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Influence of the Weather on Capture of *Micromammalia* I. Rodents *(Rodentia)*

Wpływ pogody na odłowy *Micromammalia* I. Gryzonie *(Rodentia)*

I. INTRODUCTION

The aim of this work was the documentation of the statement made by Borowski & Dehnel (1952) that weather affects captures of *Micromammalia* in the Białowieża National Park, in particular rain, which causes a marked increase in the number of mammals captured. These authors found that temperature and precipitation have such a distinct effect on the number of small forest mammals captured, that they frequently cloak significant variations caused by fluctuations in the population numbers. As regards rainfall it was found that the amount, quality and duration of rainfall affect captures, and may even increase the results of trapping tenfold or more. The authors explain these results by the increase in the activity of mammals, especially of insectivores, caused by rain. They observed that the absolute level of temperature does not affect captures, but that a jump in temperature is important. This is particularly marked in the winter. The statements made by the above authors were based on the results of research carried out over a period of many years in the Białowieża National Park, where regular trapping of small mammals has been carried out from 1946 up to the present time. Trapping was at first (up to 1952) carried out by the Białowieża branch of the Forestry Research Institute, and taken over by the Mammals Research Institute. This material which was collected by various methods, is extremely numerous (about 40,000 specimens).

When analysing the course taken by trapping of *Micromammalia* over a considerable period, differences over a period of 24-hours can be observed in the numbers of mammals captured, in addition to seasonal fluctuations. If we trap these animals using one method only, within one area, and find that there are differences over 24-hour periods, we may assume that this is due to the influence of meteorological factors. Observations of this phenomenon in the Białowieża National Park are easier to make than elsewhere, since we have a network of meteorological stations everywhere. There are as yet very few ecological works supplying comprehensive material, and indicating in what way meteorological factors, or sets of these factors, affect the activity of small mammals. The views of research workers on this question vary considerably. Barbehenn (1955), for instance, did not find that the weather influences the activity and breeding of *M. pensylvanicus* (Ord, 1815), but the same author (1958) demonstrated that weather conditions greatly affected a population of small mammals, in particular their numbers. Wildhagen (1953) describes the influence of climatic conditions on the breeding of rodents in Norway, and also indicates the connection between these phenomena and mass appearances. Steven (1952) also gives certain data on the effect of weather conditions on trapping, while Dehnel (1949), Gentry & Odum (1955), Saint Girons (1957) and many others have emphasised this effect. Saint Girons, gives numerical data on the increase in numbers of small mammals trapped as a consequence of rainfall.

Weather has a distinct influence on the occurrence of mass appearance of rodents. Elton (1942) and Wildhagen (1952) have supplied a large amount of information on this subject. A knowledge of the action of the interdependence between climatic conditions and their effect on the animal population permits of making certain population „forecasts" of considerable economic importance. The part played by climatic conditions on populations of small mammals is emphasised as an important factor by such scientific workers as Naumov (1948; 1955), Ognev (1951) and many others. The influence of climate on the spread and settlement of mammals in Finland was investigated by Kalela (1952).

As will be seen from the above review, although very incomplete, of theriological literature on the influence of climate and meteorological factors on mammal population, all the authors attribute a very great influence to them, which is manifested in the most varied ways. In this work I have analysed only the influence of the weather on numerical results of trapping.

In working out results I took the statistical method as my basis, since the material to which I had access, and which I used in this work, is extremely numerous and the methods by which it was collected make it possible to draw extremely varied comparisons.

The action of the various meteorological factors on different species of mammals depends to a great extent on the type of spontaneous activity peculiar to the animals. This must be kept in mind, particularly when comparing results from different areas distinct from each other, as there is considerable geographical variation in types of spontaneous activity (Kalabuchov, 1940). Field and laboratory studies (Elton, Ford & Baker, 1931; Brown, 1956; Davis, 1933; Hatfield, 1940; Kowalski, 1951; Miller, 1955; Saint Girons, 1957) show that with the majority of species compared in this work [*Clethrionomys glareolus* (Schreber, 1870) and *Apodemus flavicollis* (Melchior 1834)] intensification of, or peak activity takes place in the summer season at dusk, in the night hours or at dawn. For this reason special attention was paid to factors acting during these periods.

