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Weight Dynamics of Bats Wintering in the Cave at Puławy (Poland)

Zmienność wagi u nietoperzy zimujących w jaskini w Puławach

[with 4 figs. and 9 tables]

I. INTRODUCTION

Research of this kind, based on extensive material, has up to the present been reported by Dumitrescu et al. (1955), Beer & Richards (1956), Hooper & Hooper (1956) and Twente (1955). In all cases however, the work was carried out in different areas and concerned different species. Less extensive research work dealing with part only of the same species which form the subject of the present work was reported by Rulot (1902), Gruet & Dufour (1949), Pearson, Koford & Pearson (1952), Twente (1954; 1956), Van Nieuwenhoven (1956) and Mumford (1958). These investigations also were carried out in different areas.

II. MATERIAL AND METHODS

Work on these measurements started on October 1st, 1954, and was completed on April 30th 1958. The bats found were taken to the laboratory situated 400 m. away, where they were weighed on analytical balance. Specimens were not weighed until their fur had dried. The period between finding the bat and releasing it again in the cave varied from 1—2 hours. A total of 1016 measurements of 646 individuals were made; the material is set out in Table 1. Data on the habitat (cave, surroundings) and methods of capture used are to be found in my work published in 1959.

III. RESULTS AND DISCUSSION

The results are given in the form of tables and diagrams, so that I shall here discuss them only.

Autumn increase in weight. Some species of bats grow fat rapidly in the autumn. With the males of *Myotis nattereri* (Kuhl 1818), for instance, the increase in weight from the second half of October to the second half of November is 1.01 g., while the females exhibit an even more intensive increase in October, of 1.93 g. in weight per month. The increase in weight of a certain male specimen of *Myotis myotis* (Borkhausen 1797) is very striking, as between October 3rd — 20th it put on 27.1% of its original weight. The increased rapidity of the fattening process is indicated by the standard deviation of the mean weight (Table 2) which is in general greater than that at other periods.

Table 1.
Species and numbers of bats weighed.

No.	Species	Specimens weighed	No. of measurements
1	*Myotis nattereri* (Kuhl 1818)	340	472
2	*Plecotus auritus* (Linnaeus 1758)	109	211
3	*Barbastella barbastellus* (Schreber 1774)	65	132
4	*Myotis myotis* (Borkhausen 1797)	86	122
5	*Eptesicus serotinus* (Schreber 1774)	27	50
6	*Myotis daubentoni* (Kuhl 1819)	11	12
7	*Eptesicus nilsoni* (Keyserling et Blasius 1839)	3	8
8	*Myotis mystacinus* (Kuhl 1819)	3	6
9	*Myotis dasycneme* (Boie 1825)	2	3
	Total	646	1016

Dates of maximum weight. It is remarkable that the maximum weight is attained late, often in the second half of November (Figs. 1, 3). This is particularly astonishing in the case of the males of *M. nattereri,* as this is a species distincly less resistant to cold than *B. barbastellus* (Schreber 1774). The considerable difference between the time of attaining maximum weight (i. e. one month) by the males (n = 14) in comparison with the females (n = 16) of this species is also worthy of note (Fig. 1). The relatively early attainment of maximum weight by *M. myotis* is understandable in view of the high thermic requirements of this species. The late attainment of peak weight by at least some of the species of bats is striking when we remember that night temperatures at Puławy are not high: maximum temperature rarely exceeds +10° C, and often falls below 0° C. According to R y b e r g (1947) insects and bats cease their flights at temperatures below +10° C.,

Table 2.

