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HORSESHOE BATS (*RHINOLOPHUS*) IN THE DNISTER REGION AS THE MOST EAST-NORTHERN PART OF THEIR RANGE IN EUROPE

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Horseshoe bats (*Rhinolophus*) in the Dnister region as the most east-northern part of their range in Europe. *Rhinolophus* is presented in the Dnister region by two species, abundant *R. hipposideros* (Bechstein, 1800) (*RH*) and very rare *R. ferrumequinum* (Schreber, 1774) (*RF*). Geographical distribution of these bats are described in details. The more distributed species is *RH* known from 30 localities, and there are just 4 doubtful records of *RF*. Most data of the *Rhinolophus* were obtained from their winter quarters. Though both *Rhinolophus* species are included in the different list of rare and endangered species, *RH* is the most numerous species of bats hibernating in the Podolian caves. A number of *RH* per one cave during winter is about 20–60 specimens, that exceeds a total number of other the species. In the caves adapted for tourism *Rhinolophus* is absent. Summer records as a whole and breeding colonies of *Rhinolophus* are known in the south-eastern parts of Dnister region. Podolian population of *Rhinolophus hipposideros* is characterised by dominance of males (up to 8:1).

Key words: horseshoe bat, geographic distribution, abundance, cave, migration, Eastern Europe.

1. Introduction

Horseshoe bats are presented in the East Europe by two species, *Rhinolophus hypposideros* and *R. ferrumequinum*. Both species are distributed there in three different regions, that represent three relatively independent parts of their geographic ranges. These are: (1) Transcarpathians (Pannonian lowland and southern macroslope of Carpathians), (2) Dnister region (Northern Carpathians and Podolian Upland), and (3) the Crimea (mountain and seaside parts of Crimean peninsula) (ZAGORODNIUK 1999). Among them, the Dnister region is the most poorly investigated. So, besides Crimea, ABELENTSEV & POPOV (1956) registered 33 records of each species in the Transcarpathians, while in the Dnister regions these authors mentioned just 8 records of *Rhinolophus hypposideros* and 3 ones of *R. ferrumequinum*.

Dnister region lies northward from the main Carpathian ridge and includes two large geographic areas: the Northern Carpathians and the Podolian Upland. Both mentioned areas are adjacent but separated by the canyon of the Dnister river with its numerous inflows, as Carpathian (right) as Podolian (left) ones. The limits of this territories correspond in a whole to the Podolian karst region, that are characterised by numerous natural caves, coastal cavities, and artificial

limestone and gypsum mines (TATARYNOV 1966, GUNIOVSKY 1966, DUBLIANSKY, LOMAYEV 1980).

Investigated territory covers the region with the largest abundance of mammals listed in the "Red Data Book" (ZAGORODNIUK 1997). Numerous underground shelters are the important factor for the formation of the high taxonomic richness of bat fauna (TATARYNOV 1974). The Dnister region is the unique territory, where the most northern cave bat communities are distributed, and this region is recommended to the National Econet of Ukraine (ZAGORODNIUK 1999). All known records of the *Rhinolophus* in the Eastern Europe northward the Carpathians came just from this territory (TATARYNOV 1972; VARGOVYCH 1998).

The main goal of this investigation is a description of *Rhinolophus* populations occurring in the most east-northern part of the family range in Europe. Earlier, we described the *Rhinolophus* distribution in a whole (ZAGORODNIUK 1999), using just their marginal northernmost findings in East Europe. In this article, a detail analysis of their distribution in the Dnister basis is presented.

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2. Materials

Materials for the analysis were obtained by four different ways: field investigations, personal communications of colleagues, study of museum collections (review of collections see: ZAGORODNIUK 1998a), and analysis of literature (bibliography see: ZAGORODNIUK 1998b).

Field investigations were carried out during the winter period of 1999–2000 in the caves of the Central Podolia in the Ternopol Oblast and during the summer time of 1999 in the Khmelnitski Oblast of Ukraine. Winter census were carried out during our joint expeditions in the largest carst caves (with total length over 2 km): Mlynki, Ugryn, Verteba, Vitrova, Kryshtaleva, and Slavka (ANNEX 2). Summer investigation was carried out by TYSHCHENKO in the southern part of the Khmelnitski Oblast, that adjacent to the Dnister valley (left-bank part).

Investigations in museums were carried out in the three main three zoological collections: National Museum of Natural History (UMNH), Zoological Museum of Kyiv University (ZMKU, n=20), and State Natural History Museum in Lviv (LNPM). Totally, 226 *Rhinolophus* specimens from different parts of Eastern Europe were investigated, among them there were 171 *RF* and 55 *RH*. Data on the known collected specimens of *Rhinolophus* from the Dnister region are given in the ANNEX 1.

Codes for mapping. Species ranges were investigated using all known records (Tables 2–5). *Codes of localities* are the same in both tables and maps (Fig. 1). These codes consist of the letters and numbers (for example, "L1"), that is the first letter of the name of administrative region (Oblast' or state) and serial number of the record coming from this region: L – Lviv; F – Ivano-Frankivsk, C – Chernivtsi, T – Ternopol, K – Khmelnitsky Oblast' of Ukraine; M – Republic of Moldova. *Codes of species' status* (near code of locality): *w* – winter finding, *s* – summer ones, *b* – breeding colony. *Codes of references* cited in the tables are followings (in alphabetic order): A&P-56 = ABELENTSEV & POPOV 1956, BAS-98 = BASHTA 1998, BRA-10 = BRAUNER 1910, KRY-88 = KRYZHANOVSKY 1988, S&D-74 = SKVORTSOV & DOROSHENKO-KUCHUK 1974, TAT-56/67/73 = TATARYNOV 1956, 1967, and 1973, VAR-98 = VARGOVYCH 1998, VAS-97 = VASILIEV 1997, V&A-98 = VASILIEV & ANDREEV 1998, ZAG-99 = ZAGORODNIUK 1999.

Fig. 1. Ranges of the two northernmost distributed horseshoe bat species in Europe according to STEBBINGS (1988). According to this traditional point of view, *Rhinolophus* penetrates to the Northeast not far from Carpathian ridges.

RH – R. hipposideros,
RF – R. ferrumequinum,
??? – studied region.

3. Species composition and abundance of *Rhinolophus*

According to the traditional point of view, there are two *Rhinolophus* species in the fauna of the region, namely *R. ferrumequinum* and *R. hipposideros* (ABELENTSEV & POPOV 1956). Both species are considered as relatively rare and included into the "Red data book of Ukraine" (SCHCHERBAK 1994) and the List of rare and endangered bats of Moldova (ANDREEV 1999). In East Europe *Rhinolophus* form a settled populations (ABELENTSEV & POPOV 1956).