II. MATERIAL AND METHODS

The material on which my work is based consists of the results of captures of small forest mammals, carried out by the Mammals Research Institute of the Polish Academy of Sciences, in the Białowieża National Park. Trapping was made by means of permanent capture areas (50 cylinders were set in a grid 5×10 m on a 250 m^2 area). A full description of trapping methods and of the area is given by Borowski & Dehnel (1952). I have compared only the results of trapping by cylinders, in the order to consider material as far as possible uniform, and to avoid differences resulting from the application of different trapping methods, which as we know (Sealander & James, 1958) may considerably influence the numerical and qualitative result of trapping. In this work I have analysed the results of trapping made in 1953, 1954, 1955 and 1957. In order to make it possible to analyse the period during which the greatest number of mammals are caught, and which would be as nearly uniform as possible from the bioclimatic aspect, I took into consideration only the results of captures from three summer months, i. e. June, July and August, which form a characteristic bioclimatic period. .It is for this reason that I did not include May and September, which differ in many respects from the summer months. More animals are caught during the months June—August than at any other time of the year. From the ecological and bioclimatic standpoints, therefore, these three months may be treated jointly, as a sort of whole.

In this work I have dealt only with the influence of meteorological factors on captures of rodents. The influence of weather on captures of insectivores will be the subject of my next publication.

Trapping carried out over a period of four years yielded a total of 2 666 rodents. The animals most frequently encountered were two species: *Clethrionomys glareolus* (Schreber 1780) and *Apodemus flavicollis* (Melchior 1834). They constitutive over 90% of the total number of rodents captured during this period. Both species exhibit the night type of spontaneous activity, this being more distinct in the case of the yellow-necked mouse.

I had the following data available: how many and what kind of mammals were caught in a given day and on what trapping area. In addition I obtained data from the meteorological stations situated in the forest and in open spaces in the Białowieża Botanical Park. I paid most attention to the following factors: rain, falling at various times during the day, insolation and temperature (maximum and minimum). I had no data on the lighting of the forest at night, which is, of course, an important deficiency, but at that time no observations were being made in this line. In my opinion, however, small mammals are guided to a much smaller degree by sight than by smell, touch or hearing.

An undoubtedly important factor, which has on the whole not so far been given sufficient attention in works on ecology, is the bioclimatic cooling. Unfortunately the data calculated regressively dealt only with those days on which the speed of the wind exceeded 1 m./second, and it was therefore impossible to include the part played by this factor in statistical analysis.

In this work I used a certain variant of Olekiewicz's method of III components (1956) applied to the analysis of time series by M. Olekiewicz, and made available to me by the Institute of Statistical Mathematics of he Curie-Skłodowska University in Lublin, in order to be free of the developmental character of the phenomenon.

Our assumption was that over suitably short periods of time, the developmental character of conditions does not undergo any changes so great that they may lead to erroneous conclusions.

The method consisted in the division of a mean square of differences into three components, of which the first represented variation in the general level of components, while the remaining two depend on the specificity of the influence of factors. The mean square is divided by identities on the square of mean differences, the square of differences of standard deviation and the factor depending on co-variation. The last two factors were treated jointly, and this sum represents the variation of individual differences.

We took six features: rainfall — a. m., rainfall — p. m., rainfall — night, minimum and maximum temperature, and insolation. The features were standardised by subtraction of the average for the given feature and division by the variation of this feature.

From the features I made comparisons of the given day with the five preceding days. I did not, of course, exhaust all the possibilities of comparison in this way, as this would be too tedious, and unnecessary for our purposes. The mean sum of squares of differences was calculated for each comparison. Component I gave us the square of mean difference, while the difference of the mean square of differences and of the square of mean difference gave us the sum of the remaining two components (this is a variant of difference). The corresponding components I, and total of II and III were correlated with the increments of numbers of rodents caught in relation to the previous day.

