DISTRIBUTION AND SPECIES DIVERSITY OF CAVE-DWELLING BATS IN BULGARIA AND SOME REMARKS ON THE MICROCLIMATIC CONDITIONS OF THE HIBERNATION

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Investigations carried out between 1988 and 1991 on the territory of Bulgaria gave valuable information concerning the bat fauna of 65 localities. The status of the species identified is presented and microclimatic factors of the hibernation are assessed.

Key words: bats (Chiroptera, Mammalia), specific status, hibernation, Bulgaria.

During 1988–1991, on the territory of Bulgaria were observed 65 roosts of bats (caves, artificial galleries, rocky crevices). Specialists in biology of the Institute of Zoology and students took part in this investigation. In this period the roosts were visited periodically during all the seasons of the year. The aims of this investigation were:

1. to establish the species diversity of the populations of bats in Bulgaria;
2. to evaluate the number of colonies and survey the changes of bat populations in different seasons;
3. to propose for protection by the law of some roosts inhabited by a great number of bats and endangered with disturbance by the human factor.

We may separate the roosts in two types:

Type 1. Inhabited during all the time of the year (usually deep caves or galleries with relatively constant microclimatic conditions in each season). Usually they are connected with the surface by one entrance.

Type 2. Inhabited seasonally (winter, summer and transient roosts). Usually these are artificial galleries with a small depth; rocky crevices often connected with the surface by more than one entrance and having unconstant microclimatic conditions. During winter these roosts and their temperature depend on the changes of the ambient temperature and they are not suitable for hibernation. Usually this kind of roosts are used for nursing.

There are roosts with relatively constant temperature conditions in all the time of the year, but inhabited only seasonally. For example the temperature changes in the inner parts of Khaidushkata cave are unsignificant. The temperature in winter is constant and high (9—13°C), but it is inhabited only in the summer.

MATERIAL AND METHODS

Data for species diversity and population of bats were taken by means of:
1. visual estimation;

2. bat-trapping in front of, or near to the entrances of the roosts (harp-trap and mist-methods were used).

SPECIES STATUS

Twenty-seven from the 30 species inhabiting the European continent are known in Bulgaria. 22 of them are cave-dwelling and belong to 4 families (Rhinolophidae, Vespertilionidae, Miniopteridae and Molossidae).

The distribution of the roosts on the territory of Bulgaria is presented in Fig. 1. The distribution of the species in different roosts is presented on the basis of different altitudes in Table 1. From all observed roosts there prevail those settled in the North of Bulgaria at the altitude up to 400 m a.s.l. Comparatively poorer in roosts is South Bulgaria. The roosts distributed above 800 m a.s.l. are scarce.

Rhinolophus ferrumequinum Schreber, 1775 is a common species in Bulgaria. It is known from winter roosts — mostly long caves (Nos 2, 4, 7, 11, 24, 27, 30, 31, 37, 39, 41, 44). Often they form colonies with a size from 80 to 150 individuals. Winter colony with a greatest number of bats (400) was found in Orlova chuka cave (roost No 11).

Breeding colonies (30—400 individuals) were found in the roosts Nos 1, 3, 11, 16, 18, 24, 25, 34, 38, 40. Summer roosts are usually caves or rocky crevices with relatively high temperature (up to 21°C). Often this species co-exists in summer roosts with *Rhinolophus euryale* and *Myotis emarginatus*. As it is seen from Table 1 *Rhinolophus ferrumequinum* is distributed in wide altitudinal ranges (from 200 to 1100 m a.s.l.).