Both *Rhinolophus* species were registered in the fauna of the Dnister region (for previous review see: KRYZHANOVSKY 1988), but their records are rare and known ranges are restricted. These species occur in the most south-western parts of the Eastern Europe, mainly in the mountain areas of the Carpathians and the Crimea. STEBBINGS (1988) restricts the range of *Rhinolophus* distribution by the Carpathians (Fig. 1), but there are some records of both species in the Dnister region in a whole and in the Podolian Upland in particular, that are confirmed by literary data, museum collections, and our observations.

Table 1 demonstrates a share of *Rhinolophus* in the total sample of bats, known from all the administrative Oblasts (provinces) of Ukraine, that are adjacent to the Dnister region both from the Carpathian, and Podolian side of Dnister basin. It is obvious, that *Rhinolophus* occur in the Dnister region. Whereas *Rhinolophus* in a whole is an abundant group of bats in the studied region, a relative abundance of each species is different (see also: ZAGORODNIUK & TKACH, 1996).

Thus, both known *Rhinolophus* species occupy the opposite positions in the scale of bat abundance in the Dnister region (Table 1). Lesser horseshoe bat, *Rhinolophus hipposideros*, appears to be the most numerous and most distributed species of bats in the Dnister region. This species is recorded in the most of underground roosts.

During long-term period of investigations, share of this species has been continuously increasing[1], and now its portion in the cave bat communities reaches 50 %. Another species, *R. ferrumequinum* has more narrow range and smallest abundance, and most its records in the region are questionable. Detailed descriptions of species' distribution and abundance are presented separately for each species and territory.

[1] This tendency completely corresponds to general tendency in the East Europe (ZAGORODNIUK 1999).

Table 1. Bat species from the cave roosts of Dnister region and their relative abundance (species are ranged in order of their abundance; data for Ukraine part of the region) *

Species (in order of abundance decreasing)	Specimens in collections	Winter census in caves (VAR-98)	Winter census in caves (orig.)		Sum	
	1946–1985	1993–1998	1999	2000	Absol.	%
Rhinolophus hipposideros	9	288	83	328	708	54,7
Myotis myotis	4	250	40	102	396	30,6
Myotis myotis+blythii	–	92	–	–	92	7,1
Plecotus auritus	2	42	10	4	58	4,4
Eptesicus serotinus	11	–	–	–	11	0,9
Myotis daubentonii	6	3	1	1	11	0,9
Barbastella barbastellus	9	–	–	–	9	0,7
Myotis bechsteinii	2	1	–	–	3	0,2
Plecotus austriacus	–	–	2	–	2	0,2
Myotis emarginatus	–	1	–	–	1	0,1
Myotis mystacinus	–	1	–	–	1	0,1
R. ferrumequinum	–	1	–	–	1	0,1
Total	43	581	136	398	1293	100,0

* Data of different years were summed for all cases. Data of VARGOVYCH (1998) are calculated excluding the results of bat census in cave Bukovinka (valley of Prut river; *Rhinolophus* was not registered in this cave).

4. General review of new records of *Rhinolophus*

Investigations of wintering and registrations of *Rhinolophus hipposideros (RH)* were conducted twice in January and February of 1999 and of 2000 in some karst caves on the south of Ternopil Oblast. Totally seven caves were inspected: Ugryn, Mlynki, Vitrova (Optymistychna), Verteba, Slavka, and Kryshtaleva cave with two parts — entrances "Lysjachy hid" and "Central hid". Wintering of *RH* was detected in five of them (see Table 3).

It is necessary to note, that we inspected the entrance mazes and the central parts of caves most carefully. Taking this into account, it is possible that real quantity of wintering *RH* in these shelters is slightly higher than the actual registration data, and amounts probably about 350 individuals. Among inspected wintering *RH,* the number of males prevail considerably, mean ratio is 7,9:1 (n=71). (In old museum samples ratio is 2.2:1, n=38).

Wintering *Rhinolophus hipposideros* are settled on inclined walls of crypt-like or slit-like passages, and also on a ceiling. The animals place on the height from 60 cm (Verteba, Lysjachij hid) up to 10 m (Kryshtaleva), frequently on 1,7–2,5 m. *Rhinolophus hipposideros* are located more often by one or in small groups (2–6 individuals). Sometimes they form large compact groups (55 in Vitrova, 33 in Lysjachy Hid), but always on the distance not less than 6–10 cm from each other. Wintering individuals place along the whole length of caves – both not far from entrance (Slavka – 10 m; Lysjachy hid, Vitrova – 30 m) and in the farthest galleries (Verteba, Slavka). The most common neighbours of *Rhinolophus hipposideros* in the shelters are *Myotis myotis*, *Plecotus auritus*, and *Plecotus austriacus* (see ANNEX 2). And in all shelters (except for Verteba cave) *Rhinolophus hipposideros* dominates in quantity of wintering individuals.

All new data obtained after (1) investigations of museum collections, (2) census in caves in winter time and (3) summer investigations using bat-nets summarised in the ANNEX 2. Totally, 465 *Rhinolophus* were registered during our field investigations, all of them are *R. hipposideros*.

5. *Rhinolophus ferrumequinum* in the Dnister region

There are four records of the greater horseshoe bat in the region. Two records came from the small caves situated near the right bank of the Middle Dnister region in Ivano-Frankivsk and Chernivtsi Oblasts of Ukraine; other records are from Moldova.

Record from Lokitky (KRYZHANOVSKY 1988) seems an erroneous because: (1) this author never investigates this species in the field, (2) such morphological materials are absent in the museums, and (3) earlier *RH* only was registered in the same locality ("POPOV 1940" in: TATARYNOV 1956). We consider this record are a mistake happened after erroneous rewriting of POPOV'S data. Another record is mentioned by VARGOVYCH (1998), who find the one hibernated specimen in 1994 in the Pionerka cave (Zastavna distr. of Bukovyna): this specimen was listed by VARGOVYCH in the Table, but not mentioned in the text as well as in the checklist of registered species[2].

The more certain information came from Moldova, where the only mentioned *RF* specimen was collected for 12 years of investigations (SKVORTSOV & DOROSHENKO-KUCHUK 1974). Later, DOROSHENKO (1975) made this data more precise: it was 1 male, observed in 1962 in a quarry of Bychok in the Grigoriopol distr. The only reliable record of this species in the Dnister region is from the vicinity of Soroky in Moldova: *RF* breeding colony (n=14) was found in the cave La Beci near Koseuts (VASILIEV 1997). Thus, *Rhinolophus ferrumequinum* occurs just in south-eastern part of the Dnister region.

6. *Rhinolophus hipposideros* in the Dnister region

The area distribution of *R. hipposideros* findings in Ukraine can be conditionally divided into two districts according to the geographical location and considerable differences in environmental conditions.