In order to confirm the influence exerted by a long period on captures, I found the mean differences for 6-day periods in relation to the given day, and their variations, separately for each feature. Rainfall was taken without division into time of day, as over the 24-hour cycle the influence of the time of day at which rain fell would in any case be evened out. I examined the correlations of the above averages and variations of each feature with the increases in capture of the given day as compared with the previous day.

The statistical part of the work was done in the Institute of Statistical Mathematics of the Curie-Skłodowska University in Lublin, under the direct supervision of M. Dąbek, M. Sc., to whom I should like here to express my thanks for his invaluable assistance with the statistical work.
I would like at the same time to thank Dr. J. Słomka, the head of the Bioclimatological Laboratory of the Mammals Research Institute for his advice and guidance with the bioclimatological part of my work.

III. ANALYSIS OF THE INFLUENCE OF DIFFERENT METEOROLOGICAL FACTORS

a. Rain.

Borowski & Dehnel considered rain as the most important factor influencing the results of trapping, this influence being very distinctly expressed. Proof of this is supplied by the following figures: over the four-year period of observations, during the months June — August, the days on which rain occurred constitute 43% of the total. During these days on which rain fell, 55.2% of the total number or rodents trapped during the four summer seasons were caught. The average for a rainless day is 5.9 specimens (average of four years), and for one day with rainfall — 10.3 specimens.

Data on rainfall were obtained from the meteorological station and represent the total rainfall for a period of 24 hours, measured at 7 a. m. local time. In addition we have data from 1957 in the form of recordings by the pluviograph placed in the „gap" of the station under canopy, from which we have an exact picture of the course of rainfall within time limits. These recordings show that the amount of rainfall at different times of the day is not uniform, and that it occurs as shown in Diagram 1.

During the 24-hour period we have three peaks of intensity of rainfall. The greatest of these is the afternoon one, while the morning and night peaks are smaller. These data refer to an open space, the situation being slightly different in the interior of a forest (Tomanek, 1958). Part of the water is retained by the treetops, part flows down the trunks and only part reaches the floor of the forest. Tomanek found that only about 60% of the rainfall reaches the floor of a coniferous forest. Słomka (1959) obtained similar data for a *Querceto-Carpinetum* association. In addition, rain falling on a forest is delayed in relation to rain in an open space. The first drops of rain, especially when the fall is light, are almost entirely retained in the treetops, whereas rain which has completely stopped in an open space, is still felt for several hours afterwards in a forest, since drops fall from the leaves and branches, and as may be presumed, these act on the mammals in

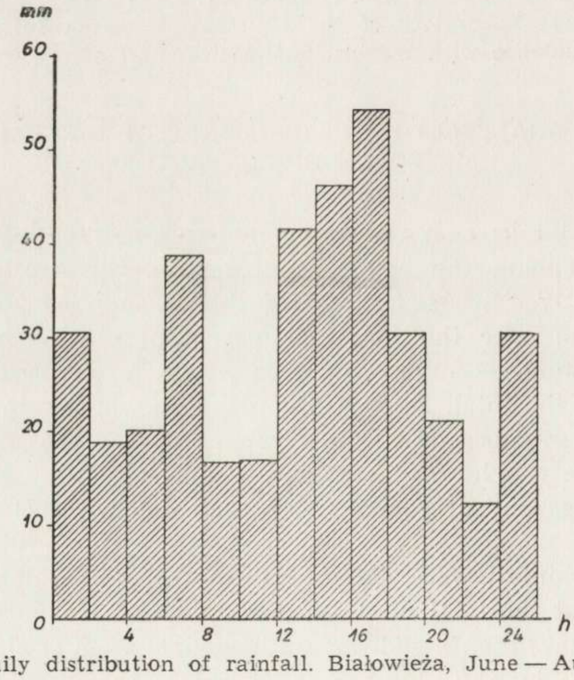

Fig. 1. Daily distribution of rainfall. Białowieża, June — August 1957.

the same way as drops of „normal" rain. The forest litter, also remains wet after rain longer than grass in an open space. Bearing this in mind, we see that the afternoon and evening rainfall peak occurs, if we accept the „shift" in time, during the peak periods of activity of different mammals. In my opinion this is of considerable biological importance, and may basically affect the possibilities of the insectivorous mammals finding food, both in this way and also by the formation of changing thermal conditions (evaporation, cooling).

