems to be unstable, similarly as the climate in the northern regions of the Mediterranean zone. Based on the records published – fundamentally reviewed by Aellen (1966) – Ibáñez & Pérez-Jordá (2004) described the northern margin of regular distribution of *T. teniotis* in Europe go to from the Pyrenees (Port d'Aula) and southernmost France (Pont du Gard) along the Rhone valley (Pont d'Arc; Le Marais) to southern Switzerland (Sankt-Gotthard-Pass; Bellinzona), northeastern Italy (Val-Lagarina), and coastal Croatia (Split) to Macedonia (Markova Kula; Demir Kapija) and Bulgaria (Sandanski; Rodopy Mts.). This line was more or less accepted by subsequent authors (Dietz et al. 2007, Aulagnier et al. 2008, Grimmberger et al. 2009). However, several known occurrence points lie northwards of the line demarcated by Ibáñez & Pérez-Jordá (2004); the Channel Island of Jersey, the town of Basel and the peninsula of Crimea. Although the latter authors doubted occurrence in the Atlantic island of Madeira indicated by Dobson (1878), they accepted the (northernmost) record from Jersey published also by Dobson (1878) as well as the record from Crimea taken from Aellen (1966).

The record from Basel (NW Switzerland) was published by Schneider (1871) and for a long time it represented northernmost known point of *T. teniotis* occurrence in mainland Europe. This record has been exceeded only recently by the finding of a handicapped *Tadarida* male in Stuttgart, SW Germany (Anonymus 1992, 1993). Anyway, both these records from regions north of the Alps as well as from Jersey are considered as accidental strays (Anonymus 1992, Ibáñez & Pérez-Jordá 2004).

The occurrence of *T. teniotis* in Crimea represents the northernmost occurrence spot of the species in the portion of Europe east of the Alps (Kock & Nader 1984, see also Benda et al. 2003 and Ciechanowski et al. 2005). This occurrence was considered real and mentioned without any notes and/or doubts by Lanza (1959), Aellen (1966), Kock & Nader (1984) and Ibáñez & Pérez-Jordá (2004). The only individual of *T. teniotis* from Crimea was reported by Jentink (1888: 202). Among eight specimens of *Nyctinomus cestonii* [= *Tadarida teniotis*] coming from Dalmatia and Egypt, he also mentioned a specimen with a note: "Femelle semi-adulte. La Crimée.". Satunin (1914: 44) mentioned, most probably based on the Jentink's (1888) report, the Crimean occurrence of *T. teniotis* as follows: "A doubtful report exists about finding of this [free-tailed] bat on the southern coast of Crimea." [translated from Russian]. Later on, Ognev (1927: 157) referred: "In Satunin's 'Conspectus Mammalium Imperii Rosici' (1914, p. 44) is a doubtful indication that a bat of the genus *Nyctinomus* [= *Tadarida*] inhabits the southern coast of Crimea. Surely this can be only *N. teniotis* Rafinesque, a species of the Mediterranean subregion." Ognev (1928) in his famous book repeated exactly the words from Satunin (1914) concerning doubts about the (Jentink's?) report of *T. teniotis* from Crimea. These three very short notes by Satunin and Ognev are the only published reports of East-European authors related to the occurrence of this species in Crimea. However, presence of *T. teniotis* was not mentioned in the

Fig. 1. Karstic depression near Pčelinoe covered by pastures and forest patches and surrounded by limestone slopes. The site of evidence of the echolocation calls of *Tadarida teniotis* (photo by Zdeňka Bendová).
Obr. 1. Krasová depresia pri dedine Pčelinoe s mozaikou pasienkov a lesov obklopená vápencovými svahmi. Lokalita záznamu echolokačných signálov *Tadarida teniotis* (foto Zdeňka Bendová).

first survey of the regional bat fauna (Brauner" 1912), and no record or museum specimen from Crimea or Ukraine was referred by later Ukrainian and Russian authors (Kuzâkin 1950, 1965, Abelèncev & Popov 1956, Strelkov 1962, 1981, Dulickij 1974, 2001a, b, Konstantinov et al. 1976, Orlov 1984, Borisenko & Pavlinov 1995, Zagorodnûk & Godlevs'ka 2001, Dulickij & Kovalenko 2003, Ševčenko & Zolotuhina 2005, Godlevskaâ et al. 2009, etc.).