This division is conform to the physical-geographical, geomorphological and geobotanical zoning of the territory: (1) Upper Dnister region and Northern Carpathians, and (2) Central and Southern part of the Middle Dnister region. Detail descriptions of *Rhinolophus* records were prepared for each these regions and their subdivisions separately.

Table 2. Records of *Rhinolophus ferrumequinum* in the Dnister region *

Code	Locality	Geographic description	Remarks	Reference
F4	Lokitka	Lokitka vill. (Lokitky), Tlumach distr., Ivano-Frankivsk Oblast, Ukraine	? erroneous record of *RH* after A&P-56	KRY-88
C1 $^{(W)}$	Pionerka	Pionerka cave, Zastavna distr. of Chernivtsi Oblast, Ukraine	1 specimen for 4 years of investigation	VAR-98
M1$^{(S,B)}$	La Beci	cave La Beci near Koseuts, 10 km N of Soroky, Moldova	breeding colony, n=14 ad., 16.06.1995	VAS-97
(no)	Bychok	quarry of Bychok, Grigoriopol distr., Moldova (outside of map on Fig. 2)	1962, 1 male among 139 *RH*	S&D-74

* Codes of localities correspond to sites mentioned on the map (Fig. 2) and to records of *RH*.

[2] VARGOVYCH (pers. comm.) made this record more precise: there was the only hibernated specimen registered in the lower (colder) floor of the Pionerka cave in 11 January of 1994.

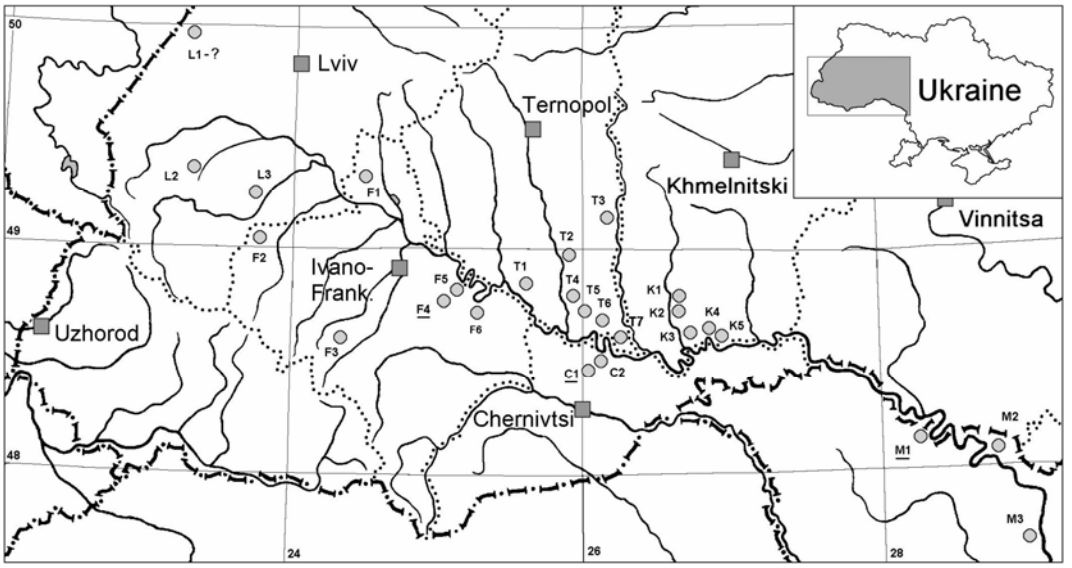

Fig. 2. Geographical distribution of *Rhinolophus* in the western part of Ukraine (except the Transcarpathian region) and adjacent parts of Moldova according to the original and literary data as well as to the results of museum collection's investigation (after data presented in Table 3–6). All the records deal with species *Rhinolophus hipposideros*. The Greater horseshoe bat (*R. ferrumequinum*) was recorded together with *R. hipposideros* in the localities F4, C1 and M1 (codes of these localities are underlined on this map). Circles with central black point sign the summer records of breading colonies.

6.1. Upper Dnister and Northern Carpathians

The region is located on the territory of Northern Carpathian Upland and External Carpathians. The territory of region includes southern part of Chernivtsi, Ivano-Frankivsk and Lviv Oblasts. According to the physical-geographical zoning the territory of Upper Dnister belongs to the Northern Carpathians province and External Carpathians province of the Carpathians Mountainous Country. The region belongs to European broad-leaved forest-steppe area. The climate of this territory is mild, without heavy frosts and droughts. Average annual atmospheric precipitation is 600–750 mm. Geological feature of region is formed by Neogene sedimentary rock which consists of clays, clay shale and sandstone. The turty-podzolized loamy soil are prevail in a soil cover. The surface of the region represents alternation of flat areas between rivers, wide valleys and depressions directed to Dnister. The mean true altitude of areas between rivers is 300–400 m, increasing near mountains up to 500 m. The natural vegetation occupies about 35 % of the region area and only 25 % from them are forests. The oak forests are predominant. The pine and oak-pine forests and steppe districts absence on the territory of region (GEOBOTANICAL ... 1977).

The winter shelters of *R. hipposideros* are presented here by small karst cavities (Mokra, Stalaktitova) located within gypsiferous-limestone stripes. Relative air moisture in this caves is very high (70–90 %). There are a lot of artificial underground cavities on the territory of region (TATARINOV 1966). Data summarised in the Table 3. Totally, there are 11 localities, where this species was registered (among them there are 2 summer and 5 winter records).

Table 3. Records of *Rhinolophus hipposideros* in the Upper Dnister region and left-banked part (Carpathian part) of the Middle Dnister region. (Lviv, Ivano-Frankivsk and Chernivtsi Oblasts of Ukraine)

Code	Locality	Geographic description	Remarks	Reference
L1	Stradchanski catacombs	Stradch vill., Javoriv distr. (vic. of Roztochchya nature reserve)	1985–1987; doubtful: see footnote [3]	BAS-98
L2	Urizh	Urizh vill. (on Bystrytsa river), Drogobych distr. ("Pidbuzh distr.")	15 km WWN from Drogobych	A&P-56*
L3a	Pidgirtsi	Pidgirtsi vill., Stryj distr.	4 km E from Stryj	A&P-56
L3b (W)	Kljuch	cave Kljuch near Kamjanka, Stryj dstr.	5–7 sp. each year since 1997	BASHTA 2000
F1 (W)	Mel'na	Mel'na vill., Rogatyn distr.	Cave in the left bank of Svirzh river	TAT-72
F2	Bubnyshche	Bubnyshche vill., Dolyna distr.	"Bolechiv distr."	A&P-56
F3	Maniava	Manjava vill., Bogorodchany distr. ("Solotvyn distr.")	Valley of Bystrytsa-Solotvynska river	A&P-56
F4 (S)	Lokitka	Lokitka vill. ("Lokitky"), Tlumach distr.	[cave Mokra (= "Stalaktytova"?)]	A&P-56
F5 (W)	Dumka cave complex	Dumka khutor (left bank of Dnister), near Odajiv in Tlumach distr.	crack-caves: Zatyshna, Vertykal'na, Strimka; n=7–55 sp.**	VAR-98
F6 (W)	Nezvys'ko catacombs	Nezvys'ko vill., Tlumach distr.	caves in right bank of Dnister; n=10–13 sp.	VAR-98
C1 (W)	Pionerka cave	near Pogorilivka vill., Zastavna distr.	(same); n=0–1 sp.	VAR-98
C2 (W)	Duche & Balamutivka caves	Balamutivka vill., Zastavna distr., right bank of the Dnister rive	(same); n=5–8 sp.	VAR-98

