Acta zool. cracov., 42(3): 407–421, Krakow, 1999

Taxonomy, biogeography and abundance of the horseshoe bats in the Eastern Europe

Igor V. ZAGORODNIUK

Received: 17 May, 1997; revised: 31 August, 1999
Accepted for publication: _____, 1999

ZAGORODNIUK I. V. 1999. Taxonomy, biogeography and abundance of the horseshoe bats in the Eastern Europe. Acta zool. cracov., **42** (3): 407–421.

The family Rhinolophidae is represented in the Eastern Europe by three rare species of *Rhinolophus*, namely *R. ferrumequinum* (*RF*), *R. hipposideros* (*RH*) and *R. euryale* (*RE*). Total 275 collected specimens are represented by 187 *RF*, 87 *RH* and 1 *RE*? (coming from the Crimea). All species have clearly distincts in body and skull measurements (forearm 52–57 mm in *RF*, 48 in *RE*, 35–40 in *RH*) and distinctive sound frequencies (80–85 kHz in *RF* and 110–115 in *RF*). Differences between geographic samples of each species are not significant, and most expressed in a pair of Carpathian and Crimean *RH* (external features) and *RF* (skull dimensions). Detailed description of species ranges are presented by their marginal localities, and all the questionable records are discussed. During the XX century their share in total bat samples continuously changed: decrease in *RF* (32.8 to 4.7 %; category "endangered") and increase in *RH* (1.9 to 11.2 %, category "lower risk").

Key words: Rhinolophidae, variation, diagnostics, distribution, protection.

I. V. ZAGORODNIUK, Institute of Zoology, National Academy of Sciences, Bohdan Khmelnitsky 15, Kyiv, UA-252601, Ukraine. E-mail: zag@palmuz.freenet.viaduk.net.

I. INTRODUCTION

Horseshoe bats (Rhinolophidae) are a very specialised mammal group with a strict tendency to extinction throughout the Western and Central Europe (FELDMANN 1967; WOLOSZYN 1976; ROER 1984; KOKUREWICZ 1990). In the Eastern Europe, the rhinolophids are characterised by relatively low taxonomic abundance and small ranges in the south (ABELENTSEV & POPOV 1956; STRELKOV 1963; ZAGORODNIUK 1998). Representatives of this family are relatively rare in the Eastern Europe, and included in all the regional Red Data Books. Only four small publications specially devoted to this group exist (KROCHKO 1965; TATARINOV 1972; VASILIEV 1997; KOVALYOVA 1997). As a result, species composition of East European Rhinolophidae thus far has not been revised; existing descriptions of the species ranges were based on the fragmentary and doubtful data, and the protection status of species was established without an analysis of their abundance. Preliminary results of this investigation were presented at the 1st Conference on the Carpathian Bats (Krakow, 7-8.12.1996).

Acknowledgements. I am grateful to Drs V. POKYNCHEREDA (Carpathian Biosphere Reserve), V. TYSHCHENKO (Kyiv Zoo), Ya. PETRUSHENKO (International Solomon University), and T. POSTAWA (Jagelon University) for organisation of field investigations in caves, Drs J. ROZORA (Zoological Museum of Kyiv University), A. BOKOTEJ (Lviv Natural History Museum), and L. SHEVCHENKO (Ukrainian Natural History

Museum) for their kind help in the investigation of the collected materials, Prof. B. WOLOSZYN (Centre of Chiropterological Information), P. STRELKOV (Zoological Institute of St. Petersburg) and Yu. KROCHKO (Uzhgorod State University), Drs M. UHRIN (Slovak Bat Protection Group), I. DZEVERIN, A. TSVELYKH (Schmalhausen Institute of Zoology), V. RIZUN (Lviv Natural History Museum) for their comments on the species identification and useful discussion. I thank Dr V. KORNEEV (Vestnik zoologii) and Prof. Z. BOCHENSKI (Acta zoologica cracoviensia) and anonymous reviewers for useful comments on primary draft of this article and proof my English.

II. MATERIALS AND METHODS

Geographic scope of region under study includes a territory between the western border of the former Soviet Union and the eastern limit of Europe (Ural Mts. and Kuma-Manych depression). Morphological materials were obtained from the main regional zoological museums: Ukrainian Natural History Museum (UNHM), Zoological Museum of Kyiv University (ZMKU), and Lviv Natural History Museum (LNHM) [in the museums of the Odessa and the Kharkiv universities rhinolophids are absent]. Totally, 275 specimens from about 70 sites of the Carpathian region, Podolia, Crimea and Northern Caucasus were investigated. Numbers of studied specimens are summed in the Table 1. Total 11 body and skull measurements of 140 skins and 121 skulls were analysed. These are: LB – body length, Ca – length of tail, Pl – length of foot, Au – ear length, W – body weight, FA – forearm length (FA' – on dry skin), Cra – skull length, CBL – condylobasal length, CM^3 – length of upper toothrow, Mand – length of mandible (except for Cra, the anterior point of skull dimensions was the front side of canine).

Species ranges are described by the marginal localities using original and published data, museum collections, and personal communications. Changes in species abundance are analysed using their share in collections accumulated during long-term periods of fauna investigations (ZAGORODNIUK & TKACH 1996). Field investigations were carried out in the caves of Podolia (Mlynky, Ugryn, Kryshtaleva: 02.1976, 02.1999) and Transcarpathians (Grebin, Druzhba, Dovgarunya: 10.1995, 02.1996, 07.1996). Bat sounds were studied using ultrasound detector "D-100 Pettersson".

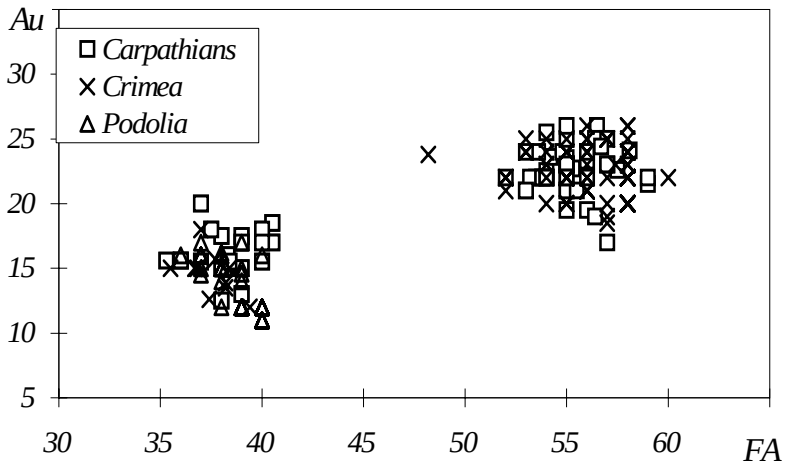
Table 1. Studied samples of East European *Rhinolophidae* in some zoological museums

Sample	Acronym	UNHM	LNHM	ZMKU	Total	Share
Total collected bats	–	840	293	298	1431	100.0 %
Total Rhinolophidae, *i. e.*:	–	206	49	20	275	19.2 %
Rhinolophus hipposideros	*RH*	52	32	3	87	6.1 %
Rhinolophus cf. *euryale*	*RE*	1	0	0	1	0.1 %
Rhinolophus ferrumequinum	*RF*	153	17	17	187	13.0 %

III. SPECIES COMPOSITION AND VARIATION

Species of East-European Rhinolophidae

East European horseshoe bats are represented by the single genus *Rhinolophus* LACEPEDE, 1799. According to traditional point of view, there are two species in the fauna of the region, namely *R. ferrumequinum* SCHREBER, 1774, and *R. hipposideros* BECHSTEIN, 1800 (ABELENTSEV & POPOV 1956; AVERIN & LOZAN 1965; KRYZHANOVSKY & EMELIANOV 1985). In the nearest regions, there are 5 *Rhinolophus* species, and BRAUNER (1911) and STRELKOV (1963) assumed the presence of *R. euryale* in the Crimea. The same assumption can be made for the Transcarpathian region also.