Standart deviation of weight (see Figs. 1—4, and sample size)

Species and sex		Oct.		Nov.		Dec.	Jan.	Feb.		March		April		May
		1-15	16-31	1-15	16-30	1 - 31	1 - 31	1-15	16-28	1-15	16-31	1-15	16-30	1 - 31
M. nattereri	♂	0.85	1.09	1.20	1.03	0.93	0.61	0.46		0.71	0.47	0.52	0.62	0.:3
		16	40	54	14	9	9	5		8	21	40	14	2
	♀	2.00	0.89	0.88	1.75	0.83	0.17	1.00		0.71		0.61	0 58	—
		7	16	22	5	9	5	2		26		85	18	—
P. auritus	♂	1 56		0.87	1.30	0.94	0.53	0.54		0 70		0.76	—	—
		5		12	6	18	7	10		9		5	—	—
	♀	1.81		1 31		0.51	1.19	0.51		0 72		0.32	—	—
		6		6		7	*7	6		15		4	—	—
B. barbastellus	♂	2.68		1.79	0.90	1.21	1.62	0.60		0.22	0.76	—	—	0.14
		3		10	14	8	2	6		6	9	1		2
	♀	0.48		0.89		0.92	1 35	0.94		0 66		—	—	—
		3		15		7	11	5		5		—	—	—
M. myotis	♂	5.14	2.45	—	3.15	1.36		2 49		—	—	1 32		—
		17	6	—	3	3		6		—	—	6		—
	♀	3.75	5.07	—	2.28	—	—	2.38	—	—	—	2.10	2.46	—
		18	6	—	3	—	—	4	—	—	—	18	18	—
E. serotinus	♂	—		2.98		1.61	2 45	1.25		0 60	—	—	—	—
		—		5		5	3	2		2	—	—	—	—
	♀	2.18		3.01		5.26	1.06	—		0.28		—	—	—
		4		8		2	3	—		2		—	—	—

at least as far as Sweden is concerned. This does not apply to Poland: according to A d a m c z e ws k i (1950) many species of moths and *Diptera* (the latter in dense „column") fly at temperatures below + 10° C., e. g. *Conistra vau-punctatum* Esp. flies and feeds even during ground frosts, and on this account A d a m c z e w s k i has called it the „winter butterfly". According to verbal information obtained from A d a m c z e w s k i, at temperatures below +10° C. frequently as many as 100 specimens of winter moths, often of considerable size, appeared on bait: in addition the abdomina of many females were swollen with eggs. The bats therefore are enabled to feed at very low temperatures, particularly as they seize sitting prey also. Rapid increase in weight is possible probably as result of the very sharp fall in the rate of metabolism of the bat caused by the low temperature of the cave, resulting in acceleration of formation of fat deposits. T w e n t e (1955) also gives a similar explanation of this phenomenon.

Table 3.

Maximum and minimum weights of bats investigated (in g.).

Species & sex		Min. weight	Max weight	Number of measurements	Min./Max. weight ratio per cent
M. nattereri	♂	6.37	12.45	232	51.2
	♀	6 80	14.09	240	48.3
P. auritus	♂	6.38	12 70	72	50.2
	♀	7.18	12.17	51	59.0
B. barbastellus	♂	7.50	14.00	61	53.6
	♀	8.84	15.23	46	58.0
M. myotis	♂	23 54	40 22	42	58.5
	♀	22.86	40.47	68	56.5
E. serotinus	♂	18 29	28.45	19	64.3
	♀	19.61	29.71	20	66.0
M. daubentoni	♂	6 42	9.77	9	65.7
	♀	7.18	10.46	3	68.6
M. mystacinus	♀	3.36	6.30	5	53.3
E. nilssoni	♂	9.49	11.21	3	84.6
	♀	9.64	11.56	2	83.4
M. dasycneme	♂	13.14	15.32	2	85.8

Observations of the late attainment of maximum weight by bats are also confirmed by B e e r & R i c h a r d s (l. c.) and T w e n t e (l. c.) — second half of October, while H o o p e r & H o o p e r (l. c.) — December. With the exception of the investigations made by B e e r & R i c h a r d s, however, these works refer to areas with a far milder autumn than is the case at Puławy. For instance, during the years forming the period discussed in this work, the average temperatures for September, October, November and December at Puławy were respectively +13.4° C, +8.7° C, +2.6° C and +0.4° C (M i t o s e k, 1960).

Correlations beetwen appearance in the cave, change in weight and hibernation. With *M. nattereri* and *M. myotis* the lack of coincidence between appearance in the cave and hibernation is very striking: the cave for these species appears to be a sort of intermediate station, where they quickly put on weight, after which they leave the cave for the true winter period (Krzanowski, 1959). As long as they remain in the cave, however, they continue to lead an active life; this fact must be emphasised, since certain research workers identify the transfer of the bats from their summer hiding-places to caves with the beginning of hibernation.