The question arises here as to whether each rainfall, irrespective of intensity, causes a uniform increase in captures. The answer is provided by Table 1, from which it will be seen that captures increase with the increase in rainfall over a 24-hour period. I imagine that the degree of humidity of the substratum has a greater influence on the rodents, as they are, in general, phytophagous, and it would be difficult to explain this, as in case of insectivores, by difficulty in finding food during and after rain. It is possible that the fact is of significance here that the paths on which the cylinders are placed, are relatively drier than the litter and ground vegetation in the forest. Unfortunately we know only the effect of rainfall — i. e. increase in the number of mammals captured after rain, but the explanation for this is hypothesis only.

Table 1.

Influence of the intensity of rainfall on the numerical results of trapping.

rainfall /in mm/	1953	1954	1955	1957	average per 1 day
0.1 - 5.0	16.5	4.8	14.5	2.4	8.5
5.1 -10.0	22.2	8.5	32.4	1.7	15.2
over 10.0	32.2	11.7	13.0	4.2	15.8

Table 2.

Dependence between trapping and the time of rainfall.

time of rainfall	AM	PM	N	AM - PM	PM - N	AM - PM	AM-PM-N
result of trapping	6.9	7.5	9.3	7.3	13.9	10.0	10.4

A further problem is the dependence of capture on the time of rainfall. Table 2 shows that rain falling at different times fo the day produces different trapping results, the most effective day being the one on which rain falls in the afternoon and at night. Rain falling during the morning exerts the least influence. The connection between the time of occurrence of rain and increase in captures is the result of the activity system of the animals during the 24-hour period, in particular of *Clethrionomys glareolus*, which forms the majority of the rodents captured by cylinder. This species has the day-night type of activity. According to M i ller (1955) during a 16-hour day, that is, in conditions similar to those prevailing in Poland during the summer, 51.4% of activity occurs during the hours of daytime. i. e. activity during the night is twice as great as during the day (almost half the activity occurs during the eight hours of night). The same author states that with *Apodemus sylvaticus,* under the same conditions, only 28.1% of activity occurs during the daytime hours. Ostermann (1956) states that the greater part of the activity of *Apodemus flavicollis* occurs during the night hours in the summer. These relations of course change depending on the length of day, reaching (Miller, 1955) during an 8-hour day (winter) 28.0% and 10.9% for *Clethrionomys* and *Apodemus* respectively. These data refer to English conditions (Oxford) and we may therefore treat them as a guide only. Data for Białowieża will be published shortly (Buchalczyk, T., 1960). In Poland Kowalski (1951) found that 63% of the activity of *Clethrionomys* occurred during the night hours. The question of the 24-hour system of activity of our mammals is an open one and requires investigation.

From the table of correlations between increases in captures and totals of rainfall for five days (Table 3) we can see the distinct positive connection between increase in rainfall and increase in captures. This leads to the conclusion that not only rain falling the previous day, but over a certain period of time, affects the increase in numbers of animals captured.

The above data make it clear that rain (or probably rather the changes caused by it in the microclimatic conditions of the habitat) affects the numerical results of trapping.

b. Insolation.

Insolation (time during which the sun shines) is an important element in climatology, since the course followed by other meteorological factors are bound up with it, and it has many characteristic consequences. When the day is sunny there is, in general, considerable amplitude of temperature during the 24-hour period. During the day we have a small degree of relative atmospheric humidity, while dew falls during the night. Reversely, on a cloudy day without sun, the amplitude of temperature and humidity is small, humidity greater, the characteristic evening and morning „jump" in humidity is absent. The differences occurring between a sunny and cloudy day follow a similar course both in the forest and in an open space, but are smaller in the former.