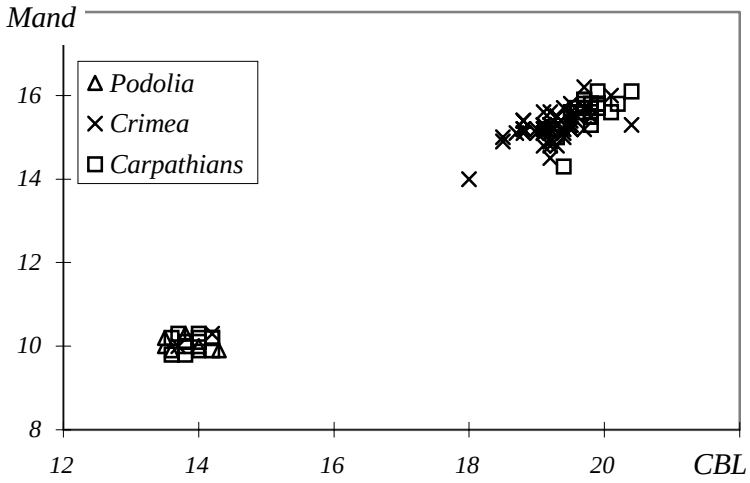


Fig. 1. Distribution of main body (above) and skull (below) measurements in the geographical samples of East-European *Rhinolophidae* (average values of these characters see in Table 2).

Analysis of variation in main diagnostic characters has shown, that *Rhinolophus* makes two compact groups: the lesser *R. hipposideros* and the greater *R. ferrumequinum* (Fig. 1) that present 2/3 and 1/3 of the total sample, respectively. The only "intermediate" specimen appeared in the sample from the Crimea (grotto Myshyna Shchel: ANNEX). Its main features are: FA=48 mm, CBL=18, both P_2 and P^1 are present and situated outside toothrow, age ca. 1 year. All its significant dimensions (Table 2) are higher than in those of any species of the "intermediate"

group[1] (see: Table 3) but the presence of *R. euryale* is the most probable in the region (STRELKOV 1963). An attempt to reveal the same species in the Transcarpathians was unsuccessful, and only *RF* (n=52) and *RH* (n=25) were identified in the total bat sample from this region.

Trends in morphological variation

Existence of two centres of bat fauna abundance, the western (Carpathians and Podolia) and the eastern one (the Crimea and Caucasus), allows to expect distinctions among geographic samples of *Rhinolophus*. No *Rhinolophus* intraspecies taxa were established from the Eastern Europe (ZAGORODNIUK 1998). In spite of this, ABELENTSEV & POPOV (1956), STRELKOV (1963) and KOVALYOVA (1997) considered these two geographic samples of each species as different subspecies, the nominative in the western regions and the other one in the East: *R. f. colchicus* SATUNIN, 1914, and *R. h. minimus* HEUGLIN, 1861.

Analysis of variation in six *Rhinolophus* samples (Table 2) shows the existence of two compact clusters. Relatively distant samples are the Carpathian *RF* and the Podolian *RH*, so interspecies distance is minimal in the Southeast (Crimea; Fig. 2). Southern *Rhinolophus* (firstly Crimean *RH*) have relatively darkish fur and wings, and a little smaller body size in comparison with the western samples. Traditional views on taxonomy of East-European *Rhinolophus* need correction. First, placing the Crimean *R. hipposideros* to "*minimus*" seems to be erroneous: morphological characters of this sample are similar to Carpathian *R. hipposideros* s. str. and essentially differ from the *minimus* s. str. (Table 3). Second, similarly to *RH*, there are no significant differences among both western and eastern *R. ferrumequinum* also, therefore all the East-European *Rhinolophus* should be identified as the nominative taxa.

Species identification

A key proposed here to species identification includes all the available diagnostic features: external, cranial, dental, and sound data. All the used morphological data were made precise and tested on the collected samples (Table 2). [So, ABELENTSEV & POPOV (1956) indicated wide variation of *Rhinolophus*, and just forearm length varied from 31 to 45 mm in *RH* and from 52 to 70.2 in *RF*, that are twice more dispersed against our data, and covered the dimensions of the "intermediate" group]. Sound frequencies were established under field conditions (Uholka reserved area). Both species have clearly distinct sound frequencies, 80 to 90 kHz in *RF* (n=3) and 110–120 in *RH* (n=7). All *Rhinolophus* were registered in rocky sites near caves in the evening (at 21:30 to 24:00 p. m). Totally, both available species differ as follows:

RH: forearm shorter than 41 mm (35–40); nose-leaf with a blunt and short superior process; sound frequency exceeding 100 kHz (110–120); skull length less than 14.5 mm (13.5–14.2); toothrow less than 6 mm (5.2–5.6); upper small premolar acute and laying on central line of teethrow; its top reaching 1/3 of canine.

RF: forearm exceeding 50 (51–60) mm; superior process of nose-leaf elongated and rounded; sound frequency less than 100 kHz (80–90); skull length exceeding 18 mm (18.5–20.5); toothrow more than 7.5 mm (7.7–8.7); upper canine and large premolar closed: small premolar laying outside teethrow or absent.

[1] This specimen was also examined by Drs. Woloszyn, Uhrin, Pokynchereda, and Dzeverin: by traditional criteria (KUZYAKIN 1965 etc.) this representative of "intermediate" group is more like to pair *bocharicus–mehelyi* than *euryale*; but Dr. Strelkov suppose it as young *RF*.

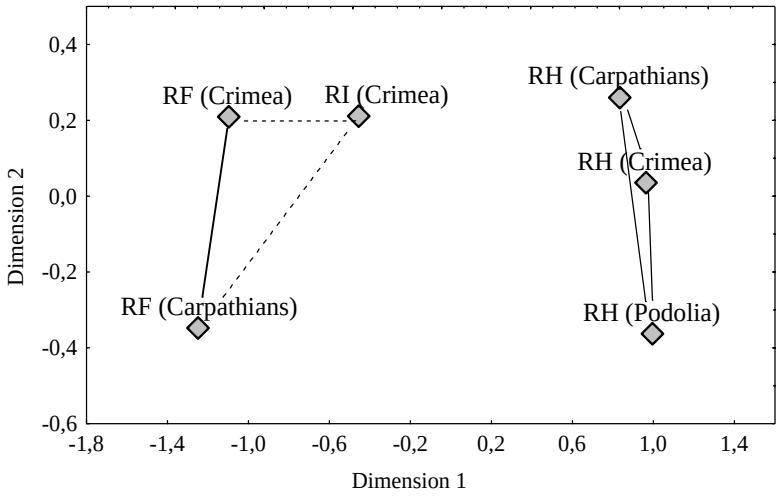


Fig. 2. Relationships among geographical samples of *Rhinolophus* from the Eastern Europe. Multidimensional scaling is carried out using Euclidean distance matrix calculated for the 11 body and skull measurements (using data given in the Table 2).

Table 2. Body and skull measurements in East European *Rhinolophus* samples (in upper row are "*min* to *max*", in lower row are *average* ± *standard deviation* (*n*))

Measur.	*RF (ferrumequinum)*		*RE* (?)	*RH (hipposideros)*		
(mm)	Carpathians	Crimea	Crimea	Crimea	Podolia	Carpathians
LB	52.0–71.0	50.0–73.0	–	37.0–45.0	36.0–43.0	34.0–49.0
	62.5±4.3 (50)	60.8±4.7 (67)	56.0	40.2±2.7 (11)	38.5±2.1 (38)	39.2±3.7 (22)
CA	31.0–45.0	28.0–46.0	–	24.0–31.0	25.0–31.0	23.0–30.0
	37.9±3.1 (49)	36.6±3.2 (67)	29.0	26.8±2.0 (9)	27.7±1.6 (39)	26.8±2.1 (23)
PL	9.5–13.0	8.0–13.0	–	6.0–7.5	6.0–9.2	6.5–9.0
	11.1±0.7 (50)	11.3±1.0 (54)	10.4	7.1±0.6 (6)	7.4±0.8 (37)	7.6±0.5 (23)
AU	17.0–26.0	17.0–26.0	–	12.0–18.0	11.0–17.0	12.5–20.0
	22.6±1.7 (50)	22.6±2.0 (66)	23.8	14.6±1.7 (10)	13.7±2.0 (39)	16.2±1.7 (23)
FA	52.0–59.0	52.0–60.0	–	37.0–39.4	36.0–40.0	35.3–40.5
	55.2±1.5 (50)	56.1±1.8 (64)	50.7	38.1±0.9 (5)	38.7±1.2 (37)	38.3±1.5 (21)
FA'	53.0–58.0	51.1–57.5	–	35.5–38.4	36.6–39.5	35.5–40.2
	55.2±1.3 (35)	54.9±1.5 (62)	48.2	37.3±0.8 (14)	38.1±1.0 (8)	38.1±1.3 (20)
CRA	21.8–23.8	21.5–23.4	–	14.8–16.1	15.3–15.6	15.1–15.9
	22.8±0.5 (24)	22.2±0.4 (56)	20.0	15.4±0.3 (13)	15.5±0.1 (8)	15.6±0.2 (11)
CBL	19.3–20.4	18.5–20.4	–	13.5–14.2	13.5–14.0	13.6–14.2
	19.8±0.3 (24)	19.3±0.4 (55)	18.0	13.8±0.3 (13)	13.7±0.2 (6)	13.9±0.2 (11)
Mand	14.3–16.1	14.2–16.2	–	10.0–10.3	9.9–10.3	9.7–10.3
	15.6±0.4 (25)	15.2±0.3 (59)	14.0	10.2±0.2 (2)	10.0±0.2 (7)	10.1±0.2 (15)
CM3	8.3–8.7	7.7–8.6	–	5.2–5.5	5.2–5.5	5.3–5.6
	8.5±0.1 (24)	8.1±0.2 (48)	7.5	5.4±0.2 (2)	5.3±0.1 (5)	5.4±0.1 (15)
Weight	13.0–27.0	14.8–17.0	–	–	4.2–6.3	3.4–6.7
	19.6±3.8 (33)	15.7±0.9 (5)	7.7	5.7 (1)	4.8±0.5 (16)	4.8±1.0 (18)
N (max)	50	67	1	14	39	23