Table 4.
Mean loss of weight during hibernation.

Species & sex		Period between the observed mean max. and mean min. weight	No. of measurements respectively	Mean max. and mean min. weight respect. in g.	Loss of weight %
M. nattereri	♂	16—30 Nov.— 16—30 Apr.	14 and 14	9.83— 7.40	24.7
	♀	16—31 Oct. — 16—30 Apr.	16 and 18	12.40— 8.14	34.4
P. auritus	♂	16—30 Nov.— 1—15 Apr.	6 and 5	10.07— 7.35	27.0
	♀	1—31 Oct. — 1—15 Apr.	6 and 4	9.76— 7.63	21.8
B. barbastellus	♂	16—30 Nov.— 1—15 Mar.	14 and 6	11.94— 8.28	30.7
	♀	1—30 Nov.— 1—31 Mar.	15 and 5	13.03— 9.21	29.3
M. myotis	♂	16—31 Oct. — 1—30 Apr.	6 and 6	33.50—25.11	25.0
	♀	16—31 Oct. — 1—15 Apr.	6 and 18	35.00—27.55	21.3

In connection with the interesting frequentation dynamics of these species in the cave (Krzanowski, l. c.) it must be made clear that with *M. nattereri* certain correlations exist between the autumn peak in the numbers of males and females appearing in the cave and the time at which they attain their peak weight: both peaks occur later (November) with males, and earlier (October) with females.

It is, however, an interesting fact that only a small percentage of females goes to the cave in the autumn for „fattening up", judging by the radical change in the numerical ratio of the sexes in

Table 5.
Weight losses in particular specimens during the approximate time of hibernation.

Tag no.	Species & sex		Capture date	Recapture date	Weight loss per cent
453	*M. nattereri*	♂	Nov. 3, 1955	Apr. 12, 1956	17.5
520	,,	♂	Dec. 28, 1955	Apr. 3, 1956	23.1
1586	,,	♂	Oct. 31, 1956	Mar. 18, 1957	29.1
1627	,,	♂	Nov. 14, 1956	Apr. 17, 1957	11.3
3164	,,	♀	Nov. 3, 1954	Apr. 23, 1955	32.5
427	,,	♀	Oct. 25, 1955	Apr. 4, 1956	38.2
608	,,	♀	Nov. 6, 1956	Apr. 13, 1957	32.9
1641			Nov. 24, 1956	Apr. 3, 1958	18.8
2271	,,	♀	Oct. 24, 1957	Apr. 15, 1958	32.1
3168	*P. auritus*	♂	Nov. 18, 1954	Mar. 9, 1955	28.0
418	,,	♀	Oct. 20, 1955	Mar. 31, 1956	27.1
1568	*B. barbastellus*	♂	Dec. 3, 1955	Mar. 23, 1956	31.6
2964	,,	♂	Nov. 22, 1954	Mar. 31, 1955	34.9
3175	,,	♂	Nov. 4, 1955	Mar. 17, 1956	38.0
3182	,,	♂	Nov. 28, 1954	Mar. 30, 1955	18.2
4664	,,	♂	Nov. 23, 1954	Mar. 16, 1955	35.4
432	,,	♂	Oct. 29, 1955	Mar. 15, 1956	38 1
506	,,	♂	Dec. 19, 1955	Mar. 15, 1956	22.6
3181	,,	♀	Nov. 27, 1954	Mar. 1, 1955	28.6
4658 2288	,,	♀	Nov. 27, 1957	Mar. 17, 1958	24.2
474	,,	♀	Nov. 15, 1955	Feb. 26, 1956	28.8
493	,,	♀	Nov. 27, 1955	Mar. 27, 1956	30.8
440 611	*M. myotis*	♂	Oct. 31, 1955	Apr. 17, 1956	22.4
1563	,,	♂	Oct. 10, 1956	Jan. 12, 1957	29 6
1569	,,	♂	Oct. 12, 1956	Mar. 9, 1957	31.2
398 588	,,	♀	Oct. 3, 1955	Apr. 7, 1956	36.0
415	,,	♀	Oct. 20, 1955	Apr. 25, 1956	28.7
2250	,,	♀	Sept. 27, 1957	Apr. 12, 1958	31.3
1581	*E. serotinus*	♀	Nov. 26, 1956	Mar. 17, 1958	11 3

the spring, when — vice versa — the males are not numerous (Krzanowski, l. c.).

