A C T A T H E R I O L O G I C A

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The Thermopreferendum of Some Species of Bats *(Chiroptera)*

[With 1 Fig. & 3 Tables]

By means of Herter's »temperature organ« 115 specimens of the following species of bats were studied both in laboratory and natural conditions *Rhinolophus hipposideros* (Bechstein, 1800), *Myotis myotis* (Borkhausen, 1779), *Myotis nattereri* (Kuhl, 1818), *Myotis emarginatus* (Geoffroy, 1806), *Eptesicus serotinus* (Schreber, 1774), *Plecotus auritus* (Linnaeus, 1758) and *Barbastella barbastellus* (Schreber, 1774). The thermopreferendum during hibernation was found to be 7—8°C for *R. hipposideros* and *M. myotis*, while the relevant values for *P. auritus* were 6°C and for *B. barbastellus* 3—7°. Reported values correspond fairly well to temperatures encountered in natural habitats. In the active state (Homoiotherm) the thermopreferendum was 25—26°C for *R. hipposideros*, 31—34° for *M. myotis* and 24°C for both *B. barbastellus* and *M. emarginatus*. Again a good agreement of laboratory measurements with natural conditions was observed. The range of preferred temperatures for *R. hipposideros* was between 4 and 39°C in the laboratory or 2—31° in natural habitats. The relevant figures for *M. myotis* and *P. auritus* were: from 4 to 41°, —4 to 34°C and from 1 to 40° or from —3.5 to 39°C, respectively. Species of bats preferring lower temperatures in winter may inhabit regions situated further north comparing with species preferring higher temperatures (*P. auritus* and *B. barbastellus* compared with *R. hipposideros* and *M. myotis*). The seasonal activity of *P. auritus* and *B. barbastellus* was more prolonged than that of *M. myotis* and *R. hipposideros*. This fact is related to the thermopreferendum: the first two species preferred lower temperatures.

I. INTRODUCTION

Bats inhabiting zone of the moderate climate are reckoned among heterotherm animals owing to their thermoregulation abilities and the dependence on external temperature (Eisentraut, 1937; Herreid, 1963; Kulzer, 1965). One of the methods of studying these biological relationships depends on the determination of the thermopreferendum, or the region of temperature preferred by animals when they have free choice during an experiment (Herter, 1923).

Studies on the thermopreferendum of mammals (hedgehogs and bats) were carried out by Herter (1934, 1936, 1952). More detailed investigations on the temperature preference and tolerance of the American bat *Tadarida brasiliensis mexicana* (Saussure) were reported by Herreid (1967). Till now the Polish literature has been lacking in studies of the thermopreferendum of bats.

The purpose of the present experiments was to determine the temperature preference of bats in a year cycle both in laboratory and natural conditions.

II. MATERIAL AND METHODS

In the described experiments 115 specimens of the following species of bats were used: *Rhinolophus hipposideros* (Bechstein, 1800), *Myotis myotis* (Borkhausen, 1797), *Myotis nattereri* (Kuhl, 1818), *Myotis emarginatus* (Geoffroy, 1806), *Eptesicus serotinus* (Schreber, 1774), *Plecotus auritus* (Linnaeus, 1758) and *Barbastella barbastellus* (Schreber, 1774). In two species: *R. hipposideros* and *M. myotis* studies were carried out during the full year, and in remaining species in some seasons only. All the specimens used in experiments derived directly from their natural habitats and were studied almost immediately. The only exceptions were specimens deliberately acclimatized.

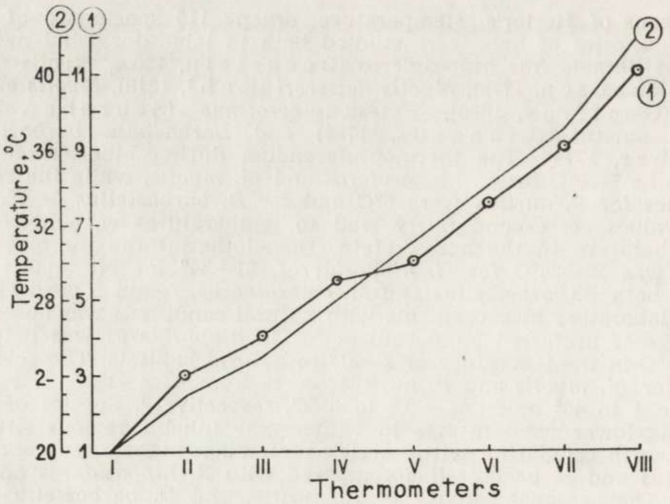

Fig. 1. Typical temperature gradient for studying the thermopreferendum of bats during hibernation (1) and active ones (2) in laboratory conditions (in °C).