The connection between insolation and captures of rodents occurs only if we correlate the total captures with the variation of insolation; the correlation then is markedly negative. When, however, we take insolation for five days and compare it with increments of captures, no connection can be seen. The above data show that only variations in insolation distinctly affect captures. I imagine that the degree of insolation does not act directly on the small forest mammals, but rather acts in an indirect way by causing changes in the moisture of the ground vegetation and forest litter, and changes in atmospheric humidity content. It must be remembered that in the majority of cases trapping was carried

Table 3.

Correlation table of the rainfall and trapping increments.

Increments of the rainfall /5 day's sum/ \ Increments of trapping during the five days	-150 – -120	-120 – -90	-90 – -60	-60 – -30	-30 – 0	0 – 30	30 – 60	60 – 90	90 – 120	120 – 150	150 – 180	180 – 210	210 – 240	240 – 270
-180 – -120			2		2									1
-120 – -60		3	2	1				1						
-60 – 0	1		1	15	15	6	2		1	1				
0 – 60				1	10	7	2							
60 – 120				1	1	1	1		1				1	
120 – 180									1					
180 – 240						1								
240 – 300				1										
300 – 360													1	
360 – 420														
420 – 480							1							1

out chiefly in *Querceto-Carpinetum* and *Fraxineto-Piceeto-Alnetum* associations, which in the conditions of the Białowieża Forest are far more shaded on account of the thick undergrowth, so that the rays of the sun penetrate to the floor of the forest to a much lesser degree than in a cultivated forest. The specific character of conditions in the Forest is here most certainly of great significance. On the other hand insolation acts on the mammals rather by its variability, that is by uniform sequences of types of weather — for instance, a sequence of sunny days or sequence of days with considerable cloudiness increases the number of captures, while they decrease when the weather is variable. The influence of longer sections of time with the given type of weather has considerable influence on captures, as is clear in the following part of this work. This is partly in accordance with the opinion expressed by Borowski & Dehnel, who observed that captures are smaller on sunny days. In addition, as we stated above, the forest rodents covered by these investigations have a nocturnal form of spontaneous activity, which is probably reflected in the result obtained, establishing the lack of connection between insolation and captures. The result establishing a connection between capture and variation of insolation may more probably be explained by the occurrence, in the event of considerable variation, of sequences of rainy weather, on which as we know captures depend to a greater extent than on periods of sunny weather.

c. Temperature.

One of the most important factors affecting the activity of mammals, in addition to food and light, is temperature. Of course, taking into consideration only the conditions prevailing during the summer period, the part played by temperature is not so distinct as it is over the whole yearly cycle. Nevertheless under summer conditions, certain optimum temperatures may be distinguished, during which the activity of mammals, expressed in the numbers captured, is greatest.

In this work I have taken minimum and maximum temperature during the 24-hour period into consideration. The first is characteristic of the night and the second of the day, and by this means we can determine to a certain extent the conditions prevailing over a 24-hour period.

From table 4 and 5 it will be seen that certain temperature conditions exist during which the captures of rodents are greatest. For minimum temperatures these lie within the limits of 13.1—16.0°C, and for maximum temperature between 24.1—27.0° C. Percentages of total captures during the summer, made when the given conditions prevailed, are given in tables. In order to ensure that rain, which as we have previously established, exerts an enormous influence on captures, did not distort the result obtained, only rainless days are included in the tables.

In working out the material by the statistical method, the relatively great influence of minimum temperature on capture is revealed (coefficient of correlation $r = 0.23$). On the other hand, the maximum temperature does not exhibit any influence on increase in captures (coefficient of correlation r = 0.14, which is a random value). It is interesting to note that the influence of maximum temperature makes itself evident only during the course of a lengthier period. If we compare the increase in captures with the maximum temperature of the previous day, this dependence is fairly great, and the coefficient of correlation is 0,32. We can find an explanation of this fact if we again revert to our knowledge of the biology of forest rodents. It is quite understandable that forest animals with, on the whole, a nocturnal type of activity

Table 4.