In the spring, the start of the active life of this species and of *M. myotis* would appear to coincide with their appearance in the cave; but with the former the loss in weight continues up to the end of April. Thus in the spring the cave once again becomes an intermediate station for both species.

It must also be emphasised that *B. barbastellus* (Schreber 1774) and *Eptesicus serotinus* (Schreber 1774) disappear almost entirely from this cave in the spring, so that as a rule their minimum weight occurs in other hiding-places. There is, therefore, a certain difference here in comparison with the analogous relations in the autumn.

Loss of weight during hibernation. This is most certainly slightly greater for individual specimens than would appear from the numerical data given in Table 4. There are two reasons for this: a) the values given on the diagrams (figs. 1—4) are only averages of periods of a fortnight or even a month, during which the weight attains its extreme values. In particular the maximum weights are reduced here since, as has already been stated, increase in weight in the autumn is especially rapid; b) the values given are the averages of observations made over a period of four seasons, while Hooper & Hooper's observations (l. c.) indicate that dates of attainment of extreme weights may differ from year to year. For purposes of comparison therefore, several actual decreases in weight of various individuals have been given in Table 5. Although it is probable that none of these individuals was weighed exactly at the moment of attaining maximum and minimum weight, this is a circumstance providing even clearer evidence of how great decreases in weight may be during hibernation and — vice versa — their increase in the autumn (Table 9). Cf. for this purpose, e. g. *M. nattereri*, No 1574, 608, *B. barbastellus*, No 3181, 3182.

Average decreases in weight with *E. fuscus* as calculated by Beer & Richards (l. c.) are 33.5% for males and 25.2% for females. Twente (1956) for *Myotis velifer incautus* (J. A. Allen 1896) gives respectively 26.8% and 29.9%, Hooper & Hooper (l. c.) for *Rhinolophus ferrum-equinum* (Schreber 1774) 23% and 28%, for *Rhinolophus hipposideros* (Bechstein 1800) (both sexes jointly): 21.7%.

As will be seen from the above data, the rate of decrease in weight may be very different for either sex. This may have some connection with the frequency of awakening during hibernation, which may very considerably depending on sex (Pearson, Ko-

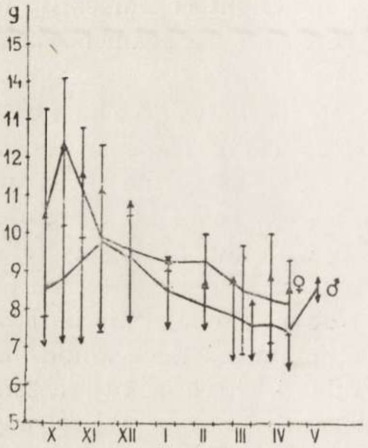

Fig. 1. Weight changes of *M. nattereri*, mainly during hibernation. Arrows and dashes indicate extreme values for males and females, resp.

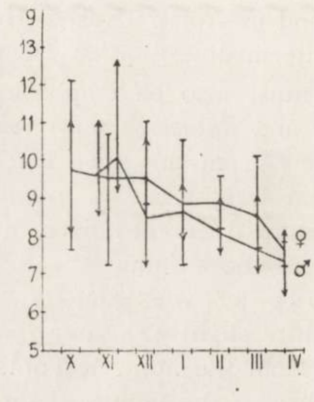

Fig. 2. Weight changes of *P. auritus*, mainly during hibernation.