In outdoor studies the preference of temperature in some natural habitats of bats in the Cracow region (50°04′ N, 19°57′ E) was systematically controlled in all seasons of the year since 1954.

In laboratory experiments a special apparatus of Herter type (1923), called »a temperature organ« (Temperaturorgel), was used. It consisted of an aluminium plate of the following dimensions: thickness 10 mm, length 830 mm and width 200 mm. A wooden frame of 150 mm height, equipped with a glass pane enabling the observation of animals, was placed on the plate. The aluminium plate was divided into 35 fields, each 20 mm length. An animal was isolated from the plate by a special lattice made of wooden listels. 8 thermometers (accuracy 0.5°C) were placed in every fifth field to indicate the temperature of the surface of the plate. The required temperature gradient was obtained by electric heating of one end of the plate. Since experiments were carried out in a cool room no special cooling of the other end of the plate was essential. Two constant gradients of temperature, based on actual conditions in natural habitats of bats were used in experiments. The first gradient from 0° to 12°C was designed to study the thermopreferendum in winter or after artificial hibernation of bats. The second gradient from 18 to 45°C was used to measure the thermopreferendum in the period of activity (Fig. 1). Experiments were carried out in such a way that after obtaining the required temperature gradient a bat was placed in the apparatus and the position of the animal on the plate was recorded every 2 minutes. On the whole 100—300 readings were taken in every experiment. The required minimal number of readings in this kind of studies was suggested as 50 (Herter, 1952). Every position of the bat during an experiment was interpolated within the curve of the temperature gradient. The total number of readings at a given temperature was treated as a final result of the experiment and expressed as percentage of chosen positions. As a rule experimental animals were used once and only exceptionally up to 3 times.

Statistical analysis of results consisted of: arithmetical mean ($\bar{x}$), standard deviation (S. D.) and standard error (S. E.) expressed in centigrades. In experimental results the range of thermopreferendum and maximal number of choice at a given temperature expressed in per cent of chosen positions were taken into account.

In outdoor studies determinations of temperature in various natural habitats of bats were carried out. The accuracy of temperature measurements was 0.5°C and in some cases a self-recording device was applied.

III. RESULTS OF LABORATORY EXPERIMENTS

1. The Artificial Hibernation

Rhinolophus hipposideros. The range of thermopreferendum varied for all specimens between 4 and 10°C, with maximal frequency of choice at 7—8°C (Table 1).

During the experiments no statistical difference was found between bats deriving from various types of natural winter habitats.

More detailed studies of 3 specimens showed that *R. hipposideros* after subsequent trials can select the proper temperature of hibernation with accuracy up to 0.8°C.

Attempts of the adaptation of *R. hipposideros* to a variable temperature of hibernation were successful and 3 specimens including 2 females deriving from the temperature of 6—7°C and acclimatized for 3 days in 10° finally had chosen the temperature of 9.5—11°C. One specimen stayed exceptionally long (20 hours) in the selected temperature and this fact may support the validity of the employed method.

Myotis myotis. The range of thermopreferendum was between 4 and 11°C with a maximum at 8° (Table 1). All specimens used in the experiments prefered a temperature close to natural conditions (7—8°C).

One female was an apparent exception: although she had been caught at —3.5° she chose 9°C for hibernation during the experiment.

Attempts of adaption of *M. myotis* to a higher temperature of hibernation brought about negative results. Specimen used in 2 experiments chose precisely the same temperature of hibernation.

A bat which was bred in laboratory conditions preferred the temperature of 9 or 10°C — apparently warmer conditions than those selected by wild specimens derving directly from natural habitats.

Table 1.
The choice of temperature by bats during hibernation (Dec.—March) in laboratory conditions (in °C).