Table 3. Variation of body and skull measurements in *Rhinolophus* from different regions

Sample (n)	LB	Ca	Au	FA	W	CBL	CM^3	Ref.
R. (hip.) minimus								
N-Africa (7)	36-42	21-26	14.5-17.0	35.0-36.0	4	12.9-13.5	4.8-5.2	KK'91
R. hipposideros								
Crimea (14)	37-45	24-31	12.0-18.0	35.5-38.4	6	13.5-14.2	5.2-5.5	Orig.
Carpathians (23)	34-49	23-30	12.5-20.0	35.5-40.2	3-7	13.6-14.2	5.3-5.6	Orig.
Podolia (39)	36-43	25-31	11.0-17.0	36.6-39.5	4-6	13.5-14.0	5.2-5.5	Orig.
USSR (n-?)	32-45	–	–	34.5-42.0	4-7	13.0-15.2	5.0-5.8	St'63
W-Europe (n-?)	–	–	–	37.0-42.5	–	13.4-14.5	–	SG'89
Balkans (49)	39-50	22-32	13.2-17.4	35.8-40.7	–	13.5-14.4	–	Kr'91
R. blasii								
USSR (?)	46-54	–	–	43.5-49.0	–	15.8-16.9	6.4-6.9	St'63
N-Africa (23)	55-58	22-31	10.0-21.0	43.0-48.0	9-12	16.2-17.0	6.5-6.9	KK'91
W-Europe (n-?)	–	–	–	45.0-48.0	–	15.8-16.7	–	SG'89
Balkans (10)	54-63	23-31	17.8-19.5	45.2-49.5	9-12	16.4-17.2	–	Kr'91
R. euryale								
USSR (n-?)	43-51	–	–	45.0-49.0	–	15.5-16.5	6.1-6.6	St'63
N-Africa (13)	50-54	22-28	18.5-22.0	46.0-49.5	8-11	15.2-16.5	5.7-6.4	KK'91
W-Europe (n-?)	–	–	–	43.0-51.0	–	16.0-17.6	–	SG'89
Balkans (23)	49-62	23-32	17.5-21.5	46.4-51.0	9-12	16.0-16.8	–	Kr'91
R. mehelyi								
USSR (n-?)	55-64	–	–	50.0-55.0	–	16.6-17.6	6.6-7.2	St'63
N-Africa (81)	49-63	25-37	19.0-23.0	47.5-53.0	11-18	16.5-17.7	6.5-7.1	KK'91
W-Europe (n-?)	–	–	–	50.0-55.0	–	16.6-17.5	–	SG'89
R. "intermediate"								
Crimea (1)	56	29	23.8	48.5	7.7	18.1	7.5	Orig.
R. ferrumequinum								
Carpathians (50)	52-71	31-45	17.0-26.0	53.0-58.0	13-27	19.3-20.4	8.3-8.7	Orig.
Crimea (67)	50-73	28-46	17.0-26.0	51.1-57.5	15-17	18.5-20.4	7.7-8.6	Orig.
USSR (n-?)	52-70	–	–	53.0-60.5	13-27	19.0-22.0	8.0-9.5	St'63
N-Africa (53)	58-71	30-42	19.0-25.0	51.0-59.0	13-22	18.9-20.1	7.6-8.7	KK'91
Balkans (20)	53-71	37-44	18.6-24.0	55.0-59.4	–	19.5-20.6	–	Kr'91
W-Europe (n-?)	–	–	–	54.0-61.0	–	20.0-22.0	–	SG'89

References: KK'91 – KOWALSKI & RZEBIK-KOWALSKA 1991 (Algeria; North-African "*minimus*" seems to be a separate species of the *hipposideros* group); Kr'91 – KRYSTUFEK 1991 (Slovenia); SG'89 – SCHOBER & GRIMMBERGER 1989 (Western Europe); St'63 – STRELKOV 1963 (former USSR).

IV. SPECIES DISTRIBUTION

Rhinolophids occur in the South of Eastern Europe, mainly in the mountain and upland areas of the Carpathians, Podolia, Crimea, and adjacent part of the Caucasus. All the previous publications (ABELENTSEV & POPOV 1956; KUZJAKIN 1965 etc.) were prepared without attempts to outline ranges and without references. New and revised data differ from the published ones (loc. cit.), and do not agree with the reconstruction based on climatic extrapolations (HORACEK 1984; KOKUREWICZ & KOVATS 1989).

Horseshoe bats are settled species in the region (ABELENTSEV et al. 1968-1970), and their ranges are characterised here by both summer and winter records, that are the same in the Transcarpathians (KROCHKO 1965, 1988; POKYNCHEREDA 1997; ZAGORODNIUK et al. 1997), Podolia (TATARINOV 1962, 1972, 1974), Moldova (LOZAN & SKVORTSOV 1965; LOZAN 1966; SKVORTSOV & DOROSHENKO 1974), and Crimea (KOZLOV 1949; KONSTANTINOV et al. 1976; BESKARAVAJNY 1988). Data on species distribution are generalised on the maps (Fig. 3 and 4) and described below. Limits of species range in the Eastern Europe are marked by their northernmost records, that are numbered in the order from the West to the East and referenced in the ANNEX.

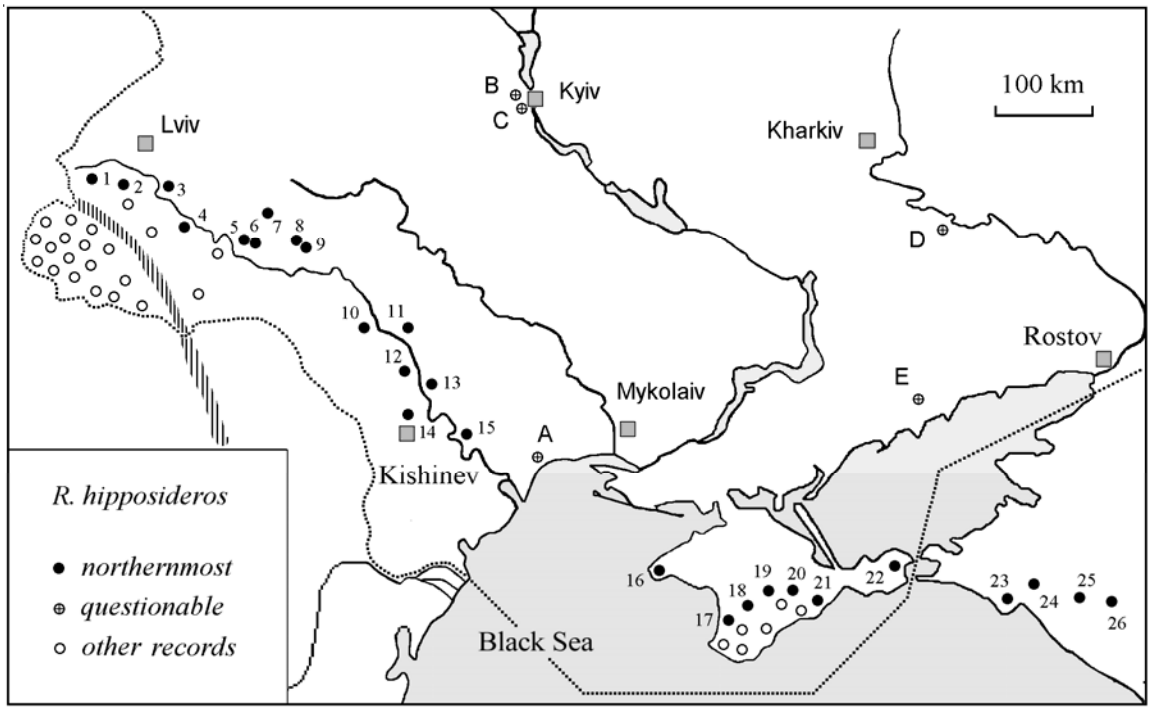


Fig. 3. Geographical distribution of *Rhinolophus hipposideros* in the Eastern Europe. Numbered characters mark the marginal (northernmost) records. References to numbered localities are given in the ANNEX; lettering characters correspond to doubtful data discussed in the text. Geographic limits of the region under study correspond to the border of former Soviet Union on the West and the Kuma-Manych Depression in the Southeast; stripped line marks the main Carpathian ridges.