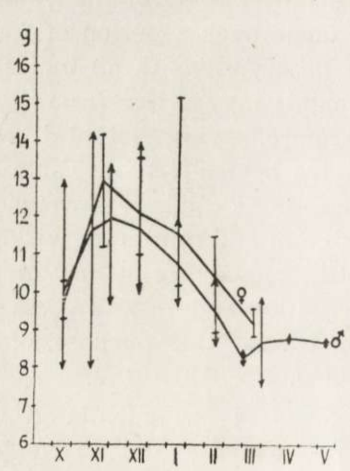

Fig. 3. Weight changes of *B. barbastellus*, mainly during hibernation.

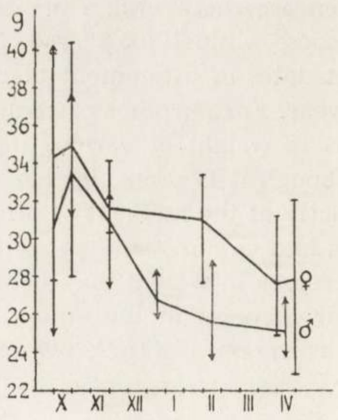

Fig. 4. Weight changes of *M. myotis*, mainly during hibernation.

ford & Pearson, l. c.). Great indvidual differences may occur in the rate of decrease in weight, as is made clear by Tables 5 and 6. Such differences are known from the research work of other authors such as Van Nieuwenhoven (l. c.); they even occur under stable laboratory conditions (Hari, 1909), as they also do in the case of other mammals (Valentin, after Eisentraut, l. c.).

Table 6.

24 hours' losses of weight in specimens caught and weighed at 24 hours' intervals.

(Column „A" compared with 24 hours' losses of weight in specimens caught and weighed at longer intervals — column „B").

Species and sex		Number of specimens (for column „A"	Min. and Max. weight loss (in g) (for column „A")	Mean weight loss (column „A")	Column „B"	A/B
M. nattereri	♂	8	0.050—0.290	0.190	Dec. — Mar.; 0.019	10.00
	♀	13	0.050—0.400	0.234	Nov. — Mar.; 0.026	9.00
P. auritus	♂	14	0.020—0.350	0.122	Dec. — Mar.; 0.020	6.10
	♀	9	0.030—0.580	0.187	Jan. — Mar.; 0.015	12 47
B. barbastellus	♂	4	0.440—0.570	0.502	Dec. — Mar.; 0.028	17.93
	♀	1	0.400	0 400	Dec. — Mar.; 0.032	12 50
M. myotis	♀	1	0.660	0.660	Nov. — Mar.; 0.049	13.47
E. serotinus	♂	3	0.110—0.280	0.197	—	—

Various cases of increase in weight during the autumn, autumn-winter and early-spring periods: in order to make it clear how as distinct from averages (figs. 1—4) — the weight of different individuals may increase, relevant cases are given in Table 7. Many of them provide support for the thesis of late attainment of peak autumn weight, and also the thesis of particularly rapid process of increase in weight during this period. Cf. for this purpose coll. nos. 0411, 0448, 1546, 3158, 65.

Individual cases of increase in weight during the winter period: in many cases I observed an increase in weight during the winter, which I at first attributed to errors made in weighing. However although increased carefulness was observed in weighing, such cases repeated themselves, despite the fact that it was not only winter by the calendar, but that it was freezing. I have set out these results together in Table 8. As will be seen, in many cases these increases are very inconsiderable, and may even be explained by accidental factors, such as, e. g. varying amount of water in the fur. In several cases these increases are greater (e. g. coll nos. 549, 1669) and then it may be assu-

Table 7.

Some cases of weight changes (mainly increase) during the October — April period (exclusive of winter).