Ambient temperature in °C	*Rh. hipposideros*	*M. myotis*	*P. auritus*	*B. barbastellus*
—1	—	—	—	—
0	0	0	—	0.09
1	0	0	0.31	0.18
2	0	0	1.72	0.99
3	0	0	0.94	28.20
4	0.38	1.35	21.50	14.26
5	2.08	10.14	20.97	9.83
6	17.27	12.81	36.30	25.22
7	32.93	18.42	0.77	24.62
8	31.04	29.06	16.70	0.18
9	15.92	21.44	0	0.18
10	0.38	5.34	—	—
11	0	1.06	—	—
12	0	0	—	—
The values of choice expressed in °C	0—12	0—12	—1—9	1—9
$\overline{X}$	7.91	8.03	6.03	4.30
SD in °C	0.9	1.45	1.44	2.50
SE in °C	0.02	0.05	0.05	0.08
n	1438	1108	634	1007
N	10(6)*	9(5)	5(3)	3(3)

* Number of females is given in parentheses.

Barbastella barbastellus. The total range of thermopreferendum was between 0 and 9°C, with two maxima at 3.6 and 7°C (Table 1). During the selection of the preferred temperature bats were fairly independent of the thermal past, *i. e.* the temperature of their natural conditions in a habitat (2—4°C). This could be due to the fact that before the experiment they were kept for some time in 10°C.

In experiments lasting 34 hours 3 specimens stayed all the time in the preferred temperature chosen at the beginning of the experiment.

Plecotus auritus. The range of thermopreferendum was between 1°

and 8°C, with a maximum at 6° (Table 1). Specimens used in experiments neglected the thermal past and chose for hibernation a temperature higher by a few degrees than their natural conditions.

2. The Thermopreferendum of Active Bats

a) Winter

Rhinolophus hipposideros. The range of thermopreferendum varied between 23° and 35°C with most often chosen 25—26°C (Table 2). All the specimen preferred higher temperatures than those of natural conditions.

Myotis myotis. The range of thermopreferendum was 22—41°C with maximal number of choice at 33—35°C (Table 2). During experiments all the bats preferred much warmer surroundings than the actual temperature of their habitats.

Plecotus auritus. The total range of temperature preferendum was 24—40°C with a maximum at 32°C (Table 2).

b) Spring

The range of thermopreferendum for *Rhinolophus hipposideros* was 22—32°C with maximal number of choice at 26°C, and respective figures for *Myotis myotis* were 22—39° and 31°C (Table 2).

c) Summer

Rhinolophus hipposideros. The thermopreferendum included temperatures 22—36° with a maximum at 26°C (Table 2). It was found that every young specimen (3—4 months old) preferred the temperature higher by a few degrees than the adult bats.

During the 24 hours experiment a young female prefered the temperature of 30°C in a daylight but changed it to 26°C at night.

Myotis myotis. The range of thermopreferendum was between 23 and 37°C with a maximum at 31° (Table 2).

In one experiment a young male left in the apparatus for 24 hours at first selected the temperature of 32° but during the evening activity moved gradually to 29°C.

d) Autumn

Rhinolophus hipposideros. The range of thermopreferendum was 22—39° with a maximum at 25°C (Table 2). In *Myotis myotis* the appriopriate figures were 25—37° with two maxima: 26 and 31° (Table 2).

Table 2.

The choice of temperature by bats active during a year in laboratory conditions.