Anyway, the occurrence of *T. teniotis* in Crimea is well conceivable from the biogeographical point of view. The species inhabits the Caucasus – a biogeographical region continuing southeast to the Crimean mountain range. Two sites of *T. teniotis* records are known from the northern slopes of the Greater Caucasus Mts.; Korneev & Marisova (1950) reported a record of a male from the Berezovaâ river canyon (43° 52' N, 42° 42' E) near Kislovodsk made in July 1948. A colony of ca. 10 individuals of *T. teniotis* was discovered in a small cave in the Čerek river canyon (43° 15' N, 43° 20' E) ca. 30 km SW of Nalčik on 21 August 1960 (Tembotov & Šabaev 1962) and a juvenile male was found at the same site on 23 September 2005 (Gazarân & Tembotova 2007). Several records of *T. teniotis* are known also from Transcaucasia (Kuzâkin 1950, 1965; E. Yavruyan ad verb.) as well as from the Pontic region of Turkey (Benda & Horáček 1998).

Results of a bat research carried out in Crimea in the last years (Konstantinov et al. 1976, Petrušenko 2001, Godlevskaâ 2003, Godlevskaâ et al. 2009) did not bring any signs of occurrence of *Tadarida teniotis*. However, during a recent field trip to Crimea we recorded several call sequences which could suggest presence of *T. teniotis* in this southernmost part of Ukraine.

MATERIAL AND METHODS

Bat calls were recorded during a two-week (10–23 September 2009) field trip carried out mainly in the forested mountain portion of the Crimean Peninsula (Krymskye gory Mts.). Acoustic recordings were made using the portable ultrasound detectors D240x (Pettersson Elektronik AB, Uppsala, Sweden). Detectors were set on the time-expansion mode and were connected to Sony MD Walkman MZ-NH600 or to Edirol R-09 (Roland Corp., Japan) recorders. Altogether, 257 sequences with bat calls were recorded in the field.

The recordings were analysed with the software BatSound 3.0 (Pettersson Elektronik AB, Uppsala, Sweden). The sampling frequency of 22,050 samples/s with 16 bits/sample and expansion factor 10 were used. Using Edirol, time-expanded sequences were digitised at the sampling rate 48 kHz with 16-bit precision and saved as *wav files. A 512 pt. FFT with Hanning window was used for analyses and oscilograms, power spectra and spectrograms were evaluated. For echolocation calls, the following parameters of the call were measured: total pulse duration (D), start frequency (SF), end frequency (EF; both SF and EF at –40 dB below the peak power spectral intensity), frequency of maximum energy (Fmax) and inter-pulse interval (IPI, the time between two consecutive calls). The measured parameters of potential *Tadarida teniotis* calls were compared with the published data concerning this species (e.g., Zbinden & Zingg 1986, Zingg 1990, Russo & Jones 2002, Obrist et al. 2004, Bayefsky-Anand et al. 2008).

RECORDS

In total, among more than 250 bat call sequences, eight call sequences (23 calls), were considered as possible *Tadarida teniotis* calls.

1. Pčelinoe [Пчелиное], pastures and a small lake ca. 3 km E of the village (Belogorsk [Белогорск] Dist.), 44° 56' N, 34° 35' E, 460 m a. s. l. (Fig. 1), 19 September 2009, one call sequence of one individual recorded, two calls analysed.