* Data in ABELENTSEV & POPOV (1956) are the same as in TATARINOV (1956). ** Numbers in the remarks to records after VARGOVYCH (1988) mean all the registered specimens per one year (period 1994–1998).

6.2. Central and Southern part of the Middle Dnister region

The region is located on western part of Podolian Upland and includes northern parts of Chernivtsi and Ivano-Frankivsk Oblasts, central part of Lviv Oblast, southern parts of Ternopil and Khmelnitsky Oblasts. According to the physical-geographical zoning, territory of the Middle Dnister belongs to West-Podolian hill region, Prut-Dnister region and Roztotsko-Opilska region of the West-Ukrainian forest-steppe province (ATLAS 1978). This territory is represented by rolling plain indented by numerous steep valleys of rivers with karst cavities and the Tovtry ridge with relative altitudes of 40–60 m. The southern exposition of this slopes defines the warmer climate in this region. Original orientation and direction of the Dnister valley slopes promote specific microclimatic conditions, which successfully influence on humidifying and thermal mode.

In comparison with other regions of Forest-steppe area of Eastern Europe, the climate of this territory is less continental. Winters are the mildest, summers are moderately warm. Average annual temperature is $+6,6^0$ C, and in the valley of Dnister river 0,5–0,7 ^{0} C higher. About 160–165 days have temperatures above zero. Substantial sum of annual precipitation varies from 650 mm (north-western part) to 520 mm (southern part).

[3] BASHTA (1998) did not find this species and cites data of LUGOVOJ from "Chronicle of Roztochchya reserve 1987". Earlier *Rhinolophus* was not registered in the same site by POLUSHYNA & BOROVETS (1988) and TKACHYK *et al.* (1995).

It is beneficial for vegetation of Middle-European forest species[4]. The area with natural vegetation totals about 15% in the region (GEOBOTANICAL… 1977). Wealth and originality of animal kingdom of the region are conditioned by particularities of the landscape. Territory of Western Podolia is one of the main centres of endemism in Ukraine. Old forest tracts and numerous caves contribute to abundance of bats.

The territory of the region is strongly karstened and forms the Podilsky karst district. Carbonaceous karst with huge latticed labyrinths of caves is the most widespread here (GVOZDETSKY 1981). Powerful limestones promote successful development of various forms of karst relief. About 75 % of caves in Western Ukraine are on the territory of Ternopil and Chernivtsy Oblasts. The majority of them are of a karst genesis and originated in gypsums (ANDREJCHUK 1987). Some cavities (Zatyschna, Vertykal'na, Strimka) are formed in tectonic cracks on the river banks (VARGOVYCH 1998). The morphology of karst cavities of Western Podolia is characterised by a large variety. The surface of grottoes and passages has tracks of horizontal water streams (Kryshtaleva, Verteba). The profile of grottoes is oval or round, "gothic" (Kryshtaleva) or "crypt" (Verteba, Kryshtaleva, Ozerna), altitude ranges from 1,5–2,5 up to 6–7 m. The grottoes in Kryshtaleva, Ozerna, and Verteba have length from several up to several tens of meters.

There is a lot of burrows and blind niches in the cavities of the Kryshtaleva cave. The Verteba (="Vertepa") and Kryshtaleva caves are full of columns, which sometimes form big aggregations. The incrustations of many caves (Kryshtaleva, Ozerna, Verteba) are represented by druses of secondary gypsum, occasionally by small calcareous stalactites (GUNIOVSKY 1966).

The physical features of the Podolia caves air differ by almost absolute stability of a thermal mode and humidity during day, independently of the season. The temperature in the internal grottoes of caves is 12–13 ^{0}C. This value is constant already 300–350 m apart from the entrance. But in some small cavities (Pionerka, etc.), the temperature sometimes falls down to 0^{0}C (VARGOVYCH 1998). Vertically temperatures very slightly – 0,5–1^{0}C. Relative air moisture in internal grottoes of Kryshtaleva is about 100%, in Verteba 80–82 %. There are constant or temporary water-drains in some cavities (Balamutivka, Duche). The CO_2 contents in the Kryshtaleva cave is 0,53–0,60 %. The slight intensity of modern karst processes is being observed in caves (GUNIOVSKY 1966).

There are a lot of new underground cavities occur on this territory because of limestones and gypsums intensive mining (cave Perlyna, Atlantyda, many adits). More than 20 deposits of gypsum are known in the Ternopil Oblast. They are located in a wide, 20–30 km wide band which is extended through the whole southern part of this area lengthwise Dnister river valley (SVYNKO et al., 1994). More than 40 deposits of limestone and 5 gypsum fields have been exploited in a southern part of Khmelnitsky region till recently (BUILDING … 1966).

6.2a. Central Podillya

Records of *R. hipposideros* in the central part of Podillya originated from the caves of left bank of Middle Dnister region (Ternopol Oblast). These data are summarised in the Table 4. There are 7 localities, where *R. hipposideros* was registered, all of them are the caves (Table 4). Most caves were investigated many times, and the total number of records reaches 20. Among them there are 4 summer and 8 winter records (our data were obtained in winter only).

State of *RH* populations in this region is stable.

[4] Oak, hornbeam-oak, hornbeam-oak-ash and beach phytocenosis, peculiar steppe communities, including feather grass, original grassland vegetation all form plant cover.