Ambient temperature in °C	*Rh. hipposideros*				*M. myotis*				*M. nattereri*	*M. emarginatus*	*E. serotinus*	*P. auritus*	*B. barbastellus*
	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Autumn	Autumn	Winter	Winter	Autumn
22	0	0.27	0.05	0.09	0.27	0.52	0	0	0	0	—	—	0
23	8.13	11.90	14.88	0.09	0.32	0.70	1.03	0	0.53	29.75	0	0	0
24	3.79	14.10	8.61	0.11	0.46	0.70	10.04	0	1.06	58.08	0	1.03	3.06
25	24.17	22.50	14.13	36.87	2.11	0.70	7.66	7.15	1.06	1.92	0	13.41	33.80
26	25.43	30.90	35.48	11.12	0.78	5.27	11.07	26.53	2.67	0.96	0	0.68	18.42
27	20.77	1.35	11.70	10.41	7.63	0.35	11.28	16.17	1.60	1.92	0	0.17	18.44
28	6.39	0.95	1.25	24.07	7.54	2.07	13.45	6.39	2.30	1.44	0	2.92	3.92
29	3.31	16.10	10.00	0.62	8.00	0.35	4.34	1.50	1.06	0.96	0.48	1.54	5.43
30	3.00	0.95	0.06	0.52	5.19	11.50	2.97	8.09	2.13	1.90	0.48	0.86	0
31	1.50	0.65	0.05	12.10	5.10	28.20	27.40	25.87	87.57	0.96	0.48	25.97	15.43
32	1.10	0.13	0.04	0.62	5.47	19.80	0.31	1.88	0	0.48	28.61	40.42	1.20
33	1.12	0	0.01	0.90	12.78	14.40	2.27	2.35	0	0	0.48	0.34	1.81
34	0.55	0	0.02	0.44	13.47	1.56	3.93	0.66	0	0	2.42	0.34	0
35	0.31	0	0.04	0.53	12.74	0.52	1.60	1.60	0	0	1.45	0.34	0.60
36	0	0	0.02	0.80	6.76	11.50	0.31	0.18	0	0	3.88	0	0
37	0	—	—	0.35	4.00	0.52	0.51	1.22	0	0	59.17	0	0
38	0	—	—	0.17	7.36	0.35	0	0	0	0	2.42	0.34	0
39	0	—	—	0.09	1.01	0.35	0	0	0	0	0.48	2.92	0
40	0	—	—	0	0.96	0	0	0	0	0	0	8.60	0
41	0	—	—	—	0.36	0	—	—	—	—	—	0	—
The values of choice expressed in °C	18—41	20—36	20—37	20—40	22—45	23—41	20—40	20—40	20—40	20—40	23—41	23—41	20—40
$\overline{X}$	26.74	26.17	26.43	27.58	30.94	31.03	29.21	28.95	30.54	24.53	34.58	31.86	27.13
SD in °C	2.06	4.01	2.55	2.52	3.60	2.72	3.64	2.71	1.49	2.36	4.40	3.87	2.20
SE in °C	0.04	0.14	0.06	0.07	0.07	0.14	0.11	0.07	0.14	0.16	0.30	0.16	0.12
n	1312	738	1199	1115	2131	738	952	1115	187	205	206	580	331
N	11(8)*	6(3)	11(7)	9(7)	14(9)	6(3)	9(6)	9(7)	1(1)	1(1)	1(1)	5(3)	5(4)

* Number of females is given in parentheses.

In experiments with *M. myotis* 2 groups of specimens could be distinguished. Bats deriving from a natural cave preferred the temperature higher by a few degrees than specimen caught in articifial caves (casemates).

A bat kept for a long time at a room temperature (18°C) had chosen 32° during the experiment — one of the highest temperatures among all studied specimens.

Myotis emerginatus. The range of thermopreferendum in one studied specimen was 23—32° with a maximum at 24° (Table 2). A slightly less broad range 23—31° was found for *Myotis nattereri* but the maximum was localised at 31°C (Table 2).

Barbastella barbastellus. The range of thermopreferendum was 24—35° with a maximum at 25°C. The appropriate values recorded for *P. auritus* were 24—40° with a maximum at 32°C (Table 2).

IV. RESULTS OF OUTDOOR OBSERVATIONS

Table 3 shows data concerning the choice of preferred temperature by studied specimen of bats in their natural conditions at various habitats in all seasons of a year.

Table 3.
The range of temperatures preferred by bats during a year in natural conditions (in °C).

Species	Winter	Spring	Summer	Autumn	n
Rh. hipposideros	2—14 (7—8)	6—12(7)	14—31(25)	10—13(10)	194
M. myotis	—4—15(7—8)	3—12(8)	30—34	8—15(10)	184
M. nattereri	6—10	8	—	8—14	8
M. emarginatus	1—10	3	20—25	6—12	12
E. serotinus	0.5—6	—	—	5—11	5
P. auritus	—3—11(6)	4—9(6)	21—29	6—12(8)	80
B. barbastellus	—3—9(4)	8	—	5—9	28

Temperatures most frequently chosen are given in parentheses.

The temperatures preferred in autumn and spring were similar, while substantial differences are visible in this respect between winter and summer. A close relationship in preferred temperatures can be seen in *R. hipposideros* and *M. myotis* as well as *P. auritus* and *B. barbastellus*. Bats belonging to these species occupied similar habitats. On the other hand there are differences in preferred temperatures among various representants of the genus *Myotis* (Table 3).