Table 1

Distribution of the roosts and species according to different altitudes

Altitude	Roosts	Species
0—200 m	1, 3, 6,7, 10, 11, 15, 16, 18, 19, 20, 21, 22, 23, 33, 38, 44	*Rh. fer., Rh. eur., Rh. bl., M. m., M. bl., M. cap., M. em., P. pip.*
200—400 m	9, 17, 24, 25, 26, 27, 29, 30, 31, 34, 35, 39, 41, 42, 43, 49, 51	*Rh. fer., Rh. hip., Rh. eur., Rh. bl., Rh. meh., M.m., M. cap., M. schr., P. pip., P. savii, E. ser.*
400—600 m	2, 14, 25, 47, 40, 55	*Rh fer., Rh. hip., Rh. eur., M. m., M. schr., P. pip.*
600—800 m	19, 48	*Rh. hip., Rh. eur., M. m., M. schr., Pl. austr.*
800—1000 m	5	*M.m., M. schr.*
1000—1200 m	4,12, 32, 37	*Rh. fer., Rh. hip., M. m., M. myst., M. schr., Pl. aust.*
above 1200 m	45	*M. myotis*

Rhinolophus hipposideros Bechstein, 1800 is also a common species in Bulgaria. The lesserhorseshoe bat is distributed up to 1100 m a.s.l. Winter roosts were found in deep caves (Nos 14, 24, 27, 30, 37, 41, 43, 44), or in mines, in a small group from 10 to 25 individuals or isolated specimens. Summer roosts in Bulgaria are rarely found — usually in rocky crevices.

Rhinolophus euryale Blasius, 1853. This species was established in the roosts at the altitude up to 800 m a.s.l. Winter roosts inhabited by 20—80 individuals were found in caves (roosts Nos 14, 24, 27, 30). Breeding colonies — mixed with *M. emarginatus* and *Rh. ferrumequinum* were found in artificial galleries with a population from 100 to 300 individuals (Nos 17, 19, 20, 23, 30, 34, 38, 42).

Rhinolophus blasii Peyers, 1866 and *Rhinolophus mehelyi* Matschie, 1901 were established rarely in investigated roosts — only isolated specimens up to 400 m a.s.l. (Nos 20, 30, 49, 50, 53). Species *Myotis myotis* Borkhausen, 1759 and *Myotis blythi* Thomas, 1857 often form mixed colonies with *Miniopterus schreibersi* with a great number of individuals — from hundreds to thousands. Because of the co-existence of *M. myotis* and *M. blythi* and closely morphologycal likeness of these two sibling species, it is difficult to distinguish them in mixed colonies. Due to these factors the distribution of *M. myotis* and *M. blythi* in Bulgaria is not clear. *M. myotis/blythi* inhabit predominantly deep caves from 200 to 1600 m a.s.l. during winter and summer seasons.

Myotis capaccinii Bonaparte, 1837 is exclusively a cave-dwelling species. During the winter isolated specimens or clusters (16—50) were found. Nursing colonies usually form with *M. myotis* and *M. schreibersi* (Nos 31, 35, 39, 3, 26).

Myotis emarginatus Geoffroy, 1806 was found in summer in few colonies (Nos 23, 38) with population to 300 individuals. Isolated specimens were found hibernating in caves.

Myotis mystacinus Kuhl, 1819 and *Myotis brandti* Eversmann, 1845 are considered to be rare in Bulgaria. Only few records (Heinrich, 1936; Atanassov, Peschev, 1962; Červeni, 1971) are known from the literature. During our investigation, one female of *M. mystacinus* hibernating in cave No 46 and also one female of *M. brandti* in winter roost No 37 were established.

Myotis bechsteini Kuhl, 1819. Only few records are known from the literature (Heinrich, 1936; Georgiev, Beron, 1963). *Myotis daubentoni* Kuhl, 1819 has been found only a few times (Beron, 1963) in Bulgaria. In our investigation we established one female specimen hibernating in roost No 46 in the winter of 1991.

Myotis natterreri Kuhl, 1817 is known in South of Bulgaria from previous publication (Červeni, 1971).

The distribution of the two sibling species *Plecotus auritus* Linnaeus, 1775 and *Plecotus austriacus* Fischer, 1829 is little known. Till 1964 (Beron, 1964) only *Pl. auritus* has been reported. Because of the lack of enough information about the distribution of these species we cannot describe the status of *Pl. auritus* and *Pl. austriacus*. In recent investigation only isolated individuals from *Pl. austriacus* were established hibernating in caves (Nos 13, 37, 47, 48, 53) from 800 to 1100 m a.s.l. Summer roosts were not found, but few specimens were mist-netted in some karstic regions in South and North Bulgaria — only at altitudes from 300 – 400 m a.s.l.