Table 4. Records of *Rhinolophus hipposideros* in the Central part of Podolia (caves of left bank Middle Dnister region, Ternopil Oblast of Ukraine)

Code	Locality	Geographic description	Remarks	Reference
T1 (S?)	Dzhuryn	Dzhuryn dstr., not far from Dnister river (? vic. of Sadky vill.)	cavity in quarry; data from speleologists[5]	this article
T2	Mlynki cave	near Zalissya vill., Chortkiv distr.	=”Entuziastiv cave”	TAT-73 (6)
T2 (w)	(same)	(same), valley of Seret river	in 1998–2000 absent	our data
T3 (W)	Perlyna cave	near Krutyliv vill., Gusyatyn distr. Medobory Natural Reserve	census by Labokha & Rizun in 1997	ZAG-99 (7)
T3 (S)	(same)	(same)	n=1 (20.08.1999)	our data*
T4 (SW)	Verteba cave	caves near Bil'che Zolote vill., Borshchiv distr., valley of Seret	“Verteb”, “caves of Bilche-Zolote”	A&P-56
T4 (W)	(same)	(same)	n=10–80 (1951–1971)	TAT-74
T4 (W)	(same)	(same)	n=31 (2000)	our data
T5 (W)	Optymistych-na cave	near Korolivka (Koralivka) vill., Borshchiv distr.	(=Vitrova cave)	A&P-56
T5 (SW)	(same)	(same)	n=60–320 (1951–1971)	TAT-74
T5 (W)	(same)	(same)	n>20–40 (1995–1996)	VAR-98 (8)
T5a (W)	(same)	(same), division “Vitrova cave” **	n=204 (2000)	our data
T6 (W)	Kryshtaleva cave	near Kryvche vill. (Nyzhnie Kryvche), Borshchiv distr.	="Kryvchenski caves", incl. "Serednja cave"	TAT-73
T6a (W)	Kryshtaleva–1	(same, wild part “Lysiachy hid”)	n=65–66 (1999–2000)	our data
T6b (W)	Kryshtaleva–2	(same, “tourist” part of a cave)	n=7–15 (1999–2000)	our data
T7 (W)	Slavka cave	near Kryvche vill. (Verchnie Kryvche), Borshchiv distr.	discovered in 1993; n=10–13 (1999–2000)	our data

* Additional information about data referred as "our data" (winter census in caves, summer bat netting, collected specimens) see in the Annex 2. ** Cave Vitrova has a separate non-closed entrance near the main entrance of Optymistychna cave.

6.2b. Southern part of the Middle Dnister

Southern part of the Middle Dnister (Khmelnitski region of Ukraine, and Moldova) is characterised by 10 records of *R. hipposideros* corresponding to 8 geographical sites (Table 5). Main peculiarity of this territory is frequently registration of horseshoe bats in summer time (6 records), and presence of breeding colonies (2 records). Conditions of underground shelters of *RH* in Moldova are the same as were described previously. There are many artificial cavities in gypsum mining places, and the most known among them are those in the "Sacharna galleries" (VASILIEV, ANDREEV 1998).

Our field investigations of this territory also demonstrate an abundance of *Rhinolophus hipposideros* in southern part of Khmelnitsky Oblast. Using just 2 mistnet, during summer expedition in 1999 we found 14 specimens of this species in 4 localities (TYSHCHENKO 2000).

[5] Personal communication of V. SNIGUR (speleoclub “Crystal” in Chortkiv, Ternopil Oblast): observation of large number of bats like to the horseshoe bats (probably, it was a summer colony of *R. hipposideros*).

[6] TALPOSH & PYLIAVSKY (1998) mentioned *R. hipposideros* from "caves near the Mlynky vill.", without references to original data or references to literature.

[7] Record was published after RIZUN's personal communication; the same information presented also in the Annual report “Chronicle of the Medobory natural reserve for 1997”.

[8] VARGOVYCH cites the results of by census carried out by speleologist TURCHYNOV.

Table 5. Records of *Rhinolophus hipposideros* in the Southern part of the Middle Dnister region (Khmelnitsky Oblast of Ukraine, and Moldova)

Code	Locality	Geographic description	Remarks	Reference
K1 (W)	Zaluchans'ka cave	near Zaluchchya vill. on left bank of Smotrych river, Chemerivtsi distr.	=Bezimenna cave	TAT-67
K2a (SB)	Sokil grotto	on the Sokil hill near Nigyn vill., Kam'yanets-Podilsky distr.		TAT-67, TAT-73
K2b (WB)	Karmaliuk cave	near Zaluchchya vill. on the left bank of the Smotrych river, Chemerivtsi distr.	incl. adjacent grottoes	TAT-67, TAT-73
K3 (S)	Old Fortress	Kam'yanets-Podilsky Historical and Architectural Reserve	underground shelters, n=4 (1999)	our data*
K4a (S)	Chapli-1 (mine)	Zakaznyk "Chapli" near Demshyn, Ka-m'yanets-Podilsky distr., left bank of Ternava river	ancient limestone mine, n=3 (1999)	our data
K4b (S)	Chapli-2 (forest)	Zakaznyk "Chapli" near Demshyn vill., Kam'yanets-Podilsky distr.	storehouse in forest, n=1 (1999)	our data
K5 (S)	Demshyn cavities	near Demshyn vill., Kamyanets-Podilsky distr. (left bank of Dnister)	rock cavity, n=6 (1999)	our data
M1	Soroki	Soroka city, Moldova	=? La Beci cave	BRA-10 (9)
M2	Khrustova	Khristevaya vill., Kamenka distr., Moldova	"Khrustovaja in Olgopol prov."	BRA-10
M3 (SW)	Sacharna galleries	Sacharna vill., right bank of Dnister (limestone mines with galleries)	winter and breeding colonies, n=47–50	V&A-98
M4	Kishyniv	Kishineu (=Chisinau), Moldova	ref. to BRAUNER, doubtful record	A&P-56

* Data for Kmelnitski region referred in this table as "our data", (codes K3 to K5) were obtained during summer expedition of TYSHCHENKO (2000) and described in details in Annex 2.

7. Discussion

7.1. Regularities in geographical distribution of species

Analysis of all known records of *Rhinolophus* in the Eastern Europe shown, that species distribution is fragmented (ZAGORODNIUK 1999). It is obviously, both species of *Rhinolophus* are distributed along a valley of the Dnister river, and this part of their geographic range is separated from the Transcarpathian range. *Rhinolophus hipposideros* is the most distributed species than *R. ferrumequinum*, and most abundant bat species in the cave communities of mammals.

Generally, geographical borders of *Rhinolophus* range in the North-eastern direction from the Carpathians coincide with the limits of the Dnister region as a whole and to the Podolian karst region in particular. There are two different lines, that define a geographical range of the horseshoe bats in the studied region (Fig. 3).

The first line limits the *Rhinolophus* range in the Northern Carpathians, the second one corresponds to the northern border of the "Warm" Podolia (SVYNKO *et al.* 1994) as well as to the geographical range of the family Rinolophidae in a whole. Both lines, on our opinion, correspond

[9] Both this and next localities are listed by BRAUNER (1910) with reference to communication of OSTERMANN; later the same localities were mentioned by ABELENTSEV & POPOV (1956) without clear references. Site "Soroki" in these publications (loc. cit.) are probably identical to modern description of the cave La Beci near the Koseuts (10 km N of Soroky) where breeding colony of *R. ferrumequinum* was found (VASILIEV 1997; see: Table 2).

to geographical limits of relatively warm (in regional scale) part of the region, that is situated between comparatively cold most northern and mountain regions (see: Fig. 3).