Table 3 illustrates a high degree of variability in the selection of preferred temperature in various seasons of year. This may result from some characteristic features of our transitional climate.

V. DISCUSSION

One of the main purposes of the present work was to establish the temperature requirements of bats in experimental conditions and to compare the obtained results with outdoor observations. In general one can conclude that active bats are characterized by the high thermopreferendum when compared with other mammals (Herter, 1952). This fact can be related to the high level of metabolism, body temperature and activity of bats.

It has been found that active bats preferred always higher temperatures out of a broad temperature gradient in experimental conditions. In natural conditions of our climate, however, bats encounter rather variable temperatures, especially in spring and autumn. Therefore, results of laboratory studies may be compared with outdoor observations in winter and summer.

Results of investigations of artificial hibernation in *R. hipposideros* and *M. myotis* have shown a good agreement with outdoor observations in respect of the temperature of hibernation (Table 1 & 3). In the case of *B. barbastellus* the agreement is less clear. In laboratory experiments *M. myotis* and *R. hipposideros* preferred the temperature of 7—8°C for hibernation, while *P. auritus* preferred 6° and *B. barbastellus* 3—7°C. In natural conditions this last species was encountered mainly in the temperature of 4°C (Table 3).

Results of experiments presented above remain in a good agreement with relevant data of the literature concerning the hibernation of the studied species of bats (Ancieaux, 1948; Kowalski, 1953; Nieuwenhoven, 1956; Punt & Parma, 1964). It is conspicuous that Kuzjakin (1950) suggested a phylogenetic relationship between *P. auritus* and *B. barbastellus,* and both species are regarded as resistant to a low temperature (Ancieaux, 1948).

There is also an agreement between laboratory experiments in the present study and the outdoor observations in summer. *R. hipposideros, M. myotis, P. auritus* and *M. emarginatus* in active state preferred following temperatures: 26, 31—34, 31 and 24°C respectively. Very similar temperatures were found in summer in their natural habitats (Table 2 & 3). Some similarity may be seen in the preferred temperature of *R. hipposideros* and *M. emarginatus,* what remains in agreement with observations reported by Ancieaux (1948). The relationship of the thermopreferendum of *M. myotis* and *P. auritus* should also be mentioned.

Results obtained in the present study generally confirm reports of other authors (Eisentraut, 1937; Kolb, 1950; Abelencev *et al.*, 1956; Gaisler, 1963).

The temperature preferendum of *R. hipposideros* and *M. myotis* in active state showed some seasonal variations. The temperature of most frequent choice in *R. hipposideros* (25—26°C) was fairly constant (Table 2) but the range of thermopreferendum varied within extreme limits (22—39°C). In *M. myotis* most specimens preferred the temperature of 31—34°C, but 34° was chosen only in winter and this fact may be related to the awakening from hibernation. The range of thermopreferendum in this species varied only slightly within extreme limits (23—41°C).

The higher thermopreferendum in *M. myotis* than in *R. hipposideros* may be explained by differences in the degree of perfection of the thermoregulation mechanism and the reactivity to external temperature. Since in bats the body temperature depends almost always on external temperature, it is likely, that *R. hipposideros* exhibits more stable thermoregulation being sensitive to higher temperatures, while *M. myotis* prefers warm conditions. Brosset (1965) reported that *R. hipposideros* avoids the temprature above 26° for the sake of possibility of drying up the flying membranes. According to Gaisler (1963) and Abelencev *et al.* (1956) *R. hipposideros* prefers the temperature around 26° in the natural summer habitats and very often it escapes from warmer surroundings.

Results of the present experiments indicate that the maximal range of preferred temperatures in studied species of bats in laboratory conditions is following: *R. hipposideros* 4—39°C, *M. myotis* 4—41°C, *P. auritus* 1—40°C. In natural habitats *R. hipposideros* was found within the temperature range from 2 to 31°, *M. myotis* from —4 to 34° and *P. auritus* from —3.5 to 39° (Table 1, 2 & 3). It is clear that the broadest range of temperature is associated with *P. auritus*.