The site is situated in a large karstic depression surrounded by a range of limestone slopes without vegetation cover on the top (Fig. 1). The main habitat types include pastures and deciduous forests (composed

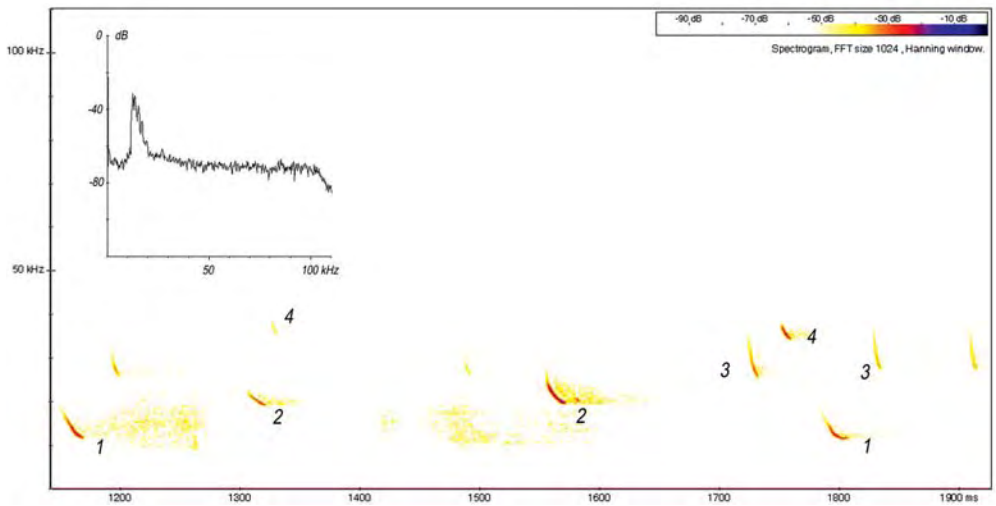

Fig. 2. Spectrogram of echolocation calls of bats recorded above a small artificial lake at Pčelinoe, 19 September 2009 (1 – *Tadarida teniotis*, 2 – *Nyctalus noctula*, 3 – *Eptesicus serotinus*, 4 – *Hypsugo savii*). The smaller figure (above left) shows power spectrum of the first pulse of *T. teniotis* call.
Obr. 2. Spektrogram echolokačných signálov netopierov zaznamenaných nad umelým jazierkom pri osade Pčelinoe, 19. september 2009 (1 – *Tadarida teniotis*, 2 – *Nyctalus noctula*, 3 – *Eptesicus serotinus*, 4 – *Hypsugo savii*). Na malom obrázku vľavo hore je zobrazené spektrum energií prvého výkriku *T. teniotis*.

mainly of *Carpinus* sp.), on the bottom of the depression the pastures are alternated with various lines of bushes and trees (e.g., *Juglans regia*, *Crataegus* sp., *Rosa* sp., *Betula* sp., *Populus* sp., etc.). Bats were recorded in the surroundings of a small artificial pond, from the southern side surrounded by a dense forest and from the northern side by a pasture lined by hedgerows and other higher vegetation lines. The lake is ca. 50×40 m in size, its littoral vegetation is composed of *Typha* sp., *Phragmites* sp. and manifold bush.

At minimum, tens of individuals belonging to six bat species were recorded at this site between 8.30 and 9.30 pm. No voices of the European free-tailed bat audible by a naked ear were recognised, the calls were found only during the analysis of the recordings. Among call sequences of *Nyctalus noctula*, *Eptesicus serotinus*, *Hypsugo savii*, *Pipistrellus pipistrellus* and *P. nathusii / P. kuhlii* (see some of sequences in Fig. 2) only two calls of *T. teniotis* with non-linear FM-QCF structure could be detected and measured (Fig. 2). The parameters of these two calls are as follows: D=21.4 and 25.0 ms; SF=16.1 and 13.5 kHz; EF=11.8 and 11.7 kHz, Fmax=12.8 and 11.9 kHz, and IPI=653 ms.

2. Partizanskoe [Партизанское], above the Avunda [Авунда] creek (Âlta [Ялта] Dist.), 44° 33’ N, 34° 15’ E, 435 m a. s. l. (Fig. 3), 16 September 2009, seven call sequences of 1–2 individuals were recorded and analysed.