So, in the adjacent mountain regions of the Northern Carpathians *Rhinolophus* does not registered, and the most mountain localities are on the altitudes not higher than 400–500 m above sea level (loc. L2–L3 on Fig. 2). Moreover, in these localities *Rhinolophus* is not an abundant group, and it is absent in most investigated underground sites. For example, horseshoe bats were not recorded in such caves of Northern Carpathians as Bukovinka (VARGOVYCH 1998) and Popelyushka (ZHDANOVYCH, pers. com.) in Chernivtsi Oblast, in Yamnetski tectonic caves near Yaremche, Ivano-Frankivsk Oblast (TATARYNOV 1988), etc.

Thus, the localities nearest to the Carpathians are situated in the Dnister canyon and in the adjacent karst regions of the Podolia. This region is characterised as a relatively warm site comparing with adjacent territories. The slopes of this part of Podolia are exposed to the South, and the average both summer and winter temperatures are relatively high. Dnister basin presents a numerous suitable, relatively warm cavities for the summer roosts of the horseshoe bats, and the caves of Podolia are good quarters for *Rhinolophus* winter roosts also.

Rhinolophus is the most abundant bat species in the caves, and its portion reaches 50 % of all bat population of the caves. The most of the summer records of the *Phinolophus* were obtained from the south-eastern parts of the Dnister region (see: Fig. 3). Moreover, all known breeding colonies of the horseshoe bats are known in the Lower Dnister region only. Regarding this, significance of large caves can be estimated as follows.

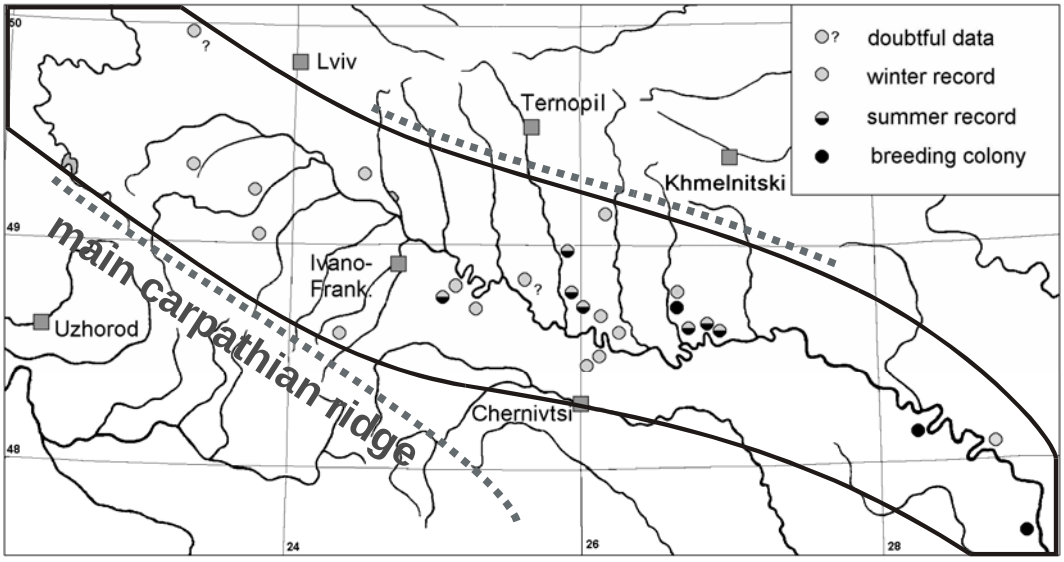

Fig. 3. Geographical limits of *Rhinolophus* distribution in the Dnister region. Localities are the same as on Fig. 1, and marks were divided on a three groups according to zoning of *Rhinolophus* range in the studied region: grey circles correspond to winter records only, with-and-black — summer records, completely black signs means records of breeding colonies (after data in Tables 2–5).

7.2. Seasonal dynamics

Horseshoe bats are the most numbered bats in the cave communities. Their abundance is a dynamic characteristics changed seasonally. Most registrations of *Rhinolophus* in Dnister region were in winter times, during their hibernation in the caves. Records of the horseshoe bats in summer are relatively rare, and both species are usually absent in the caves in summer. All caves investigated by us in the warm season, were free from the horseshoe bats. The average temperature in Podolian caves varied near 10^{o} C, and such conditions are suitable just for hibernation. In Podolia, *Rhinolophus* usually appears in caves after 1^{st} decade of November (Slavka cave etc.).

Therefore, Dnister populations of *Rhinolophus* are characterised by clear spatial dynamics during cold and warm seasons. Probably, podolian *Rhinolophus* are migrants from more southern breeding areas (similar trend is known for northernmost populations in Poland: HARMATA 1992). In our samples, sex ratio in winter (hibernacula) colonies was essentially shifted to males (maximal value was 63:8). Most males examined in February had a clearly enlarged testis, and they were ready to copulate. Possibly, copulation period in their population take place in autumn before their hibernation, and both sex occupy different areas during long time of a year.

Thus, we suppose that *Rhinolophus* in Upper and Middle Dnister form just seasonal (hibernacula) colonies, migrated to the Western and Central Podolia from lower part of Dnister region. It is supported by some other facts. So, one male of *R. hipposideros* hibernated in the Vitrova cave (site T4 on Fig. 2) had a home-made bird ring [MO… XA 714845], but bats had never been ringed in Podolia. Whereas East-European *Rhinolophus* described commonly as settled bat (ABELENTSEV, POPOV 1956; KROCHKO 1992), the shortest distance between Vitrova cave and nearest possible place of bat ringing (Sacharna quarries in Moldova) is about 150 km. One more fact deals with the largest forearm length in Podolian *R. hipposideros* (FA=38.7±1.2, n=37) comparing with neighbour Transcarpathian population (FA=38.1±1.3, n=20; ZAGORODNIUK 1999).

7.3. Abundance and prospects of protection

Rhinolophus is the most abundant groups of bats in cave communities of Dnister region. In the total sample its portion reach 50 % of all registered bats. Since review of ABELENTSEV and POPOV (1956), the total number of known records of horseshoe bats in Dnister region has increased 4 times, from 11 (3 *RF* & 8 *RH*) to 49 (4 *RF* & 45 *RH*). Therefore, *Rhinolophus* is not a rare group of bats in Dnister valley. At the same time, it is an endangered group because an intensive exploitation of caves for tourism. So, the comparison of the two entrances of the Kryshtaleva cave, "wild" and the tourist ones (see ANNEX 2), showns great differences in the bat abundance in these two sites: 65–66 against 6–15 registered specimens. Moreover, *Rhinolophus* is completely absent in some large caves situated inside of known *Rhinolophus* range but adopted for speleo-tourism (Mlynki and Ugryn).