According to Kuzjakin (1950) bats can tolerate temperatures between —7.5 and 48°C. In our climate only in summer (July) some bats having their daily habitats in garrets of building with roofs exposed to hot sunbeams may encounter thermal conditions provided in the laboratory.

A large summer colony of *M. myotis* found in Bat Cave in Ojców National Park exhibits some peculiar features from the point of view of thermal economy. There is a constant temperature in this cave during a year — approximately 8—9°C. The bat colony consists of females and their offspring, and bats are active during a day. According to Ponugajeva (1949) a sufficiently high temperature of bats is achieved by the formation of a compact cluster. Thus in spite of relatively low external temperature bats retain the required temperature of the body and this fact may illustrate various features of thermoregulation.

A similar colony of *M. myotis* in a cave in Roumania was described by Dumitrescu *et al.* (1958).

The endurance of bats to high temperatures is sometimes significant. As animals well acclimatised to warm conditions they inhabit mainly subtropical and tropical regions. Some observations in the nature as well as experiments with American bats: *Myotis lucifugus* (Le Conte, 1831), *Myotis yumanensis* (H. Allen, 1864), *Tadarida brasiliensis mexicana* (Saussure, 1860), demonstrated that these bats can endure temperatures up to 55°C but are rarely encountered above 42° (Twente, 1956; Henshaw, 1960; Herreid, 1963; Stones & Wiebers, 1965; Henshaw & Folk, 1966). Other authors (Licht & Leitner, 1967) reported that *M. yumanensis, Antrozocus pallidus* (Le Conte, 1856) and *T. b. mexicana* avoid the temperature of 40—42°C as too high. Herreid (1967) found the temperature preferendum of *T. b. mexicana* from 16 to 35° and the lethal temperature equal to 40°C. This author claimed that the temperature tolerance in bats is much higher than the temperature preferendum (Herreid, 1963).

Bats inhabiting our country are less resistant to high temperatures comparing with some species from the southern hemisphere. During the present experiments with *R. hipposideros* the death of a bat occurred at 32—35°C. With the exception of one case none of the studied specimen stayed longer above 38°, and most frequently chosen temperature did not exceed 34°C (Table 2).

The endurance of bats to a low temperature is their characteristic feature. Among studied species the lowest temperatures for hibernation were preferred by *P. auritus* (1°C) and *B. barbastellus* (0°C) (Table 1). In outdoor conditions bats belonging to these species were observed in —3°C (Table 3). In one exceptional case *M. myotis* was found to hibernate in a natural habitat in —4°C.

The literature provides examples of endurance to low temperatures in some species of bats inhabiting the zone of moderate climate. Natuschke (1950) reported that *B. barbastellus* had hibernated in —14°C. Abelencev *et al.* (1956) found that —7.5° was lethal to *P. auritus*. Several authors (Ancieux, 1948; Abelencev *et al.* 1956; Frank, 1960) described the hibernation of *P. auritus* and *B. barbastellus* in —3 or —5°C in natural habitats, what was confirmed in the present study (Table 3). Some American species of the genus *Myotis* could hibernate in natural conditions at —4°C (Hurst & Wiebers, 1967). It has been found that young specimens are more resistant to low temperature (Kuzjakin, 1950), similarly as to high temperatures (Herreid, 1967).

In experimental studies with high temperatures bats generally preferred warmer conditions than those encountered in natural habitats. Also in the case of low temperature bats most frequently chose temperatures slightly higher than those found in natural surroundings.

The seasonal rhytmicity of bats and their behaviour depend critically on the external temperature (Harmata, 1960, 1962; Gaisler, 1963). Quite commonly the discontinuity of hibernation in the natural habitats has been observed in the case of *P. auritus* and *B. barbastellus*. These species have the shortest period of hibernation and during the experimental hibernation they prefer low temperatures (Table 1). On the other hand *R. hipposideros* and *M. myotis* during the experiments prefer higher temperatures and in the nature hibernate much longer (Table 1).

There exists a relationship between the thermopreferendum of studied bats and data on their geographical distrubution in the Central Europe. According to Bezem *et al.* (1964) the order of the geographical range of some species of bats, starting from the north and moving south, is following: *Myotis mystacinus, Plecotus auritus, Myotis daubentoni, Myotis nattereri, Myotis dasycneme, Myotis myotis, Rhinolophus hipposideros* and *Myotis emarginatus*. In the present experiments *P. auritus* preferred for hibernation lower temperatures than *M. myotis* and *R. hipposideros*. At the same time *P. auritus* and *B. barbastellus* were more resistant to a low temperature during hibernation comparing with *M. myotis* and *R. hipposideros* (Table 1).