Tag no.	Species & sex	Date of measuring weight	Weight in g.	Night temperatures (in C°) and other remarks
3161	*M. nattereri* ♂	Oct. 29, 1954 Oct. 30, 1954	9.66 9.78	+1,3 — +6,6.
3185	„ ♂	Oct. 20, 1955 Feb. 5, 1956	7.75 8 75	19 nights with max. temperatures between +5.0 — +9.9; 10 nights with max. t +10.0 — +14.1.
0411	„ ♂	Oct. 31, 1955 Nov. 28, 1955	8.42 11.20	5 nights with max. t +10.0 — +11.3; 8 nights with max. t +5.0 — +9.9.
0422	„ ♂	Oct. 20, 1955 Jan. 13. 1956	7.33 8.40	15 nights with max. t between +5.0 — +9.9; 10 nights with max. t +10.0 — +14.1.
0448	„ ♂	Nov. 2, 1955 Nov. 28, 1955	7.11 8.99	8 nights with max. t +5.0 — +9.9; 5 nights with max. t +10.0 — +11.3.
1546	„ ♂	Oct. 7, 1956 Nov. 8, 1956	9.15 10.08	10 nights with max. t +6.1 — +10.0; 13 nights with max. t +10.1 — +13.3.
3156	*B. barbastellus*	Oct. 9, 1954 Jan. 10, 1955	9.32 10.86	14 nights with max. t +10.2 — +14.8; 4 nights with max. t +15.1 — +18.2.
3158	„ ♀	Oct. 18, 1954 Nov. 24, 1954	9.61 12.00	10 nights with max. t +10.2 — +14.8; 3 nights with max. t +17.2 — +18.2.
65	*M. myotis* ♂	Oct. 3, 1955 Oct. 20, 1955	24.80 31.53	6 nights with max. t +10.9 — +13.6; 5 nights with max. t +15.1 — +19.3.
1553	„ ♂	Oct. 8, 1956 Oct. 17, 1956	28.42 31.35	Max. t of all the nights above 0, from +6.4 to +10.6.
1552	„ ♀	Oct. 9, 1956 Oct. 16, 1956	29.63 31.78	Max. t of all the nights above 0, from +6.4 to +10.6.
1562	„ ♂	Apr. 15, 1958 Apr. 19, 1958	26.02 26.86	Max. t of all the nights above 0, from +4.5 to +12.8.
450	*E. serotinus,* ♂	Nov. 3, 1955 Mar. 12, 1958	20.22 23.68	5 nights with max. t +10.1 — +11.3; 15 nights with max. t +5.1 — +9.6, all the remaining nights colder.

Table 8.

Cases of weight increase during approximate activity period.

Tag no.	Species & sex	Date of measuring weight	Weight in g.	Night temperatures (in C°) and other remarks
0548	*M. nattereri* ♂	Mar. 18, 1956 Mar. 20, 1956	7.30 7.55	Max. t of the two nights -2.7, -3.5.
1655	,, ♀	Dec. 20, 1956 Jan. 3, 1957	7.85 7.93	Only four nights with max. t above 0: +0.8 +0.6, +0.5, +2.7.
		Jan. 5, 1957	7.75	Taken to author's house, 3 km away, and released from it Jan 6. Max. t of the following 3 nights: +6.1, +4.0, +5.5.
		Jan. 9, 1957 Jan. 12, 1957	8.54 8.61	Defecation observed; max. t: +6.2, +2.3, +1.0.
528	*P. auritus* ♂	Jan. 19, 1956 Jan. 21, 1956	8 09 8.09	2 nights with max. t +1.2 and +3.6.
		Feb. 8, 1956 Feb. 9, 1956 Mar. 4, 1956	7.76 — 7.83	Awoken by author; max. t between the two last measurements: only two nights with t above 0, up to +3.4.
542	,, ♂	Mar. 9, 1956 Mar. 12, 1956	8 01 8.14	Max. t of 3 nights: -5.0, -3.4, -3.7.
546	,, ♂	Mar. 15, 1956 Mar. 16, 1956	7 12 7.39	Max. and minim. t +0.2 and -4.9, resp.
2	,, ♀	Mar. 14, 1955 Mar. 19, 1955	9 06 9.18	Only two nights with max. t above 0: +1.2 and +2.4.
1665	,, ♀	Jan. 15, 1957 Jan. 31, 1957	8 36 8.40	Only 6 nights with max. t above 0, up to +2.5.
3182	*B. barbastellus* ♂	Mar. 31, 1955 Apr. 2, 1955	8 72 8.94	Max. t of the 2 nights +2.2 and +0.6, resp.
549	,, ♂	Mar. 15, 1956 Mar. 16, 1956	8 11 8.64	Max. and minim. t of the night +0.2 and -4.9, resp.
609	,, ♀	Jan. 4, 1958 Jan. 16, 1958	10 17 10.59	9 nights with maxim. t above 0, up to +6.2.
470	*E. serotinus* ♀	Nov. 24, 1955 Feb. 7, 1956	21 61 24.52	3 nights with max. t +5.1 — +7.7, 41 nights with max. t +0.1 — +4.9, all the remaining nights colder.
1669	*M. daubentoni* ♂	Jan. 28, 1957 Feb. 8, 1957	6.91 8.34	All the nights with max. t above 0, up to +6.1.