Barbastella barbastellus Schreber, 1774 is only known from previous publications. Beschkov (1963) reports one individual hibernating in cave in mountain area. The other record is from Lednicata cave (1600 m a.s.l.) — (Cerveni, 1971).

Pipistrellus pipistrellus Schreber, 1775 is considered to be more frequent than it was established. The distribution of this species needs future investigations. Individuals were found in winter roosts (Nos 15, 47, 55).

Pipistrellus savii Keiserling et Blasius, 1839 was mist-netted in front of the caves, but it is considered that it inhabits rocky fissures in limestone terrains.

Pipistrellus nathusi Blasius, 1819 has been reported only once (Jancev, 1971).

Eptesicus serotinus Schreber, 1774 is also usually netted in front of the entrances of the caves. Cluster of some individuals was found in cave (No 57) in the summer of 1990. It is considered that this species inhabits fissures in the rocks near to the entrances of the caves. For example a cluster of about ten individuals was observed in fissure in front of the Emenskata cave (No 35).

Miniopterus schreibersi Kuhl, 1819 is a very common species in Bulgaria. It usually forms colonies with a greater population — to 10,000 individuals. It inhabits deep caves. Winter roosts (Nos 2, 4, 5, 7, 12, 14, 15, 22, 24, 27, 28, 30, 31, 32, 39, 49); summer (Nos 2, 3, 6, 7, 9, 10, 13, 17, 22, 24, 26, 29, 30, 32, 33, 36) and transient roosts No 37 were found. It often co-exists with *M. myotis/blythi* and *M. capaccinii*.

Tadarida teniotis Rafinesque, 1814 has been established only once till recent investigation (Beshkov, Beron, 1962). We caught one individual at the time of the night activity in limestone area at 400 m a.s.l. by mist-netting.

MICROCLIMATIC FACTORS OF THE HIBERNATION

In the months XI—III 1990 and 1991 we investigated temperature conditions of 15 winter roosts of bats (caves and galleries). Basically air temperature were measured. Temperature preference of 6 species were established.

Temperature conditions in caves are relatively constant — between 3 and 13°C. Some pecularities, connected with the geomorphology and altitudinal position of the caves influence the distribution of bats in Bulgaria. Only two of the investigated roosts are vertical precipices (Nos 41, 43). All the others are horizontal caves or galleries with length more than 100 m (except Nos 48 — 15 m). From the twilight in the direction of the depth, the cave temperature remains relatively constant. More widely temperature changes usually occur in the outer parts of caves, where the temperature is influenced by the ambient conditions.

Minimal temperature in outer parts of some roosts decreases extremely to 0°C, when the ambient temperature decreases below 10°C.

Microclimatic conditions in caves in Bulgaria are suitable for hibernation.

I established some peculiarities of the behaviour of species connected with the differences in temperature preferences. Solitary individuals of *Pl. austriacus* usually hibernate at low cave temperatures. Isolated specimens of this species usually settle down in the outer parts of the caves, where air temperature is unconstant and comparatively low. *Pl. austriacus* hibernate in Bulgaria in temperature ranges from 1.8 to 7.2°C (Fig. 2).

Differing from the latter species, *Rh. ferrumequinum* and *Rh. hipposideros* hibernate in inner parts of the roosts, in relatively constant temperature conditions. *Rh. ferrumequinum* has wider temperature tolerance than *Rh. hipposideros* — Figs. 3, 4. The temperature optimum of *Rh. ferrumequinum* ranges between 6° and 10°C. *Rh. hipposideros* often hibernate in temperature ranges from 5.8°C to 8.8°C.

Some peculiarities were observed in the behaviour of these two species, connected with the type of their termoregulation. Spontaneous arousals and changes of the position of the individuals in the hibernacula reflect the adaptation to the cave temperature changes (Dwyer, 1971).

The behaviour of these species in the roosts No 37 I followed during the months — XI, I, II 1991. I established intercave movements to the inner parts of the cave. So, in February (when the ambient temperature was lowest), these species inhabit the innermost parts of the cave, when the microclimatic conditions are relatively constant.