The locality is situated in an old-growth beech forest in the creek canyon. From 8.30 to 10.30 pm, bat or bats which emitted the calls, flew several times above the forest canopy. The calls were well audible by a naked ear and in the heterodyne mode of the bat detector. The recorded calls had only CF structures with the following parameters: D=210.0–341.0 ms (n=6, mean=272.50 ms), SF=10.7–12.2 kHz (mean=11.43); EF=11.8–16.0 kHz (mean=13.36), Fmax=11.9–12.4 kHz (mean=12.44 kHz), IPI=780–950 ms (Fig. 4). Along with the above mentioned calls, echolocation and social calls of *Rhinolophus hipposideros*, *Pi-*

Fig. 3. Limestone walls above the Avunda creek canyon at Partizanskoe. The site of evidence of the echolocation calls of (perhaps) *Tadarida teniotis* (photo by Suren Gazaryan).
Obr. 3. Vápencové steny nad kaňonom potoka Avunda pri dedine Partizanskoje. Lokalita záznamu echolokačných signálov (azda) *Tadarida teniotis* (foto Suren Gazarjan).

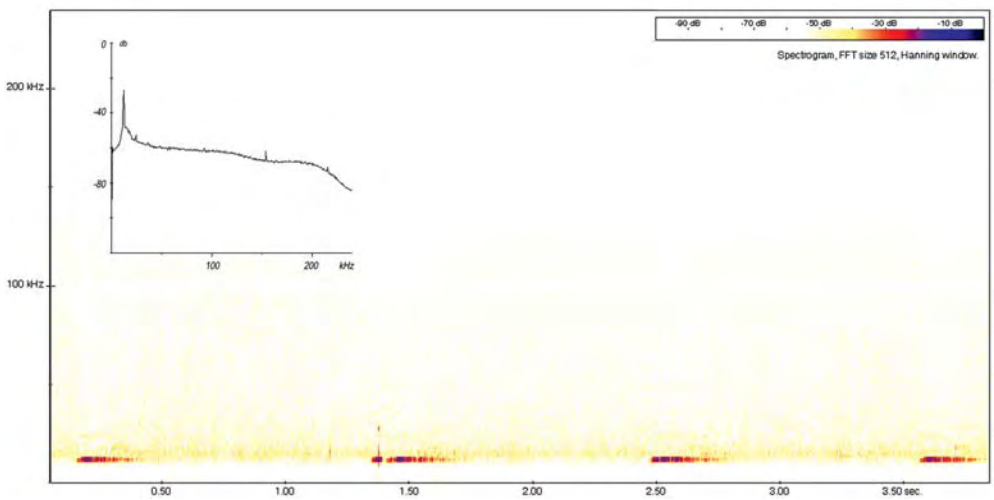

Fig. 4. Spectrogram of echolocation calls of cf. *Tadarida teniotis* recorded at the Avunda creek near Partizanskoe on 16 September 2009.
Obr. 4. Spektrogram echolokačných signálov cf. *Tadarida teniotis* zaznamenaných pri potoku Avunda blízko osady Partizanskoe 16. septembra 2009.

pistrellus pipistrellus, *P. pygmaeus*, *Barbastella barbastellus* and *Plecotus auritus* were recorded in this locality.

DISCUSSION

The call recorded near Pčelinoe could represent an evidence of *Tadarida teniotis* in Crimea – despite the fact that only two particular calls were detected and analysed. The measured parameters of these calls lie within the variation ranges evidenced in the European range of *T. teniotis* (Zbinden & Zingg 1986, Zingg 1990, Obrist et al. 2004). The values of pulse duration are near the range maximum described by Russo & Jones (2002) and/or Bayefsky-Anand et al. (2008), all other parameter values from the Crimean recordings conform to the measure ranges given by the latter and former authors. Similar call patterns as we found in the Crimean recordings were also reported from *T. teniotis* calls recorded in the Middle East (Sinai, Israel, Syria; Ulanovsky et al. 2004, Benda et al. 2006, 2008, Bayefsky-Anand et al. 2008).