med that the bat has taken some food, despite the winter season. Such winter increases in weight are even more worthy of attention in view of the fact that animals awakened from their winter sleep — which is inevitably connected with weighing — lose weight extraordinarily rapidly, as is confirmed by many investigations, including those made by Kayser (1953).

It must also be recalled that increases in the weight of other mammals during the winter period, even under laboratory conditions (i. e. without access to food) are known from Barkow's work (1846); different theories explaining this phenomenon have been collected by Eisentraut (l. c.) and Kalabukhov (1956).

Table 9.

Some cases weight changes (mainly increase) during the winter.

Tag no.	Species & sex	Capture date	Recapture date	Weight gain per cent
575	*M. nattereri* ♂	Apr. 4, 1956	Nov. 6, 1956	18.4
1574	„ ♀	Mar. 30, 1955	Oct. 28, 1955	29.3
573	„ ♀	Apr. 4, 1956	Oct. 17, 1956	26 9
608	„ ♀	Apr. 14, 1956	Nov. 6, 1956	35.7
28	*P. auritus* ♀	Mar. 31, 1955	Oct. 7, 1956	35.2
3182	*B. barbastellus* ♂	Apr. 3, 1955	Nov. 3, 1955	40.3
3181	„ ♀	Mar. 1, 1955	Nov. 27, 1955	31.7

Losses in weight of individuals weighed at 24-hour intervals. The respective losses in weight given in Table 6 and compared with losses in weight of individuals weighed at intervals of several months reveal the unfavourable effect that waking the animal has on its weight. These results in addition agree — as recalled above — with the researches of many physiologists. For instance Kayser, referred to above, stated that with the ground squirrel 90% of the losses in weight during hibernation occur during the short periods (constituting 7.4% of the whole period) when the animal was woken from sleep. Therefore, in view of the above facts, I did not take into account the weights of bats frequently woken (of course apart from cases treated separately). I am of the opinion, however, like Gruet & Dufour (l. c.) that since bats frequently wake up spontaneosly during hibernation this would not give rise to much error.

Observations on the weights of the same individuals weighed on similar dates, but in different years. A study of suitable examples reveals that such weights may differ greatly from each other. On account of lack of space I am here giving only three examples: *B. barbastellus,* ♀, no. 494, which on 30. XI. 1955 weighed 11.98 g., on 30. XI. 1957 weighed 8.80 g.; *M. myotis* ♀, no. 1705, which on 16. IV. 1957 weighed 32.03 g., on 15. IV. 1958 weighed 28.01 g.; *Plecotus auritus* (Linnaeus 1758) ♂, no. 2341, which on 3. IV. 1958 weighed 8.14 g., on 11. III. 1960 weighed only 7.25 g.; therefore, on account of the general tendency to a decrease in weight during this period (fig. 2), by 3. IV. 1960 it would certainly have weighed even less, and thus the difference in weight would be even greater. It has not, however, proved possible to establish a connection between these differences and possible different temperature systems prevailing during the period of autumn fattening. For example, in the case of bat no. 494, the average maximum night temperatures for October and November in 1955 were respectively + 11.9 and + 4.7° C., and in 1957 they were + 10.9 and + 5.5° C. It is, therefore, possible that it is connected with the varied dynamics of the appearance of insects.