According to Davis (1964), Mc Nab (1974), clustering behaviour of some species would vary inversely with cave temperature. As it is seen from Fig. 5, *M. capaccinii* is distributed in wide temperature ranges — between 4°C and 12,2°C. Clusters of individuals in outer parts of caves at temperatures from 4°C to 6.2°C were found, but only solitary individuals hibernated at higher temperatures.

At altitudes from 200 to 400 m, *M. myotis* inhabits caves with different microclimatic characteristics. The majority of the investigated caves are horizontal, relatively warm, where *M. myotis* occurs at temperatures 6.8°—11.2°C. But the presence of this species in the precipice Bankovica cave (300 m altitude, with temperature ranges from 0° to 8.4°C, and great air circulation between inner and external atmosphere) verifies the great temperature tolerance of *M. myotis* (Fig. 6).

The presence of *M. myotis* in roosts at altitudes 1100 m and 1600 m a.s.l. (Nos 4, 37, 47), with cave air temperatures from 0°C to 9.8°C affirms that this species is eurythermic on the territory of Bulgaria.

Hibernating individuals of *M. schreibersi* were observed in wide temperature ranges (Fig. 7). Mostly this species forms colonies in winter roosts at temperatures higher than 8°C.

CONCLUSION REMARKS

Potentially extensive karstic areas and the great number of caves, as well as the favourable climatic and geographic situation of Bulgaria, cause the diversity of cave-dwelling bat fauna. The bat fauna in South Bulgaria is insufficiently investigated. The scarce findings of *M. natter-*

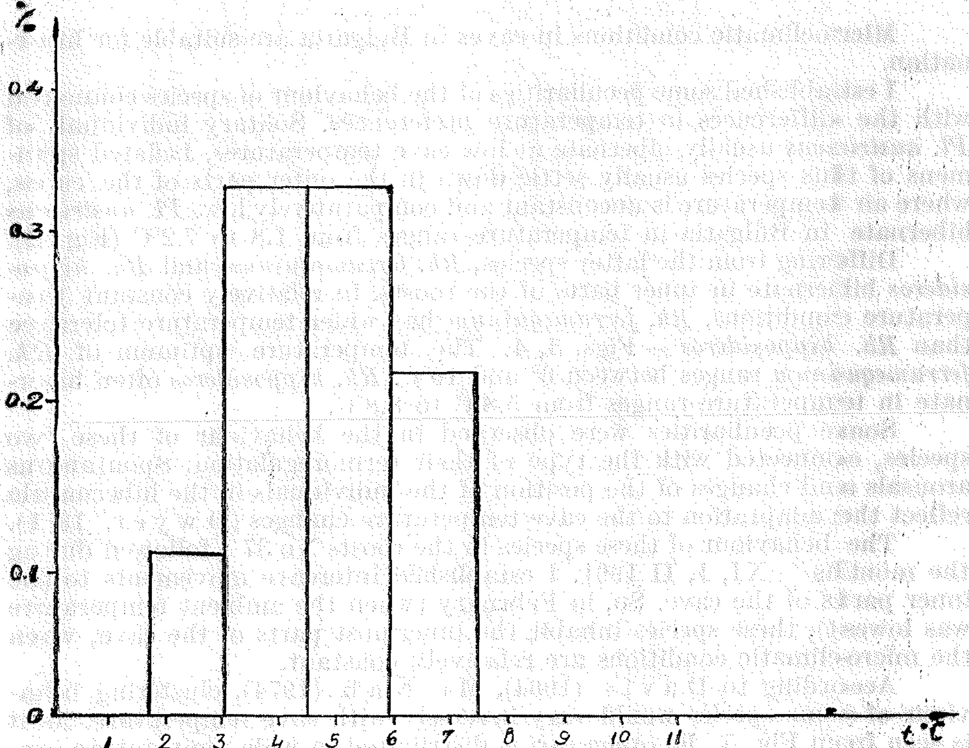

Fig. 2. — Ranges of the temperature tolerance of *Plecolus austriacus*.