When only the values of the frequency of maximum energy are considered, the calls recorded in Crimea could be theoretically confused with the territorial or social calls of *Eptesicus nilssonii* (Keyserling et Blasius, 1839), *Vespertilio murinus* Linnaeus, 1758 and/or *Nyctalus leisleri* (Kuhl, 1817) (see Ahlén & Baagøe 1999, Pfalzer & Kusch 2003, Ahlén 2004, and von Helversen & von Helversen 1994). While *Eptesicus nilssonii* has never been recorded in Crimea and this region is far outside its distribution range (see e.g., Rydell 1993), the latter two species are common bats in the Peninsula, at least seasonally (unpubl. observations of the authors). The "advertising songs" of *Nyctalus leisleri* are usually displayed from one site (perch), which is most usually situated on the bark of a tree trunk (von Helversen & von Helversen 1994). However, the Crimean *T. teniotis* calls were recorded among numerous bats of several species flying above the surface of a small lake and were well distinguishable from their calls (*Nyctalus noctula* (Schreber, 1774), *Eptesicus serotinus* (Schreber, 1774), *Hypsugo savii* (Bonaparte, 1837); see Fig. 2). Additionally, the general pattern of these *T. teniotis* signals, mainly their pulse durations, inter-pulse interval, frequencies of maximum energy and also the lack of harmonics can be well distinguished from all the mentioned species. In conclusion, the parameters of the respective calls recorded at Pčelinoe fall well into the ranges of the parameters given for various Mediterranean populations of *T. teniotis* and hardly give other identification alternative.

Interpretation of the recording of a call sequence made above the Avunda creek near Partizanskoe is rather difficult. These calls have a linear character with clear constant frequency (CF) pulse and with very long duration. The frequency of maximum energy in these calls was 11.9–12.4 kHz. Such echolocation pattern has not been described for *T. teniotis* calls from any region within its distribution range (e.g., Zbinden & Zingg 1986, Russo & Jones 2002, Bayefsky-Anand et al. 2008, Benda et al. 2008) and the oscilogram and spectrogram of these calls give a picture rather similar to those of some representatives of grasshoppers (see e.g., Ragge & Reynolds 1998). On the other hand, the calls were clearly audible directly in the field from a fast-flying object, and in the heterodyne mode of the bat detector they had the patterns (e.g. loud and sharp sounds) described by Ahlén (1990) and/or Barataud (1996). There are no other bat species in Crimea, which could emit similarly strong audible calls at these frequencies. Only Obrist et al. (2004) showed among echolocation call variations also examples of very narrow-band, (quasi-)constant frequency vocalizations in e.g. *Pipistrellus* spp., *Vespertilio murinus* and also in *T. teniotis* which are similar to our recordings.

The presented recordings, at least that made at Pčelinoe, seem to be good evidence of the presence of *Tadarida teniotis* in Crimea. It is the first direct record of the species in the Peninsula