Range of the lesser horseshoe bat

All the verified records form a continuous range from the Western Ukraine through the Podolia and the Crimea up to the Northern Caucasus (Fig. 3). This area continues the Polish part of species range (see: PUCEK & RACZYNSKI 1983), and reaches more northern latitudes, than it was mentioned earlier (STEBBINGS 1988). The northernmost *RH* records are arranged along the Dniester river, but just few modern records from the Podolia are known (Table 4 and ANNEX). Populations of the Northern Carpathians and Podolia are apparently separated from the Transcarpathian ones by the mountain ridges. *RH* was registered in mountains at the altitudes less than 600 m (ZAGORODNIUK et al. 1997), but in the northern slope it is absent in the caves on much lower altitudes (TATARINOV 1988). The second part of *RH* range lays in the Crimea and Caucasus, where northern limits of species range are described by 11 records (ANNEX). Most *RH* findings in the Crimea belong to its southern (mountain) part, from the Tarkhankut to the Kerch peninsula (VOLOKH & KROCHKO 1994). In adjacent part of the Caucasus, this species is recorded in a few localities of the Krasnodar Kray (DUVAROVA 1980; KAZAKOV & YARMYSH 1974).

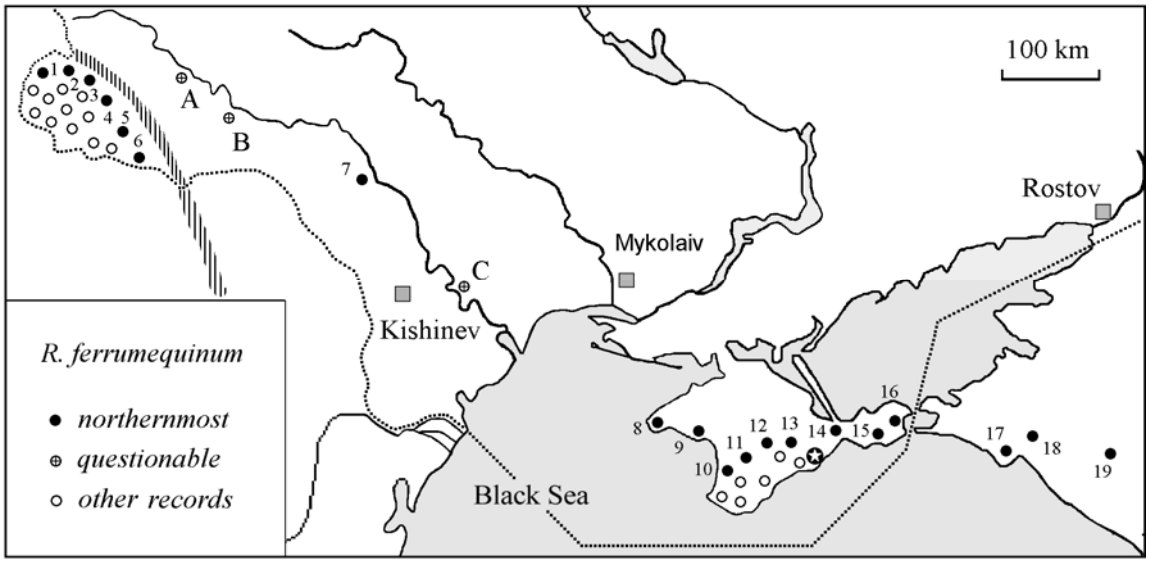


Fig. 4. Geographical distribution of *Rhinolophus ferrumequinum* and *R.* cf. *euryale* (asterisk) in the Eastern Europe. For details see: Fig. 3.

Erroneous and questionable records. There are 5 marginal records, that were not confirmed by any collected materials, detailed descriptions, or new reliable records in the same or adjacent regions: (A; Fig. 3) Odessa city ("Brauner in lit." in: MYGULIN 1938; without details: ABELENTSEV & POPOV 1956); (B-C) vicinity of Kyiv (KESSLER 1851; CHARLEMAGNE 1915). (D) Sloviansk in the Donetsk oblast (SOMOV 1897; for details see: MYGULIN 1938); (E) Ossipenko in Zaporizhzhia oblast (ABELENTSEV & POPOV 1956). Mentioned record of *RH* in Odessa was not confirm by Brauner's publications (1910; 1923) and contradicts the data of ZUBKO (1937) and VOLIANSKY (1967), which do not register *Rhinolophus* in the different part of mainland Black Sea region. Records of *RH* in the vicinity of Kyiv were discussed earlier (LIKHOTOP et al. 1990) and are erroneous. The only record of *RH* in the Northern Azov region (Ossipenko) was based on the observation of one migrant specimen in autumn of 1940. This fact was cited without details by Abelentsev (ABELENTSEV & POPOV 1956: 281) but not mentioned by POPOV (1941) in his special article on bat migrations.

Range of the greater horseshoe bat

This species is characterised by more restricted range, and is known from the most southern parts of the region, namely the Transcarpathians, the Crimea and the Northern Caucasus (Fig. 4). In the West of region, this species occurs in the Transcarpathian lowland only (see also: HORACEK & CERVENY 1984), and penetrates in the mountains just to 600 m of altitude. Known samples were collected in 1948–1950 (ZAGORODNIUK 1998a) and described by ABELENTSEV (1950; ABELENTSEV & POPOV 1956) and KROCHKO (1965; 1988). New data were obtained during bat census in the Carpathian biosphere reserve (POKYNCHEREDA 1997; ZAGORODNIUK et al. 1997), but northernmost localities are confirmed mainly by the old findings (ANNEX).

Most records from the Podolia and Bukovyna (Fig. 4) are questionable. The first of them is from Lokitky (KRYZHANOVSKY 1988): earlier *RH* only was registered in this locality ("Popov 1940" in TATARINOV 1956: see ANNEX), and this record seems to be a mistake (fig. 4, A). Another record "B" is from the Pionerka cave (Zastavna distr. of Bukovyna: VARGOVYCH 1998): one *RF* specimen was listed in the table, but not mentioned in the text and the checklist of species. Another doubtful information came from Moldova. The only *RF* specimen was mentioned (without details[2]) together with 139 *RH* collected during 12 years (SKVORTSOV & DOROSHENKO 1974); and newly finding of *RF* breeding colony in the cave La Beci (VASILIEV 1997: see ANNEX) is the only reliable record.

In the Crimea this species is distributed wider than *R. hipposideros*, and known from both natural and artificial habitats: caves, grotto, quarries, and buildings (MYGULIN 1938; KOZLOV 1949; ABELENTSEV & POPOV 1956; BESKARAVAJNY 1988). From the Tarkhankut peninsula (west of Crimea) to the Kerch peninsula (east) it settles rocky seaside massifs and old buildings (KRYZHANOVSKY 1988; VOLOKH & KROCHKO 1994; ZMKU and UNHM). Similarly to *RH*, the great horseshoe bat is known in the Northern Caucasus from the Kuban distr. to Daghestan (YARMYSH et al. 1980; AMIRKHANOV 1980). The records nearest to studied region are from the Krasnodar Kray (DUVAROVA 1980; KAZAKOV & YARMYSH 1974; UNHM; see: ANNEX).

Record of *Rhinolophus* cf. *euryale*

The nearest record is known from all the southern neighbours of studied region, from the Pannonia and Southern Carpathians to the Western Caucasus (KUZYAKIN 1965; STRELKOV 1976; YAVRUNIAN 1990; HORACEK et al. 1995).