Influence of the minimal temperature on the numerical results of trapping.

year / min. temp.	1953	1954	1955	1957	avg.
4.1 - 7.0°C	1.40	1.48	2.23	1.61	3.37
7.1 - 10.0°C	1.28	1.42	2.00	1.72	3.87
10.1 - 13.0°C	2.25	2.39	1.95	2.19	6.09
13.1 - 16.0°C	2.23	2.24	2.20	4.21	6.25
16.1 - 19.0°C	0.92	2.07	2.08	2.59	3.16

Table 5.

Influence of maximal temperature on the numerical results of trapping.

year / max. temp.	1953	1954	1955	1957	avg.
below 18°C	-	-	3.41	2.35	3.24
18.1 - 21.0°C	2.51	1.96	1.70	3.40	4.74
21.1 - 24.0°C	1.62	1.56	2.23	2.28	4.97
24.1 - 27.0°C	2.24	2.26	1.92	1.88	6.57
over 27.1°C	1.27	2.42	1.94	-	4.65

are not directly affected by the temperature at noon to the extent that they are by night temperatures, but over a certain period of time the maximum temperature affecting the general level of weather factors may undoubtedly influence the number of mammals caught during this period. The influence exerted by maximum temperature is, however, indirect.

d. Cooling.

For warmblooded animals conditions in which loss of heat occurs are more important than the temperature of their surroundings.

In order to obtain an objective measurement of loss of heat, the idea of cooling was introduced into climatology. The measure of cooling is the amount of heat lost by a unit of area (1 cm^2) of a standard body at a constant temperature (usually 36.5° C) in a unit of time (second). Cooling may be measured by the use of instruments or established by means of empirical formulae. The second method has been used in this work, and cooling calculated by means of Hill's formula (Stone, 1943). The air temperature and wind speed, obtained by observations on the climatological station at Białowieża, were applied to this formula. Cooling calculated in this way refers to conditions prevailing in an „open space" and differs greatly from conditions prevailing in the forest. Słomka (1958) showed, however, that there is a constant dependence which can be defined, between cooling in an open space and cooling in a forest. Such corrected values of cooling are given in Table 6. For reasons given at the beginning of this work, the data

Table 6.

Influence of cooling on the numerical results of trapping.

cooling	below 10.0	10.1–15.0	15.1–20.0	20.1–25.0	over 25.1
per cent of trapping results	4.7	23.5	36.9	15.7	19.2

obtained could not be analysed statistically. For the same reason, the results obtained as to the influence of cooling on the results of trapping are for guidance only, and are not complete. It is, however, clear from them that certain optimum cooling conditions exist, during which captures are greatest. This is a matter, hawever, requiring further investigation.

IV. INFLUENCE OF SETS OF WEATHER CONDITIONS ON NUMERICAL RESULTS OF TRAPPING

As will be seen from the above data, the various meteorological factors affect captures, but only a whole set of such factors, not isolated ones.

Olekiewicz's method of three components was used here to describe each day defined by six factors, mentioned above. I correlated the first component — the square of mean difference — representing a variation in the general level of components and the sum of II and III component, which depends on the specificity of the influence exerted by factors — with increments of the numbers of rodents. trapped in relation to the previous day. Increments of the mean difference were correlated with the increments of captures for the following six days. From these comparisons it will be seen that factors defining the weather play a secondary role in relation to the general level of these factors. The coefficient of the correlation between the general level of increments of factors and variation in capture is considerably greater than for individual factors ($r = 0.36$ when $r = 0.28$ for insolation and 0.23 for minimum temperature). In the same day of capture great differentiation occurred in the action of different factors. The maximum temperature did reveal any influence, while the minimum temperature has a fairly considerable influence. Of course each rainfall markedly increases captures.

As comparisons are made with the six preceding days, so the coefficient of correlation increases. For the difference in factors in relation to the previous day it is 0.36, for two days before $r = 0,53$, for three days before $r = 0,51$ and for four days before as much as 0,72. Further on correlation decreases (for 5 days before $r = 0,54$). The conclusion is therefore reached that trapping of forest rodents under the conditions in the Białowieża National Park depends on the behaviour of weather over a longer period of time. The variation of different factors does not, on the other hand, affect captures (with the exception of insolation).