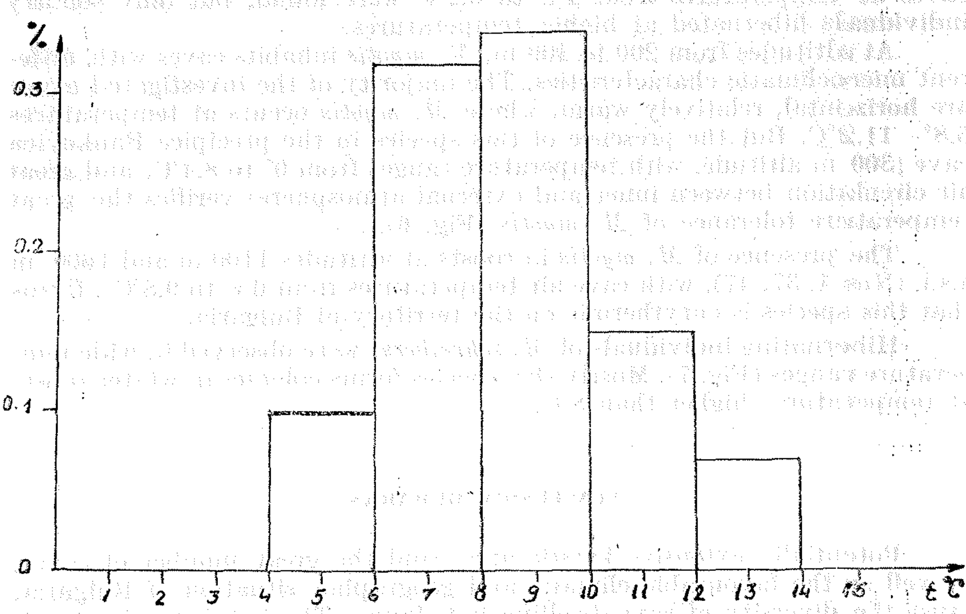

Fig. 3. — Cave-air temperature preferences of *Rhinolophus ferrumequinum*.

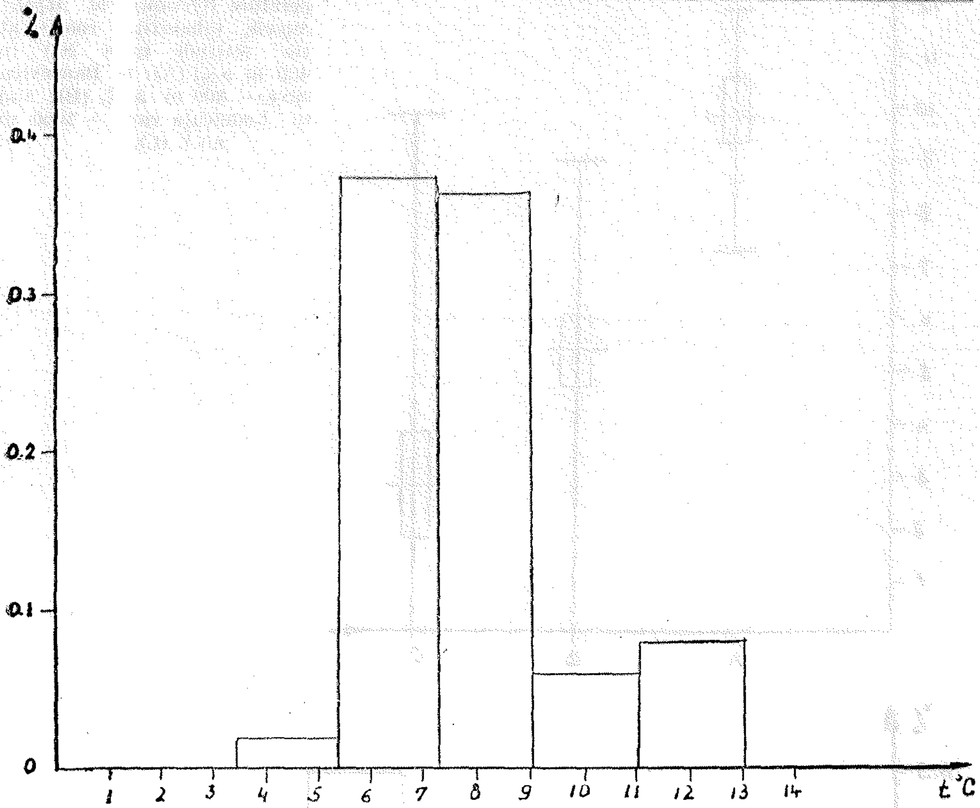

Fig. 4. — Cave-air temperature preferences of *Rhinolophus hipposideros*.