The only questionable record is from the Crimea (see Fig. 4). The only specimen of *RE* was captured in seaside grotto Myshyna Shchel ["Bat Crack"] in the Karadagh natural reserve (near Shchebetovka, Theodosia distr., 13.08.1988, leg. Beskaravajny, female N 12379 in UNHM).

V. SPECIES ABUNDANCE AND PROTECTED STATUS

Modern state of *Rhinolophus* populations

Populations of Rhinolophidae are in a decline throughout the Europe (DAAN 1980; VIERHAUS 1984; ROER 1984), and HORACEK (1984) explains this fact by the changes in position of suitable isotherms. East-European *Rhinolophus* populations are commonly described as relatively abundant. So, in the Crimea, *RH* occupies 5th and *RF* occupies 3rd positions in bat abundance scale (respectively, n=38 and n=106: DULITSKY 1974). In Moldova, SKVORTSOV & DOROSHENKO (1974) counted 139 *RH* (1st position in the same scale) and just 1 *RF* among 865 bats collected during 12 years. Among 1431 known collected bats in Ukraine, Rhinolophidae share was 1/5, including 13% *RF*, 6% *RH*, and 0.1% *RE* (Table 1). Modern bat census in the win-

[2] It was 1 male from a quarry in Bychok (Grigoriopol distr., 1962: DOROSHENKO 1975) (Fig. 4, C).

ter roosts shows an opposite result: 3 % of *R. ferrumequinum* and 12 % of *R. hipposideros* were counted among hibernated bats (Table 4). A reason of this discordance is simply.

Table 4. Rhinolophidae abundance in the winter roosts (caves) of the Carpathians and Podolia

Species	Carpathians ('95/96)		Podolia ('98/99)		Total	
	Druzhba	Grebin	Mlynky & Ugryn	Kryshta-leva-1,2	absolute	percent
Rhinilophus hipposideros	85	6	0	73	164	11.5
Rhinolophus ferrumequinum	25	12	0	0	37	2.6
Myotis(Myotis) myotis (s. l.)	969	160	39	16	1184	83.0
Myotis (Selysius) mystacinus	1	0	0	0	1	0.1
Myotis (Leuconoe) daubentoni	11	0	1	0	12	0.8
Myotis indet. (small)	13	1	0	0	14	1.0
Barbastella (*barbastellus*)	7	0	0	0	7	0.5
Plecotus (*auritus+austriacus*)	0	0	3	5	8	0.6
Total bats	1111	179	43	94	1427	100%

Long-term changes of *Rhinolophus* abundance that were estimated by their share in zoological collections during the XX century (Table 5) are continuous and regular. This share is promptly decreasing in *R. ferrumequinum* (33→ 9→ 3 %), and increasing in *R. hipposideros* (2 → 4→ 11 %). Both last numbers (3 and 11 %) completely correspond to our last results of bat census in caves (Table 4). The results of bat ringing in Ukraine in the middle of the XX century (ABELENTSEV et al. 1968; n=3875 during 1939 to 1959) give an adequate intermediate values: 6.0 % of *RF* and 2.3 % of *RH*.

Prospects of long-term species existence

It is obvious, that the level of *Rhinolophus* abundance depends on the protection of their roosts. All caves adopted for tourists (Mlynky, Kryshtaleva-1 etc.) became unsuitable for bats. Such situation exists throughout the region (DULITSKY et al. 1986 etc.), and TATARINOV (1974) indicates a decrease of *Rhinolophus* numbers in Podolian caves about 2–3 times for 3 decades, that he explains by large speleological activity. In the protected ecosystems, abundance of *Rhinolophus* is relatively stable. So, comparison of bat census in the largest reserved cave "Druzhba" in 1983 (CHYZHMAR & DOVGANYCH 1988) and 1997 (Table 4) shows the increasing of *Rhinolophus* abundance in 18 times! Now *Rhinolophus* (first of all, *RH*) are still most distributed bats in the protected areas of the Carpathians (POKYNCHEREDA 1997; our data), Podolia (VARGOVYCH 1998; our data), and Crimea (BESKARAVAJNY 1988).

According to the European Red Data Book (1997), both *R. hipposideros* and *R. euryale* are included in the List 2 of globally threatened species, while *R. ferrumequinum* is in the List 3 "species of special European concern". In the Annex 2 to Bern convention (1979) and the Red data book of Ukraine (1994), both *RF* and *RH* have identical category (Table 5), that is incorrect. Decreasing of *RF* share during the XX century in 10 times should be stopped by special programs on cave protection. Thus, East-European rhinolophids are conservation dependent taxa, and according to new IUCN categories (1994), *RH* is a species of "Lower Risk" of extinction (LR), *RF* is an "Endangered" species (EN), *RE* needs category "Data Deficient" (DD).

Table 5. Rhinolophidae abundance during the 20th century based on the analysis of the UNHM and ZMKU collections, and their protection status in the Eastern Europe

Taxa	Collected specimens			Protection status (category)*					
	1900 1939	1940 1959	1960 1998	A2BC 1979	RDBU 1994	UPSU 1996	RDBE 1997	SRBM 1999	Pro-posed
R. ferrumequinum	32.8 %	9.3 %	3.3 %	+	II cat.	1 cat.	special concern	III (R)	EN
R. euryale	0.0 %	0.0 %	0.5 %	+	–	–	VU, 2ac	–	DD
R. hipposideros	1.9 %	4.1 %	11.2 %	+	II cat.	4 cat.	VU, 2ac	IV (VU)	LR
Total Chiroptera	320 ex.	604 ex.	214 ex.	25 sp.	12 sp.	15 sp.	10 sp.	14 sp.	–

References: A2BC – Annex 2 to Bern Convention (1979), RDBU – Red data book of Ukraine (VOLOKH & KROCHKO, 1994), UPSU – updated protection status in Ukraine (ZAGORODNIUK & TKACH 1996), RDBE – Red data book of European vertebrates (1997); SRBM – Status of rarity of bats in Moldova (ANDREEV 1999).

VI. DISCUSSION AND CONCLUSIONS

All *Rhinolophus* species are represented in the Eastern Europe by their marginal populations. The most distributed is the lesser *R. hipposideros* (Carpathians, Podolia, Crimea, and Northern Caucasus); area of *R. ferrumequinum* is more narrow (Transcarpathians, Crimea, and Northern Caucasus); *R.* cf. *euryale* is known from the only locality in Crimea. Taxonomic capacity of regions is increasing in the following order: (1) Northern Carpathians and Podolia (1 sp., *RH* [occasionally *RF* also]); (2) Transcarpathians, Crimea, Northern Caucasus (2 sp., *RH+RF*); (3) seaside of Crimea (3 sp., *RH+RF+?RE*), where caves and grottoes are most warm and suitable for both winter hibernation, and summer breeding of the horseshoe bats.

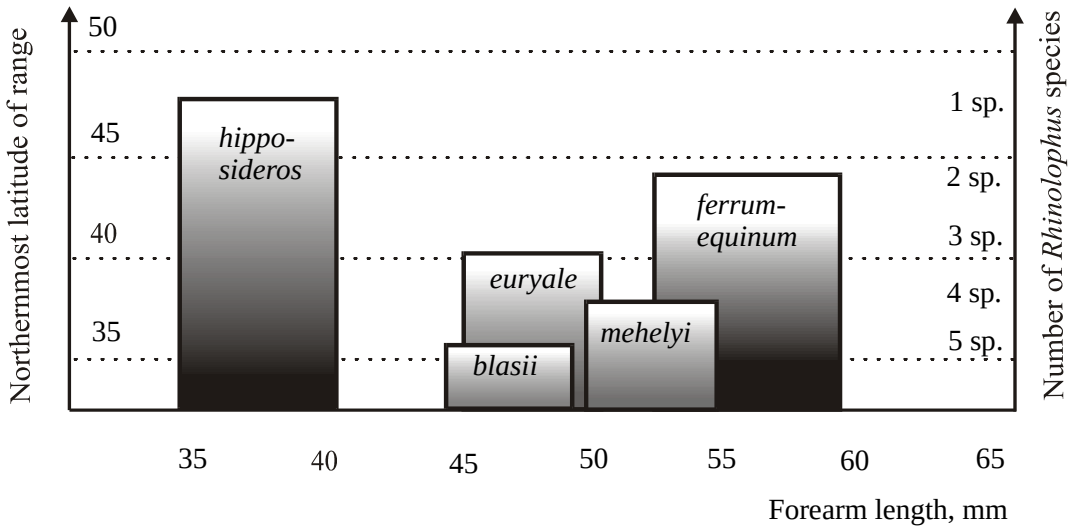


Fig. 5. Distribution of the forearm length in European Rhinolophidae known or supposed in Eastern Europe and neighbours. Species order corresponds to the idea about "intermediate" species insetting in fauna. Northernmost altitudes of species ranges are given according to the results of this investigation and after KUZYAKIN 1965; limits of forearm length are given after Table 3.