Comparing variation of differences, which is the means of measuring the degree of specificity of the action of factors, capture depends in this variation only for comparison of one day before, while the remaining days do not exhibit differentiation of influence. χ^2 for comparison of one day before is 2.74, for two days before 1.16 and for three days before 0,05. The consequence is the influence of maximum temperature for comparison of two days before, which did not take place in the case of comparison with one day before.

The results obtained in this work, owing to the use of the statistical method, make it possible to define the connection existing between variations in weather, i. e. all meteorological components which combine to form what is meant by this term, and its influence on the activity of forest rodents, which is expressed in numbers of animals captured.

It appears that the absolute level of different elements of the weather is not of such significance to animals, as the general level of these factors. Weather does not affect the activity of rodents directly from day to day. Rain does, of course, cause great jumps in the number of animals caught, but in general the weather over a certain period of several days is the important factor. The animals react by a change in their activity to all variations in the general level of these factors. Changes in the weather exert a greater influence on rodents than on insectivores (Sidorowicz, in preparation). It is difficult to find an explanation of this phenomenon. It is possible that differences in physiological structure between rodents and insectivores play a part here.

V. AN ATTEMPT AT CLASSIFYING "TYPES OF WEATHER" OF IMPORTANCE IN CAPTURES OF FOREST *MICROMAMMALIA*

Up to the present there has been no universal method of classifying „types of weather" for ecological purposes, in this case for the ecology of mammals. The classifications of types of weather used by climatologists are of a more general character, and we do not yet know to what extent they may be of use to the ecology of mammals, since they refer chiefly to the macro-climate. In addition, the data supplied by normal meteorological stations are not fully sufficient for the purposes of mammal ecology.

As will be seen from the data given previously, a whole set of factors determining the weather acts on the activity of small mammals. For this reason I assume that it is of greater use to examine the whole set of factors and their influence, than the action of individual factors. It is only possible to change one factor at will, and maintain the remainder on a constant level under laboratory conditions in a climatising chamber. Under field conditions, however, the action of one factor is closely connected with the remainder.

My attempt at classifying „types of weather", which may prove of use in research work on the ecology of forest *Micromammalia*, refers to the summer period, i. e. June, July and August. As the majority of small forest mammals have a more or less nocturnal type of spontaneous activity, I took as my basis a very much simplified description of conditions prevailing during the summer night. Using the analysis made previously of the influence of meteorological factors on the activity of small mammals, three main elements characterising night may be distinguished — rainfall, minimum temperature and humidity — occurrence or absence of dew. From the above three factors I drew up six combinations characterising different types of weather during a summer night (the two remaining combinations do not occur in reality) — Table 7.

R a i n f a l l. I took data on rainfall from the monthly meteorological reports and from pluviograms, supplied by the base climatological station at Białowieża.

Minimum temperature. I accepted the average minimum temperature for a month as the limit for the division into „low" or „high" temperatures. This division is, of course, an agreed one only, but at the present time we have no biological criteria making it possible to accept any other division.

Humidity. As a criterion of humidity I accepted the state of atmospheric saturation by water vapour, i. e. dewpoint. I obtained the necessary data from the hygrograms supplied by the forest station at a height of 20 cm. above ground level, and in

Table 7.
„Type of weather".

factor \ type	A	B	C	D	E	F
dew	+	+	–	+	+	–
rainfall	–	+	–	–	+	–
temperature	+	+	+	–	–	–

Explanations:
Dew + = appeard; – = lack of dew.
Rainfall + = appeared; – = lack of rain.
Temperature + = higher than mean minimal remperature of month.
Temperature – = lower than minimal temperature of month.