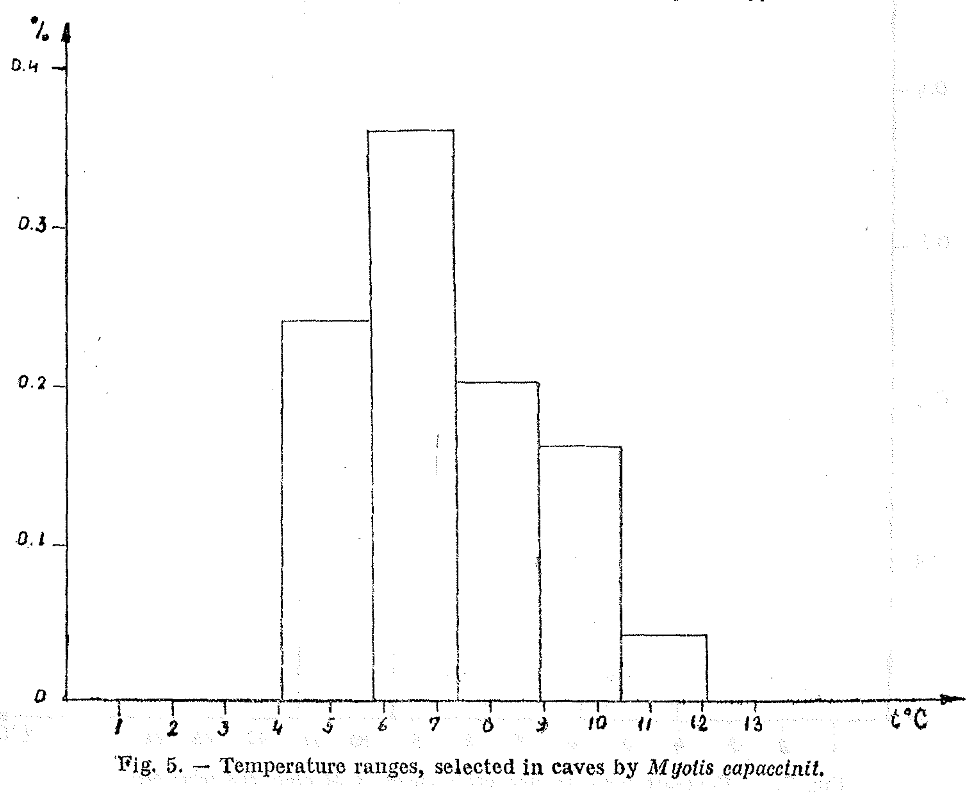

Fig. 5. — Temperature ranges, selected in caves by *Myotis capaccinii*.