Comparison of weights of bats at Puławy with weights of bats from the north. When comparing the weights of bats at Puławy with those of northern bats of the same species (Ryberg, 1947) it is noticeable that the weights of the former are in general considerably greater, e. g. *M. nattereri* at Puławy weighs 6.37 — 14.09 g., while in Sweden the weight is only 5 — 9.5 g.; *P. auritus:* 6.38 — 12.70 g., and correspondingly 5—10 g.; *B. barbastellus* 7.50 — 15.23 g., and correspondingly 6 — 8.5 g.; *E. serotinus* 18.29 — 29.71 g. and correspondingly 13 — 17 g. If Bergman's law is applied here it appears that the bats behave like poikilothermic animals, their size becoming smaller the further north they live. This is in agreement with the results of investigations made by Hock (1951) and by Hanuš (1959) on the metabolism of bats.

IV. SUMMARY

During the period October — April in four years, 1016 measurements were made of the weight of 646 specimens of bats belonging to 9 species. The following conclusions were reached:

1. Increase in weight with *M. nattereri*, *B. barbastellus*, *M. myotis* is decidedly quicker in the autumn than in the summer.

2. The bats may put on weight, in fact very rapidly, even in the late autumn. The peak weight of males of *M. nattereri* and *B. barbastellus* is reached in the second half of November; *M. myotis* and female *M. nattereri* attain peak weight in the second half of October;

3. There is no coincidence in time between the beginning of hibernation and the autumn appearance in the cave of *M. myotis* and *M. nattereri:* these species in October — in the case of *M. naterreri* even in November — continue to fly out from their hiding-places in search of food. On the other hand there is a spring correlation between the appearance of these species in the cave at the beginning of April and the beginning of their active life; decrease in weight, however, at least with *M. nattereri*, lasts right up to the end of April;

4. With *B. barbastellus* and *E. serotinus* the spring extreme weight takes place outside the cave, differently than in analogous relations in the autumn;

5. Decrease in weight differs greatly not only between different species and between the sexes, but also between individuals. In extreme cases it may even exceed 40% of the original weight (i. e. autumn maximum);

6. In several cases an increase in weight was observed during hibernation, despite low external temperatures.

7. The weights of many species of bats at Puławy are considerably greater than those of bats of the same species living in the north.

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STRESZCZENIE

W okresie październik — kwiecień w ciągu 4 lat wykonano 1016 pomiarów wagi 646 nietoperzy należących do 9 gatunków. Wyciągnięto następujące wnioski:

1. Przybieranie na wadze *M. nattereri, B. barbastellus, M. myotis* jest w jesieni znacznie szybsze, niż w ciągu lata;

2. Jeszcze późną jesienią nietoperze mogą przybierać na wadze i to znacznie: szczyt wagi jesiennej u samców *M. nattereri i B. barbastellus* występuje w drugiej połowie listopada; *M. myotis* oraz samice *M. nattereri* osiągąja szczyt wagi w drugiej połowie października;

3. Nie ma czasowej zbieżności między początkiem hibernacji a jesiennym pojawieniem się w jaskini *M. myotis* i *M. nattereri:* gatunki te w październiku, a *M. nattereri* nawet w listopadzie, wylatują z tej kryjówki na żer. Istnieje natomiast wiosenna korelacja między pojawieniem się tych gatunków w jaskini w początku kwietnia a początkiem życia aktywnego; jednakże, przynajmniej u *M. nattereri,* spadek wagi trwa aż do końca kwietnia;

4. *B. barbastellus* i *E. serotinus* przechodzą wiosenne ekstremum wagi poza jaskinią, inaczej, niż w analogicznych stosunkach jesienią;

5. Spadek wagi jest bardzo różny nie tylko dla różnych gatunków i płci, lecz również nawet dla różnych osobników. W wypadkach skrajnych może przekroczyć 40% wagi pierwotnej (tj. maksymalnej jesiennej);

6. W szeregu wypadków zaobserwowano zwiększenie się wagi w czasie hibernacji, mimo niskich temperatur zewnętrznych;

7. Wagi kilku gatunków puławskich nietoperzy są znacznie wyższe od wag tych samych gatunków żyjących na północy.

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