Among five European rhinolophids, the two most different species are present as a rule in most regions. These are the greater *R. ferrumequinum* and the lesser *R. hipposideros* (fig. 5), while "intermediate" *R. euryale*, *R. mehelyi* and *R. blasii* are known in neighbouring regions, from Central Europe to Caucasus. Analysis shows that species of "intermediate" group penetrate northward by some order. A northernmost distributed species is *R. euryale*, that separated clearly by morphological hiatus from both common species, *RH* and *RF*. Two other "intermediate" species (*R. mehelyi* & *R. blasii*) occur in more southern regions (Fig. 5), so their appearance in the higher latitudes corresponds to the level of their morphological differences from other species.

Analysis of long-term changes in Rhinolophidae number shows a regular tendency to increasing of abundance, and number of *RF* is extremely reduced (10 times per century). Taking into account their marginal distribution in the Eastern Europe, this family in a whole should be included in the List of vulnerable taxa. Their risk of extinction in this region completely depends on the strict protection and monitoring of their natural underground roosts.

VII. ANNEX (MARGINAL RECORDS OF SPECIES)

Numbering of locality records correspond to the numbers on maps (Fig. 3–4). Abbreviations of administrative units: CRR – Crimean autonomy region, IFO – Ivano-Frankivsk oblast, KHO – Khmelnitsky obl., KRK – Krasnodar Kray, LVO – Lviv obl., MLD – Moldova, TEO – Ternopol obl., TRO – Transcarpathian obl. Frequent references to ABELENTSEV & POPOV (1956) are abbreviated as AP'56.

Rhinolophus hipposideros

Western part of range. Northern Carpathians (Ukraine): (1) Urizh in Sambir distr., LVO ("Popov 1940" in: TATARINOV 1956; AP'56); (2) Pidgirtsi in Stryj distr., LVO (ibid.); (3) cave in left bank of Svirzh river near Melnya in Rogatyn distr., IFO (TATARINOV 1972); (4) [cave Mokra] near Lokitky ("Popov 1940" in: TATARINOV 1956 and AP'56) and cave Dumka near Odajiv in Tlumach distr., IFO (UNHM, n=5, 1965). **Podolia (Ukraine):** (5) cave Verteba near Bilche-Zolote in Borshchiv distr., TEO (UMHN, n=4, 1965; Pyliavsky in: TATARINOV 1956, 1974; AP'56); cave [Optymistychna?] near Bilche-Zolote (LNHM, n=31, 1951-1952; ZMKU, n=2, 1951; UNHM, n=3, 1965; TATARINOV 1956; AP'56); (6) cave Vitryana, Koralivka [6-SW of Borshchiv], TEO (UNHM, n=1, 1965; AP'56); (7) cave Perlyna in the Medobory Natural Reserve, Krutyliv, Gusiatyn distr., TEO (ca. n=20, 17.02.1997, RIZUN, pers. comm.); (8) Cave Karmelyuk on left bank of Smotrich river between Zaluchia and Karachkivtsi, Chemerivtsi distr., KHO (TATARINOV 1967); (9) Sokil Mt. near Nigyn, Kamianets-Podilsky distr., KHO (ibid.). **Middle Dniester region (Moldova):** (10) Soroky, MLD (OSTERMANN in: BRAUNER 1910; OSTERMANN 1912); (11) Khrustove in Kamenka distr., MLD (n=1; BRAUNER 1910); (12) artificial undergrounds near Sakharna, right bank of Dnister, MLD (LOZAN 1966); (13) undergrounds on left bank of Dnister near Zhura, MLD (wintering, LOZAN 1966); (14) Kishinev, MLD (BRAUNER in: AP'56); (15) quarries on left bank of Dniester, between Bychok and Krasnogorka, Grigoriopol distr., MLD (1995–1996, wintering and breeding colony, ANDREEV & VASILIEV 1997).

Eastern part of range. Crimea (Ukraine): (16) Tarkhankut peninsula (VOLOKH & KROCHKO 1994: on map only); (17) Chufut-Cale (Solonchik) in Bakhchisaray distr., CRR (ZMKU, n=1, 1956); (18) Sympheropol, CRR (AP'56); (19) cave Kyzyl-Koba near Perevalne in Zuya distr., CRR (AP'56); (20) "Karasu-Bashi" in Bilogirsk distr., CRR (UNHM, n=5, 1938); (21) Karadagh Mts in Sudak distr., buildings and grottoes, CRR (UNHM, n=11, 1980; n=2, 1981; AP'56; BESKARAVAJNY 1988); (22) Kerch, CRR (UNHM, n=2, 1907). **Northern Caucasus (Russia):** (23) vicinity of Novorossijsk, KRK (UNHM, n=2, 1907); (24) geological gallery near Derbent in Severska distr., KRK (DUVAROVA 1980); (25) cave Fanagoriyska in Goriachiy-Klyuch distr., KRK (DUVAROVA 1980); (26) vicinity of Kamenomostska, Kamyshki, Nikel and Dakhovska in Majkop distr., KRK (KAZAKOV & YARMYSH 1974).

Rhinolophus ferrumequinum

Western part of range. Transcarpathians (Ukraine): (1) Maly Berezny, TRO (UMHN, n=2, 1948, Abelentsev; ABELENTSEV 1950); (2) Lyuta and "Begendianska Pastil" (?) in Velyky-Berezny distr., TRO (ibid.); (3) Verkhni Vorota and Pidpolozzia in Volovets distr., TRO (ibid.); (4) Kushnytsa in Irshava distr., TRO (ibid.); (5) Uglya, caves Druzhba, Grebin etc. in the Uholka massive, Tyachiv distr., TRO (AP'56; KROCHKO 1965, 1988; this article); (6) quarries in the Kuziy reserved massif, near Lough in Rakhiv distr., TRO (POKYNCHEREDA & POKYNCHEREDA 1997). **Middle Dnister region (Moldova):** (7) cave La Beci near Koseuts (10-N of Soroky), Soroky distr., MLD (breeding colony, n=14, 16.06.1995; VASILIEV 1997) [questionable records listed in the text above].

Eastern part of range. Crimea (Ukraine): (8) Olenivka in Tarkhankut peninsula, vicinity and Dzhangul coast, CRR (ZMKU, n=1, 1956; UNHM, n=1, 1982; KRYZHANOVSKY 1988); (9) Evpatoria, vicinity, CRR (KRYZHANOVSKY 1988; VOLOKH & KROCHKO 1994, on map without details); (10) Chufut-Kale in Bakhchisaray distr., vicinity, Solonchik, Starosillia and cave Golubyna, CRR (ZMKU, n=2, 1956; UNHM, n=3, 1965; KRYZHANOVSKY 1988); (11) Sympheropol, in buildings (UNHM, n=5, 1904, n=51, 1927; MYGULIN 1938); “Sabli” near Sympheropol, CRR (UNHM, n=2, 1915); (12) cave Kyzyl-Koba near Perevalne in Zuya distr., CRR (UNHM, n=1, 1905, n=4, 1911, n=30, 1913, n=1, 1982; AP'56); (13) “Karasu-Bashi” in Bilogirsk distr., CRR (UNHM, n=2, 1938; n=1, 1948); Kvitkove, Mizhgiria and Biyuk-Karasu river in Bilogirsk distr., CRR (KRYZHANOVSKY 1988); (14) Kamenske in Lenin distr., near basis of Arabatka Spit, CRR (ibid.; VOLOKH & KROCHKO 1994: on map without details); (15) cave in Opuk Mt., CRR (in colony of *M. myotis*, 1995, 1996, Tsvelykh, pers. comm.); (16) quarry near Kerch, CRR (KRYZHANOVSKY 1988; VOLOKH & KROCHKO 1994: on map without details). **Northern Caucasus (Russia):** (17) vicinity of Novorossijsk, KRK (UNHM, n=2, 1907); (18) Derbent in Severska distr., KRK (DUVAROVA 1980); (19) vicinity of Kamenomostska, Kamyshki and Dakhovska in Majkop distr., KRK (KAZAKOV & YARMYSH 1974).