as well as in Ukraine and gives credit to the only available previous report by Jentink (1888), considered doubtful by most of Ukrainian and Russian authors (see Introduction). Although the Crimean records of *T. teniotis* could seem to be exceptions from their extreme rarity, there are good conditions for the occurrence of this bat in southern Crimea. The climatic, vegetation and faunal zoning traditionally include southern parts of the Peninsula – coastal areas and coastwise mountain ranges – into the Pontic province of the Mediterranean arboreal zoogeographic zone (Sedlag & Weinert 1987, Blondel & Aronson 1999). This relatively narrow strip of Mediterranean habitats in southern Crimea continues from Pontic and Colchic regions of that province adjacent to the eastern shore of the Black Sea, where *T. teniotis* is already a well known inhabitant (see Introduction); the Crimean localities lie at the distance of ca. 650 km from the closest Caucasian site near Kislovodsk. The steep limestone mountain ranges along the southern shore of Crimea could undoubtedly provide adequate roosting opportunities for this bat (cf. Arlettaz 1990, Ibáñez & Pérez-Jordá 2004; Fig. 3). At least *Rhinolophus ferrumequinum* (Schreber, 1774), *Myotis emarginatus* (Geoffroy, 1806), *Miniopterus schreibersii* (Kuhl, 1817), and *Hypsugo savii* (Bonaparte, 1837) represent true Mediterranean elements in the Crimean bat fauna (Dulickij 2001a, b, Godlevskaâ et al. 2009); records of these bats are reported only from the mountainous southern part of Crimea where they also reach the northern margins of their distribution ranges in the broader region of easternmost Europe (see e.g. Corbet 1978). *T. teniotis*, another typical Mediterranean element among European bats, could find natural limits of its northern distribution in eastern Europe just in southern Crimea, which however, is not the northernmost point within its whole range (see Introduction).

Although the occurrence of *T. teniotis* in Crimea seems to be well veritable from the ecological and biogeographical points of view, it is rather impossible to consider it regular. The real regular distribution of *T. teniotis*, known from southern European countries and from many Mediterranean islands (see the reviews by Ibáñez & Pérez-Jordá 2004 and Benda et al. 2009), is well detectable both with the help of bat detectors and by a naked ear only after a very short field exploration in quite different landscape types. On the other hand, in the Mediterranean habitats of the Levant (Cyprus, Syria, Lebanon), *T. teniotis* is considered to represent a regular inhabitant of the region but its evidence is rather scarce when compared to the abundace of records in the European thermo-Mediterranean zone (see Benda et al. 2006, 2007, 2009, Horáček et al. 2008). Anyway, based on our field experience, in these countries of the eastern Mediterranean, *T. teniotis* can be detected in suitable habitats with certain luck regularly during every research trip. However, no evidence of *T. teniotis* existence was available in Crimea in the last 120 years.

Thus, we consider the occurrence of *T. teniotis* in Crimea rather temporal and its records as evidences of strays from a region of known (regular) occurrence and repeated records, most probably from the Caucasian region. *T. teniotis* is a strong and fast flyer, certainly able to make long-distance migrations within and from areas of its regular occurrence in the thermo-Mediterranean zone. The habitats where the records were made, a forested mountain valley and a plateau covered with a mosaic of pastures, light forests and lakes, are not the most typical foraging areas of the species (Ibáñez & Pérez-Jordá 2004). On the other hand, the species shows individual variation in foraging habits (Russo & Jones 2003, Marques et al. 2004) and our (probably) accidental recordings cannot indicate a different preference under the Crimean conditions (Figs. 1, 3).

Anyway, although the occurrence of the European free-tailed bat, *Tadarida teniotis*, in southern Crimea is very likely, it should be verified by further field studies and by catching of an

individual. An eventual genetic analysis of such specimen could indicate its geographic origin, i.e. from a Caucasian, Turkish, Balkan or indigenous population, and also elucidate our records as well as the Jentink's (1888) finding.