Both species of the horseshoe bats have the high protection status in Ukraine (SHCHERBAK 1994). Earlier, comparing the data on *Rhinolophus* portion in the bat collections of different age as well as the results of bat census in different decades of the XX century, we estimate the status of East-European populations of the horseshoe bats as vulnerable, that corresponds with category "Lower risk, conservation dependent" (ZAGORODNIUK 1999). Whereas many authors indicate a reduction of *Rhinolophus* number in Ukraine (TATARINOV 1974, SHCHERBAK 1994, etc), new results confirm our previous conclusion about the stable level of the *Rhinolophus* abundance. It is very interesting, that general decline of West-European populations (HORACEK 1984 etc.) has the same rates as increasing of *Rhinolophus* abundance in the Dnister region.

8. Conclusion

1. Dnister region is the territory of most north-eastern distribution of the horseshoe bats in Europe, and the Rhinolophidae family is presented by two species, more abundant *Rhinolophus hipposideros* and rare *R. ferrumequinum*.
2. More widely distributed species of the horseshoe bats is *Rhinolophus hipposideros* known from 30 localities, and there are just 4 (2 doubtful) records of *R. ferrumequinum*. Most records of the *Rhinolophus* were obtained from their winter quarters.
3. The average number of *Rhinolophus hipposideros* per one cave during winter is about 20–60 specimens, that exceed the total number of all other species, but in the caves updated for tourism this species is absent or relatively rare.
4. Though both *Rhinolophus* species are included in the different list of rare and endangered species, *R. hipposideros* is rather numerous among the bat species hibernated in the caves of Dnister basin, above of all in gypsum caves of Central Podolia (Ternopil Oblast of Ukraine).
5. Summer records as a whole and the breeding colonies of the *Rhinolophus* are known in the south-eastern parts of the Dnister valley, whereas in Upper and Central parts of the region just winter records of *Rhinolophus* are known.
6. *Rhinolophus hipposideros* from the Dnister region is characterised by the largest forearm length (37–41 mm) among East-European populations of this species, and males are the dominant sex in *R. hipposideros* (in different samples sex ratio varied from 3:1 to 8:1).
7. It is supposed, that *Rhinolophus* in the Dnister region is not settled, and in the upper and middle parts of this region it forms seasonal (winter) populations after the autumn migrations from more southern territories of their summer distribution.

9. Streszczenie

Region Dniestru jest najbardziej wysuniętym na północny-wschód obszarem występowania podkowców w Europie. W tym regionie nietoperze z rodzaju *Rhinolophus* są reprezentowane przez dwa gatunki: liczny *Rhinolophus hipposideros* i bardzo rzadki *Rhinolophus ferrumequinum.* Praca zawiera opis geograficzny zasięgu tych gatunków. Szerzej występującym gatunkiem jest podkowiec mały znany z 30 stanowisk. Podkowiec duży podawany jest z czterech stanowisk, w tym dwa wymagają weryfikacji. Większość danych o występowaniu podkowców na tym obszarze była uzyskana z obserwacji zimowych. Mimo, że obydwa gatunki podkowców są, zamieszczone na listach zwierząt rzadkich i zagrożonych, to podkowiec mały jest najliczniejszym gatunkiem hibernującym w gipsowych jaskiniach w basenie Dniestru. Średnia frekwencja podkowców małych podczas hibernacji w jednej jaskini waha się od 20 do 60 osobników, i przekracza liczebnością wszystkie pozostałe gatunki. W jaskiniach udostępnionych dla ruchu turystycznego podkowce małe nie występują. Latem obserwowano kolonie rozrodcze podkowców w południowo-wschodniej części doliny Dniestru podczas gdy z północnej i centralnej części tego regionu znane są wyłącznie stanowiska zimowe.

Podolska populacja podkowca małego charakteryzuje się wyraźną dominacją samców, nawet 8:1, oraz najdłuższym przedramieniem (37–41 mm) wśród wszystkich wschodnioeuropejskich populacji tego gatunku. Autorzy przypuszczają że populacja podkowców w regionie Dniestru nie jest osiadła i nietoperze te sezonowo migrują z południa na północ.

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Annex 1.

Collected specimens of *Rhinolophus* from Dnister region, deposited in the museums. (all specimens are *R. hipposideros* originated from caves in Borshchiv district of Ternopil Oblast of Ukraine)