REFERENCES

ABELENTSEV V. I., POPOV B. M. 1956. Order of bats, or the bats – Chiroptera. In: Fauna of Ukraine. vol. 1. Mammals. Issue 1. Naukova dumka Press, Kyiv: 229-446. (in Ukrainian).

ABELENTSEV V. I., KOLYUSHEV I. I., KROCHKO Yu. I., TATARINOV K. A. 1968–1970. Results of bat ringing in Ukrainian SSR in 1939–1967 years. Communication 1–3. Vestnik zoologii, **2** (6): 59-64; **3** (2): 20-24; **4** (1): 61-65. (in Russian).

AMIRKHANOV Z. M. 1980. Distribution of bats in Daghestan. In: Bats (Chiroptera). Nauka Press, Moscow: 63-69. (In Russian).

ANDREEV S. P. Protection of bats in Moldova. Information package for the 4 Meeting of the Advisory Committee EUROBATs. Kishinev, 1999, pp. 1-6. (inf.EUROBATs.AC4.24).

ANDREEV S. P., VASILIEV A. G. 1997. Bats (Chiroptera, Mammalia) of the complex of artificial undergrounds of v. Bychok. In: Pamyati Professora Alexandra Alexandrovicha Braunera (1857–1941). Astroprint, Odessa, pp. 100-103. (In Russian).

AVERIN YU. V., LOZAN M. N. 1965. Bats of Moldavia. In: Problems of ecology and practical significance of birds and mammals in Moldavia. Kishinev, pp. 25-32. (In Russian).

BESKARAVAJNY M. M. 1988. Modern state of bat fauna in Karadagh (Crimea). In: Bats (morphology, ecology, echolocation, parasites, protection). Naukova dumka, Kyiv, pp. 113-116. (in Russian).

BRAUNER A. 1910. On flight mice of the Bessarabia and the Podolia. Trudy Bessarabskogo Obshchestva Estestvoispytatelej (Kishinev), **2**, issue 1: 1-2. (in Russian).

BRAUNER A. 1911. Flight mice of the Crimea. Zapiski Krymskogo Obshchestva Estestvoispytatelej i lyubitelej prirody, N 1: 1-13. (in Russian with German summary).

BRAUNER A. 1923. The bats or flying mice (Chiroptera). In: BRAUNER A. Agricultural zoology. Gosizdat of Ukraine, pp. 3-7. (in Russian).

CHARLEMAGNE E. V. 1915. Mammals of the vicinities of Kyiv. In: Materials to investigation of fauna of the South-west of Rossija. Kessler Ornithol. soc., Kyiv, **1**: 26-92. (in Russian).

CHYZHMAR Ju. Ju., DOVGANYCH Ya. O. 1988. Carst objects of the Carpathian reserve. In: Problems of investigation and protection of reserved ecosystems. Rakhiv, pp. 138–140. (in Russian).

DAAN S. 1980. Longterm changes in bat populations in the Netherlands: a summary. Lutra, **22**: 95-118.

DOROSHENKO A. V. 1975. Habitats and number of flight mice of Moldavia In: Ecology of birds and mammals of Moldavia. Kishinev, pp. 82-95. (In Russian).

DULITSKY A. I. 1974. Abundance and problems of bat protection in the Crimea. In: Materials of the 1st All-Union Conference on Bats (Chiroptera). Zool. Inst. USSR Acad. Sci., Leningrad, pp. 63-67. (In Russian).

DULITSKY A. I., STENKO R. P., KARPENKO O. V. 1986. About protection of the flight mice in the Crimea. Vestnik zoologii, **20** (1): 54-55. (In Russian).

DUVAROVA A. S. 1980. About wintering of bats in the Krasnodar Kray. In: Bats (Chiroptera). Nauka Press, Moscow, pp. 70-71. (In Russian).

FELDMANN R. 1967. Bestandsentwicklung und heutiges Areal der Kleinen Hufeisennase (*Rhinolophus hipposideros*) im mittleren Europa. Sauget. Mitt., **15**: 43-49.

HORACEK I. 1984. Remarks on the causality of population decline in European bats. Myotis, **21-22**: 138-147.

HORACEK I., CERVENY J. 1984. K vyskytu druhu *Rhinolophus ferrumequinum* a *Rhinolophus euryale* na Slovensku. Lynx, **22** (nov. ser.): 15-17.

HORACEK I., HANAK V., ZIMA J., CERVENY J. 1995. K netopyri faune Slovenska. 1. Letni nalezy 1979-1992. In: Netopiere. Skup. Ochr. Nietoperov, Bystrica, **1**: 39-54.

[IUCN] 1994. IUCN Red List Categories prepared by IUCN Species Survival Commission. The World Conservation Union, Gland, pp. 1-21.

KAZAKOV B. A., YARMYSH N. N. 1974. On the bat fauna of the Predkavkazije [Northern Caucasus]. In: Materials of the 1st All-Union Conference on Bats (Chiroptera). Zool. Inst. USSR Acad. Sci., Leningrad, pp. 69-72. (In Russian).

KESSLER K. F. 1851. Mammalian animals. Proceedings of the Commission ... for description of the provinces of the Kyiv educational district: Kyiv, Podolian, Volyn, Poltava, Chernigiv. Kyiv, pp. 1-88. (In Russian).

KONSTANTINOV A. I., VSHIVKOV F. N., DULITSKY A. I. 1976. Modern state of bat fauna in the Crimea. Zoologicheski Zhurnal, **55** (6): 885-893. (In Russian with English summary).

KOKUREWICZ T. 1990. The decrease in abundance of the Lesser horseshoe bat *Rhinolophus hipposideros* Bechstein, 1800 (Chiroptera: Rhinolophidae) in winter quarters in Poland. Myotis, **28**: 109-118.

KOKUREWICZ T., KOVATS N. 1989. Interpopulation differences in thermopreferendum of the Lesser horseshoe bat, *Rhinolophus hipposideros* Bechstein, 1800 (Chiroptera: Rhinolophidae) in selected areas of Poland and Hungary. Myotis, **27**: 131-138.

KORNEEV O. O. 1965. Key to mammals of UkrSSR (2nd edition). Naukova dumka Press, Kyiv, pp. 1-236. (in Ukrainian).

KOVALYOVA I. M. 1997. The horseshoe bats in Ukraine. In: B. OHLENDORF (ed.). Zur Situation der Hufeisennasen in Europa. IFA Verlag GmbH, Berlin, pp. 83-84.

KOWALSKI K., RZEBIK-KOWALSKA B. 1991. Family Rhinolophidae. In: Mammals of Algeria. Wydawn. PAN "Ossolineum", Wroclaw - Warszawa - Krakow, pp. 64-82.

KOZLOV V. I. 1949. Materials to the investigation of biology of the flying mice in the mountain Crimea. In: Ochrana prirody. Moskva, issue 8 (1948), pp. 122-137. (In Russian).

KROCHKO Yu. I. 1965. Materials about wintering of the greater horseshoe bat on the territory of Zakarpatska oblast. In: Abstracts and communications to XIX Scientific Conference of the Uzhgorod University (Biol.). Uzhgorod, pp. 72-74. (in Ukrainian).

KROCHKO Yu. I. 1988. Bats of the Carpathian biosphere reserve and actual problems of their preservation. In: Problems of investigation and protection of the reserved ecosystems. Rakhiv. pp. 110-112. (in Ukrainian).