The data presented above indicate that the geographical range of some species of bats depends on their thermopreferendum. It may be seen that mean year temperature of the air at the northern limit of the range of *R. hipposideros, M. myotis, P. auritus* and *B. barbastellus* corresponds to the value of their thermopreferendum in winter (Table 1). This fact is related to winter conditions at these geographical latitudes and thus to the limited possibilities of hibernation.

During the present experiments the ability of *R. hipposideros* to acclimatization in the temperature of 9.5—11°C during the hibernation has been proved. Such phenomenon of adaptation is rarely encountered among bats (Barabash, Nikiforov & Formosov, 1963).

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TERMOPREFERENDUM NIEKTÓRYCH GATUNKÓW NIETOPERZY *(CHIROPTERA)*

Streszczenie

Badano termopreferendum w warunkach laboratoryjnych i terenowych u 7 gatunków nietoperzy: *Rhinolophus hipposideros* (B e c h s t e i n, 1800), *Myotis myotis* (B o r k h a u s e n, 1797), *Myotis nattereri* (K u h l, 1818), *Myotis emarginatus* (G e o f f r o y, 1806), *Eptesicus serotinus* (S c h r e b e r, 1774), *Plecotus auritus* (L i n n a e u s, 1758) i *Barbastella barbastellus* (S c h r e b e r, 1774). Badania laboratoryjne prowadzono w zmodyfikowanym aparacie Hertera. Równocześnie z badaniami laboratoryjnymi prowadzono obserwacje w terenie.

Ustalono, że termopreferendum nietoperzy jest ich cechą gatunkową. Wyniki badań laboratoryjnych dadzą się porównać z danymi terenowymi w okresie zimy i lata. W okresie zimowania *R. hipposideros* i *M. myotis* najchętniej wybierały zarówno w warunkach terenowych jak i laboratoryjnych temperatury 7—8°C; *P. auritus* 6°C, a *B. barbastellus* 3—7°C. W stanie aktywnym *R. hipposideros* najchętniej wybierał 25—26°C, *M. myotis* 31—34°C, *P. auritus* 31°C a *M. emarginatus* 24°C. Temperatury te odpowiadają warunkom termicznym, w jakich nietoperze te przebywają w swoich kryjówkach latem (Tabele 1, 2, 3).

W warunkach terenowych ustalono termiczne wymagania dla *E. serotinus*, *M. nattereri* i *M. emarginatus* w okresie zimy. Gatunków tych nie badano laboratoryjnie w tym okresie (Tabela 3).

W stanie aktywnym nietoperzy przebadano termopreferendum u *B. barbastellus*, *E. serotinus* i *M. nattereri* w laboratorium, nie obserwowano ich natomiast w kryjówkach latem (Tabela 2).

Ustalono, że zakres wybieranych temperatur u *R. hipposideros* wynosi w laboratorium od 4 do 39°C, w terenie zaś od 2 do 31°C, u *M. myotis* od 4 do 41°C w laboratorium i od —4 do 34°C w terenie a u *P. auritus* od 1 do 40°C w laboratorium i od —3,5 do 39°C w terenie. Wartości te świadczą o zakresie temperatur ekstremalnych tych nietoperzy. Stwierdzono śmierć *R. hipposideros* w 32—35°C.

Wykazano istnienie pewnych związków pomiędzy termopreferendum badanych gatunków nietoperzy a ich rozmieszczeniem geograficznym w Europie. Gatunki wybierające w zimie niskie temperatury (*P. auritus*, *B. barbastellus*) sięgają w swym rozsiedleniu dalej na północ niż gatunki preferujące wyższe temperatury podczas hibernacji (*R. hipposideros*, *M. myotis*). Wybór odpowiednich temperatur ma wpływ na rytmikę sezonową nietoperzy. Okazuje się, że większą aktywność sezonową w ciągu roku posiadają gatunki *P. auritus* i *B. barbastellus* wybierające w zimie temperatury niższe, niż *M. myotis* i *R. hipposideros* preferujące temperatury wyższe.