Museum	No	Locality	Year	Legit	Sex	L	Ca	Pl	Au	FA
ZMKU	2822	Bilche-Zolote	1951 (02)	Antonenko	f	39,0	27,0	7,0	15,0	39,0
ZMKU	2823	Bilche-Zolote	1951 (02)	Antonenko	m	36,0	28,0	7,0	16,0	37,0
LNPM (box 477/1)	1021/1	Bilche-Zolote	1952	Lysenko	m	36,0	26,0	7,0	16,0	40,0
LNPM (box 477/1)	1021/2	Bilche-Zolote	1952	Lysenko	f	40,0	31,0	7,0	11,0	40,0
LNPM (box 477/1)	1021/3	Bilche-Zolote	1952	Lysenko	m	38,0	30,0	7,0	12,0	39,0
LNPM (box 477/1)	1021/4	Bilche-Zolote	1952	Lysenko	m	38,0	30,0	8,0	12,0	40,0
LNPM (box 477/1)	1021/5	Bilche-Zolote	1952	Lysenko	f	36,0	28,0	7,0	12,0	39,0
LNPM (box 477/1)	1021/6	Bilche-Zolote	1952	Lysenko	m	41,0	30,0	7,0	12,0	40,0
LNPM (box 477/1)	1021/7	Bilche-Zolote	1952	Lysenko	f	38,0	27,0	7,0	12,0	39,0
LNPM (box 477/1)	1021/8	Bilche-Zolote	1952	Lysenko	m	38,0	27,0	8,0	12,0	39,0
LNPM (box 477/1)	1021/9	Bilche-Zolote	1952	Lysenko	m	40,0	30,0	7,0	11,0	40,0
LNPM (box 477/1)	1021/10	Bilche-Zolote	1952	Lysenko	m	39,0	28,0	8,0	12,0	40,0
LNPM (box 477/1)	1022/1	Bilche-Zolote	1952	Lysenko	m	40,0	27,0	7,0	16,0	37,0
LNPM (box 477/1)	1022/2	Bilche-Zolote	1952	Lysenko	f	40,0	28,0	6,0	15,0	no
LNPM (box 477/1)	1022/3	Bilche-Zolote	1952	Lysenko	f	41,0	25,0	7,0	17,0	39,0
LNPM (box 477/1)	1022/4	Bilche-Zolote	1951	Lysenko	f	36,0	27,0	7,0	16,0	37,0
LNPM (box 477/1)	1022/5	Bilche-Zolote	1951	Lysenko	m	36,0	28,0	7,0	16,0	36,0
LNPM (box 477/1)	1022/6	Bilche-Zolote	1951	Lysenko	m	37,0	29,0	6,0	16,0	38,0
LNPM (box 477/1)	1022/7	Bilche-Zolote	1951	Lysenko	f	37,0	26,0	7,0	14,0	38,0
LNPM (box 477/1)	1022/8	Bilche-Zolote	1951	Lysenko	m	36,0	27,0	7,0	12,0	40,0
LNPM (box 477/1)	1022/9	Bilche-Zolote	1951	Lysenko	m	36,0	28,0	8,0	11,0	40,0
LNPM (box 477/1)	1022/10	Bilche-Zolote	1951	Lysenko	m	38,0	28,0	8,0	12,0	38,0
LNPM (box 477/1)	1023/1	Bilche-Zolote	1951	Lysenko	m	37,0	28,0	7,0	15,0	37,0
LNPM (box 477/1)	1023/2	Bilche-Zolote	1951	Antonenko	m	41,0	27,0	7,0	16,0	38,0
LNPM (box 477/1)	1023/3	Bilche-Zolote	1951	Antonenko	m	37,0	28,0	7,0	15,0	38,0
LNPM (box 477/1)	1023/4	Bilche-Zolote	1951	Antonenko	f	37,0	28,0	6,0	17,0	37,0
LNPM (box 477/1)	1023/5	Bilche-Zolote	1951	Lysenko	m	41,0	28,0	8,0	15,0	38,2
LNPM (box 477/1)	1023/6	Bilche-Zolote	1952	Lysenko	m	37,0	26,0	7,0	12,0	39,0
LNPM (box 477/1)	1023/7	Bilche-Zolote	1952	Lysenko	m	40,0	30,0	8,0	12,0	40,0
LNPM (box 477/1)	1023/8	Bilche-Zolote	1952	Lysenko	m	37,0	27,0	8,0	12,0	40,0
LNPM (box 477/1)	1023/9	Bilche-Zolote	1952	Lysenko	f	38,0	26,0	9,0	12,0	39,0
LNPM (box 477/1)	1023/10	Bilche-Zolote	1952	Lysenko	f	41,0	31,0	8,0	12,0	40,0
LNPM (box 477/1)	1023/11	Bilche-Zolote	1952	Lysenko	f	43,0	29,0	8,0	11,0	40,0
UMNH	2612/23	?	1965 (06)	Bachynski	m	37,0	26,0	no	15,0	38,0
UMNH	2613/24	?	1965 (09)	Bachynski	m?	58?	25,0	no	14,0	39,0
UMNH	2614/25	?	1965 (04)	Bachynski	m	36,0	25,0	8,5	14,5	37,0
UMNH	4312/26	Bilche-Zolote, Vertepa cave	1965 (05)	Abelentsev	?	42,0	29,0	9,2	16,2	38,0
UMNH	40	Bilche-Zolote	1965	Abelentsev	m	?	no	no	?	?
UMNH	10509/39	Bilche-Zolote	1965	?	?	40,0	28,0	8,0	14,0	no
UMNH	4313	Vitryana cave	1965	Abelentsev	m	42,0	25,0	8,2	14,6	39,0
Statistics:						L	Ca	Pl	Au	FA
min						36,0	25,0	6,0	11,0	36,0
max						43,0	31,0	9,2	17,0	40,0
ave						38,5	27,7	7,4	13,7	38,7
s.d.						2,1	1,6	0,8	2,0	1,2
N						38	39	37	39	37

Annex 2.

Verified records of the horseshoe bats in the Dnister region (totally, there are 465 specimens of *Rhinolophus hipposideros* from the Central Podolia)

Locality	Date	Number	Remark (museum, associated species etc.)
Museum collections (all from Borshchiv dstr. of Ternopil Oblast), n=40			
Bilche-Zolote, [?caves]	1951 (febr.)	2	ZMKU (Antonenko)
Bilche-Zolote, [?caves]	1951	12	LNPM (Antonenko: n=3, Lysenko: n=9)
Bilche-Zolote, [?caves]	1952	19	LNPM (Lysenko)
Bilche-Zolote, cave Vitryana	1965	1	UMNH (Abelentsev)
Bilche-Zolote, cave "Vertepa"	1965 (may)	3	UMNH (Abelentsev)
? [caves near Bilche-Zolote?]	1965 (apr., jun., sep.)	3	UMNH (Bachynski)
Winter census in a caves of Central Podolia (Ternopil Oblast), n=411*			
Cave Vitrova**	31.01–1.02.2000	204	*P. auritus*
Cave Verteba	31.01.2000	31	*M. myotis, P. auritus*
Cave Slavka	8.02.1999	10	*P. auritus*
	2.02; 4.02.2000	13	(no)
Cave Kryshtaleva–1***	7.02.1999	66	*P. auritus, P. austriacus, M. myotis*
	3.02.2000	65	(no)
Cave Kryshtaleva–2	7.02.1999	7	*M. myotis*
	3.02.2000	15	*P. auritus*
Summer census near the caves (TYSHCHENKO, in press), n=14			
Medobory Natural Reserve, cave Perlyna*	20.08.1999	1	for geographical details see "T3" in Table 4
Kam'yanets-Podilsky, fortress	7.09.1999	4	for geographical details see "K3" in Table 5
Demshyn, "Chapli" reserve	10.091999	3	for geographical details see "K4" in Table 5
Demshyn, Demshyn cavities	10.09.1999	6	for geographical details see "K5" in Table 5

* Additionally, some new data were obtained early in the cave Perlyna, situated on the territory of the Medobory Natural Reserve (Ternopil Oblast, site "T3"): 19.02.1997 LABOCHA, RIZUN and KAPRUS counted here 26 *Rhinolophus hipposideros*, 10 *Myotis myotis* and 1 *Plecotus auritus* (CHRONICLE… 1997). In summer, the results were opposite: 1 *Rhinolophus hipposideros*, 37 *M. daubentonii*, 7 *M. bechsteinii*, 1 *M. mystacinus*, and 12 *Plecotus auritus* (TYSHCHENKO, in press).

** Vitrova is separate entrance and gallery system of the cave Optymistychna.

*** Kryshtaleva–1 is entrance "Lysjachy Hid", Kryshtaleva–2 is "Central entrance".