KRYSTUFEK B. 1991. Druzina: Podkovnjaki (Rhinolophidae). In: KRYSTUFEK B. Sesalci Slovenije. Ljubljana, Prirodosl. muz. Slov., pp. 61-71. (in Slovenian).
KRYZHANOVSKY V. I. 1988. Order bats – Chiroptera. In: SYTNYK K. M. (ed.). Rare and endangered plants and animals of Ukraine. Naukova dumka, Kyiv, pp. 206-217. (in Russian).
KRYZHANOVSKY V. I., EMELIANOV I. G. 1985. Class of mammals. In: V. A. TOPACHEVSKI (ed). Nature of Ukrainian SSR. Animal world. Naukova dumka, Kyiv, pp. 197-234. (in Russian).
KUZYAKIN A. P. 1965. Order Bats. Ordo Chiroptera. In: Key to mammals of USSR. Prosvieshchenie Press, Moskva, pp. 79-116 (+ maps on p. 15-27 in Addendum "Atlas of ranges"). (in Russian).
LIKHOTOP R. I., TKACH V. V., BARVINSKY N. I. 1990. Bats (Chiroptera) of Kyiv city and the Kyiv region. In: Materials on the ecology and faunistics of some representatives of bats. Inst. zool. Ukr. Acad. Sci. (Kiev), Preprint N 90.4, pp. 10-27. (in Russian).
LOZAN M. N. 1966. Mammals of the Dnister valley from the village Naslavcha to the town Dubossary. In: Ochrana prirody Moldavii, N 4. Kartya Moldavenyaske, Kishinev, pp. 116-122. (In Russian).
LOZAN M. N., SKVORTSOV V. G. 1965. About the bat wintering in Moldavia. Zoologicheski Zhurnal, **44** (6): 941-943. (In Russian with English summary).
MYGULIN O. O. 1938. Family Horseshoe bats – Rhinolophidae Lesson, 1827. In: MYGULIN O. O. Mammals of the Ukrainian RSR. Acad. Sci. of URSR. Press, Kyiv, pp. 96-99. (in Ukrainian).
OSTERMANN A. I. 1912. Explanatory catalogue of the Zoological agricultural and handicraft museum of the Bessarabian province government. Kishinev. (In Russian, cit. after LOZAN, 1966).
POKYNCHEREDA V. F. 1997. Winter population of bats of underground cavities in the territory of the Carpathian biosphere reserve. In: International aspects of study and conservation of biodiversity in the Carpathians. Rakhiv, pp. 148–153. (In Ukrainian).
POKYNCHEREDA V. F., POKYNCHEREDA V. V. 1997. Species composition and numbers of wintering bats in some undergrounds of the Carpathian biosphere reserve. In: International aspects of study and conservation of biodiversity in the Carpathians. Rakhiv, pp. 154-157. (In Ukrainian).
POPOV B. M. 1941. On season migrations of the flying mice (Chiroptera). Priroda, N 2: 87-90. (in Russian).
PUCEK Z., RACZYNSKI J. (eds.). 1983. Atlas of Polish mammals maps. Warszawa, PWN, **1** (text): 1-188 pp.; **2** (maps): 1-90 pp.
ROER H. 1984. Zur Beestandssituation von *Rhinolophus ferrumequinum* (Schreber, 1774) und *Rhinolophus hipposideros* (Bechstein, 1800) (Chiroptera) im westlichen Mitteleuropa. Myotis, **21-22**: 122-131.
SCHOBER W., GRIMMBERGER E. 1987. The horseshoe bat family (Rhinolophidae): genus *Rhinolophus* (Lacepede, 1779). In: A guide to bats of Britain and Europe. Franchh'sche Verlagshandlung (Hamlyn Publ. Group Ltd.), Hamlyn, pp. 86-103.
SKVORTSOV V. G., DOROSHENKO-KUCHUK A. V. 1974. Distribution and abundance of the flight mice in Moldavia. In: Materials of the 1st All-Union Conference on Bats (Chiroptera). Zool. Inst. USSR Acad. Sci., Leningrad, pp. 67-69. (In Russian).
SOMOV N. N. 1897. Ornithological fauna of Kharkiv province. In: Trudy Kharkivskogo obshchestva ispytatelej prirody (supplement to vol. **26**), Kharkiv, pp. 149-150. (In Russian).
STRELKOV P. P. 1963. Fam. Rhinolophidae – Horseshoe flight mice. In: Mammals of the USSR fauna. Part 1. USSR Acad. Sci. Press, Moskva - Leningrad, pp. 128-140. (in Russian).
STEBBINGS R. E. 1988. Conservation of European bats. Christopher Helm, London, 1-264 pp.
STRELKOV P. P. 1976. Rare species of flight mice of USSR fauna and their protection. In: SOKOLOV V. E. (ed.). Rare mammals of the USSR fauna. Nauka Press, Moskva, pp. 50-66. (in Russian).
STRELKOV P. P. 1981. Ordo Chiroptera Blumenbach, 1779 – bats. In: GROMOV I., BARANOVA G. (eds.). Catalogue of mammals of USSR. Nauka, Leningrad, pp. 31–53. (in Russian).
TATARINOV K. A. 1956. Horseshoe bats, Rhinolophidae. In: TATARINOV K. A. Mammals of the western regions of Ukraine. Ukr. Acad. Sci. Press, Kyiv, pp. 29-34. (In Ukrainian).
TATARINOV K. A. 1962. Caves of the Podolia, their fauna and protection. In: Ochrana prirody i zapovednoje delo v SSSR. USSR Acad. Sci. Press, Moscow, issue 7, pp. 88-101 (in Russian).

TATARINOV K. A. 1967. Supplementary data on the bats of Ukraine. Vestnik zoologii, **1** (6): 68-72. (in Russian with English summary).
TATARINOV K. A. 1972. Distribution of the Lesser horseshoe bat (*Rhinolophus hipposideros* Bechstein) in the West of UkrSSR. Vestnik zoologii, **6** (5): 82-84. (in Russian with English summary).
TATARINOV K. A. 1974. Bats of the Podolia and the Northern Carpathians. Indices of their abundance and ways to protection. In: Materials of the 1st All-Union Conference on Bats (Chiroptera). Zool. Inst. USSR Acad. Sci., Leningrad, pp. 58-60. (In Russian).
TATARINOV K. A. 1988. New bat habitat in the source of the Prut river. In: Bats (morphology, ecology, echolocation, parasites, protection). Naukova dumka, Kyiv, pp. 96-99. (in Russian).
VARGOVICH R. 1998. Hibernation of bats (Chiroptera) in the gypsum caves of Bukovina and Podilja. ZAGORODNIUK I. (ed.). European bat night '98 in Ukraine (Proceedings of the Theriological School, issue 1). Kyiv, pp. 117–123. (in Ukrainian with English summary).
VASILIEV A. G. 1997. First find of the Greater horseshoe Rhinolophus ferrumequinum bat colony in Moldova. Vestnik zoologii, **31** (4): 28. (In Russian).
VIERHAUS H. 1984. Distribution patterns of some bats in Westphalia. Myotis, **21-22**: 102-108.
VOLOKH A. M., KROCHKO Yu. I. 1994. *Rhinolophus hipposideros*. *Rhinolophus ferrumequinum*. In: SCHCHERBAK M. M. (ed.). Red Data Book of Ukraine. Animal world. Ukrainian Encyclopaedia Press, Kyiv, pp. 376-377. (In Ukrainian).
VOLIANSKY Yu. E. 1967. Bat wintering in the vicinities of Odessa. Vestnik zoologii, **1** (1): 77-78. (In Russian).
WOLOSZYN B. W. 1976. Bemerkungen zur Populationsentwicklung der Kleinen Hufeisennase, *Rhinolophus hipposideros* (Bechstein, 1800) in Polen. Myotis, **14**: 37-52.
YARMYSH N. N., KAZAKOV B. A., SONINA I. Yu., USVAYSKA A. S. 1980. New findings of bats on the Northern Caucasus. In: Bats (Chiroptera). Nauka Press, Moscow, pp. 70-71. (In Russian).
YAVRUNIAN E. G. 1990. The ecological peculiarities of four horseshoe bats species in the south coast of the Mediterranean sea and in Armenia. In: Bats. Proceedings of All-Union Conference on bats. Penza, pp. 82-84. (In Russian).
ZAGORODNIUK I. 1998. Systematic review of bats from the Eastern Europe. In: ZAGORODNIUK I. (ed.). European bat night '98 in Ukraine. (Proceedings of the Theriological School, issue 1). Kyiv, pp. 32–48. (In Ukrainian with English summary).
ZAGORODNIUK I. 1998a. Bats in the Lviv natural history museum: description and comparative analysis of the collection. In: Proceedings of Lviv Nat. Hist. Mus., **12**. (in press).
ZAGORODNIUK I. POKYNCHEREDA V., KYSELIUK A., DOVGANICH Ya. 1997. Theriofauna of the Carpathian Biosphere Reserve. Vestnik zoologii Supplement, N 5: 1-60 pp. (In Ukrainian with English summary).
ZAGORODNIUK I., TKACH V. 1996. The present state of fauna and the historical changes of abundance of the bats (Chiroptera) in the territory of Ukraine. Dopovidi Nat. Acad. Sci. Ukr. [Proceedings of NASU], N 5: 136-142. (In Ukrainian with English summary).
ZUBKO A.P. 1937. Essay on fauna of Chiroptera from the South-east of the Odessa oblast. Zbirn. Prats Zool. Mus. (Inst. of Zool. and Biol., Acad. Sci. Ukr.), **20**: 121-128. (In Ukrainian).