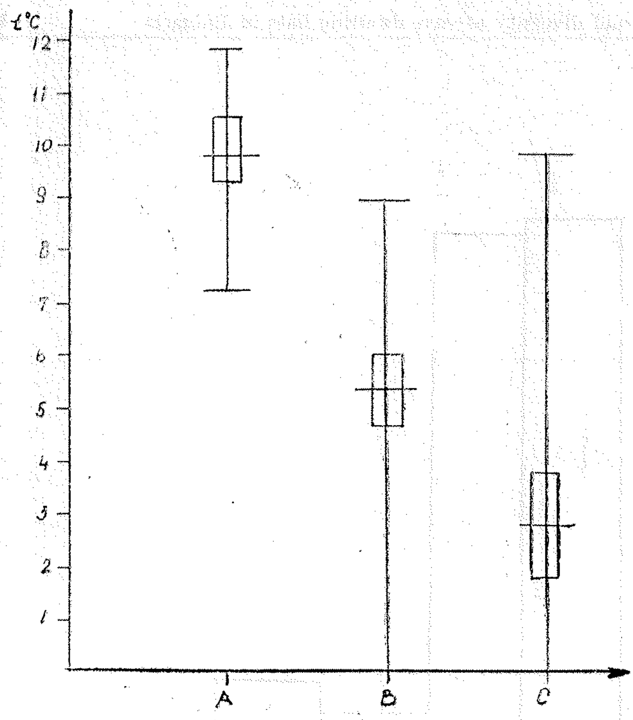

Fig. 6. — Ranges of cave-temperature tolerance of *Myotis myocls*, inhabiting roosts at the altitude from 200 to 400 m a.s.l.(A); in Bancovica cave — 300 m a.s.l. (B); and in Lednicata cave — 1600 m a.s.l. (C).

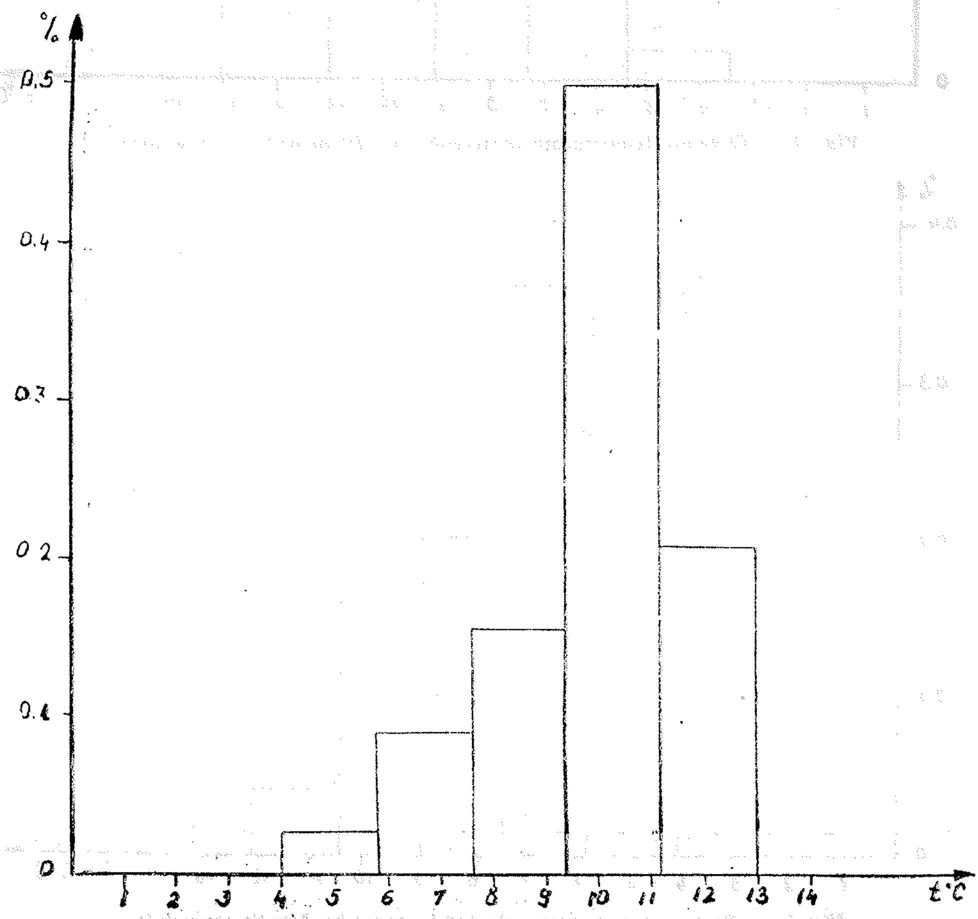

Fig. 7. — Cave-air temperature preferences of *Miniopterus schreibersi*.

reri, *P. nathusi*, *B. barbastellus* and *T. teniotis* probably result from the unsystematic investigations of the bats in Bulgaria.

In the past ten years the negative influence of the human factor on the bat populations considerably increased. Frequent visits of their roosts and the quarries operations in karstic regions often destroy the bat roosts or turn the bat communities out of them.

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