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SÚHRN

Dosiaľ jediným publikovaným údajom o výskyte *Tadarida teniotis* na Kryme (Ukrajina) bol údaj Jentinka (1888), ktorý v katalógu svojho múzea uvádza aj jedinca *Nyctinomus cestonii* [= *Tadarida teniotis*] s poznámkou "Femelle semi-adulte. La Crimée.". Kým viacerí autori zo západnej Európy považovali výskyt *T. teniotis* na Kryme za reálny a bez pochybností (napr. Lanza 1959, Aellen 1966, Kock & Nader 1984, Ibáñez & Pérez-Jordá 2004), Satunin (1914) a Ognev (1927, 1928) údaj spochybňovali a výskyt *T. teniotis* v oblasti sa nespomína v žiadnej inej práci ukrajinských alebo ruských autorov (napr. Brauner" 1912, Kuzâkin 1950, 1965, Abelèncev & Popov 1956, Strelkov 1962, 1981, Dulickij 1974, 2001a, b, Konstantinov et al. 1976, Orlov 1984, Borisenko & Pavlinov 1995, Zagorodnûk & Godlevs'ka 2001, Dulickij & Kovalenko 2003, Ševčenko & Zolotuhina 2005, Godlevskaâ et al. 2009, atď.). V príspevku sa opisujú a diskutujú echolokačné signály netopierov zaznamenané detektormi a neskôr po akustickej analýze identifikované ako signály *Tadarida teniotis*. Signály boli nahrané v hornatej a prevažne lesnatej časti polostrova Krym v septembri 2009 na dvoch lokalitách (Pčelinoe, okres Belogorsk a Partizanskoe, o. Jalta). Kým signály nahrané u Partizanskeho majú atypické parametre, signály z Pčelineho svojimi parametrami plne zodpovedajú charakteristikám zaznamenaným u *T. teniotis* v rôznych častiach jej areálu (napr. Zbinden & Zingg 1986, Zingg 1990, Russo & Jones 2002, Obrist et al. 2004, Ulanovsky et al. 2004, Benda et al. 2006, 2008, Bayefsky-Anand et al. 2008) a postačujú na druhovú identifikáciu. Keďže prezentované údaje predstavujú prvý údaj o výskyte *T. teniotis* na Kryme po 120 rokoch od publikovania jediného údaju, výskyt druhu je v budúcnosti potrebné overiť aj odchytom netopiera samotného.

РЕЗЮМЕ

До настоящего времени единственным опубликованным свидетельством обитания широкоухого складчатогуба (*Tadarida teniotis*) в Крыму было указание Ентинка (Jentink 1888), который среди восьми экземпляров *Nyctinomus cestonii* [= *T. teniotis*] из Далматии и Египта описывает один экземпляр с примечанием "Femelle semi-adulte. La Crimée" [самка полувзрослая, Крым]. Западноевропейские авторы признают реальность данной находки без каких-либо оговорок (напр., Lanza 1959, Aellen 1966, Kock & Nader 1984, Ibáñez & Pérez-Jordá 2004). В то же время, кроме Сатунина (Satunin 1914) и Огнева (Ognev 1927, 1928), другие украинские и российские исследователи не указывают на обитание *Tadarida teniotis* в Крыму (напр. Brauner" 1912, Kuzâkin 1950, 1965, Abelèncev & Popov 1956, Strelkov 1962, 1981, Dulickij 1974, 2001a, b, Konstantinov et al. 1976, Orlov 1984, Borisenko & Pavlinov 1995, Zagorodnûk & Godlevs'ka 2001, Dulickij & Kovalenko 2003, Ševčenko & Zolotuhina 2005, Godlevskaâ et al. 2009, и др.). В представленной работе описываются и обсуждаются эхолокационные сигналы, зарегистрированные с помощью детекторов ультразвука, которые по результатам акустического анализа, могут принадлежать *T. teniotis*. Сигналы

были записаны в сентябре 2009 года, в двух точках в лесном поясе горного Крыма (с. Пчелиное в окр. пос. Белогорск и над р. Авунда в окр. пос. Партизанское неподалеку от г. Ялта). Хотя сигналы из окр. пос. Партизанское имеют нетипичную для T. teniotis структуру, сигналы из Пчелиного по своим параметрам полностью соответствуют описанным из других частей ареала (Zbinden & Zingg 1986, Zingg 1990, Russo & Jones 2002, Obrist et al. 2004, Ulanovsky et al. 2004, Benda et al. 2006, 2008, Bayefsky-Anand et al. 2008) и не могут быть отнесены к другим видам рукокрылых. В то же время, приведенное спустя 120 лет после первой находки новое свидетельство обитания *T. teniotis* в Крыму должно быть подтверждено поимкой хотя бы одного животного.

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