Table 8.
Frequency of the occurrence of „types of weather" in Białowieża (June, July and August).

year \ type of weather	A	B	D	E	C + F
1953	26.1	27.2	31.5	13.0	2.2
1954	25.0	29.3	30.4	13.0	2.2
1955	21.5	21.5	37.9	11.4	7.6
1957	18.1	27.7	30.1	21.7	2.4
average	22.8	26.6	32.4	14.7	3.5

1957 from the climatological station of the Mammals Research Institute of the Polish Academy of Sciences. The self-recorder draws a straight line on the stripes of the hygrograms when a state of atmospheric saturation occurs (when dew or rain falls).

The frequency of occurrence of the different types of weather in a four-year period from 1953—1955 is given in table 8. From this table we can see that only a small percentage (average 3.5%)

of the nights were dewless (types C and F). Similarly rain fell in only 15% of the nights in type E, during which the temperature was lower than the average temperature for the month. The type relatively most frequently occurring was type D, characterised by the occurrence of dew, low temperature and a lack of rainfall, but the nights most characteristic of summer in the Białowieża National Park are warm and damp (type A), during which rain frequently falls (type B).

If we draw up a table showing what percentage of the whole captures of rodents in cylinders occurs on one day in a given type of weather (Table 9), we obtain results in complete agreement with the empirical data of Borowski & Dehnel, and with the result of an analysis of the effect of different meteorological factors on captures of *Micromammalia*.

Table 9.
Per cent of the whole trapping results of Rodents in June — August, in given „type of weather" (for one day).

year	no. of specimens caught	Type of weather				
		A	B	D	E	C and F
1953	1117	0.90	2.18	0.41	0.98	0.23
1954	402	0.83	1.65	0.73	1.18	0.88
1955	961	1.04	1.79	1.23	1.19	0.71
1957	186	1.43	1.59	0.92	0.93	1.07
average		1.05	1.80	0.82	1.07	0.72

The greatest number of captures is made with type B, which is characterised by rainfall, high temperature and high humidity content. Similarly in type E, in which rainfall also occurs, an increase in captures takes place. The smallest number of mammals is caught with type D — low temperature, no rainfall. The data on types C and F are uncertain on account of the small number of cases. It would seem that fewer mammals are caught during these types of weather (dry nights, no rainfall or dew).

The above results show that the „types of weather" method holds out the prospect of interesting results when applied to research on the ecology of small mammals, but they do, however, need checking by work on other areas. This is, of course, an attempt only, based on results of captures in the Białowieża National Park, which possesses its own clearly distinguishable special character. This method may, however, on account of its simplicity, be convenient for use in work on the ecology of *Micromammalia*.

VI. CONCLUSIONS

1. The views expressed by Borowski & Dehnel (1952) on the influence of meteorological factors on captures of *Micromammalia* are fully confirmed in this work. The author shows, on the basis of a statistical analysis of results of trapping by cylinders carried out in the Białowieża National Park from 1953—1955, and in 1957, the influence of rain, insolation, minimum temperature and cooling on the numbers of animals caught.

2. The factor most strongly acting on the activity of forest rodents is rain. It causes an increase in numbers of animals captured, which rise with an increase in the intensity of rainfall. The most effective is rain falling throughout a 24-hour period, in the afternoon and night, and in the night. Like Borowski & Dehnel, the author accepts as the mechanics of the activating action of rain the effect it causes by damping the forest litter and ground vegetation.

3. Statistical analysis reveals the great influence exerted by minimum temperature on captures, while maximum temperature does not reveal that it has any effect. The activity of rodents, expressed in numbers captured, is greatest within limits of 13.1—16.0° C. (minimum temperature) and 24.1—27.0° C. (maximum temperature).

4. Using Olekiewicz's 3-component method (1956), it was found that captures of forest rodents under the conditions prevailing in the Białowieża National Park depend on the course of the weather over a fairly lengthy period. Factors defining the weather play a secondary part in relation to the general level of these factors. Variations in insolation markedly affect the numbers captured, but variation in other meteorological factors does not affect this. The dependence between the general level of variation of factors and variation in captures increases as the intervals between day of capture and day under consideration increase. For instance the coefficient of correlation for difference between factors in relation to the previous day is 0.36, for increments of capture

for two days before r = 0.53, for three days before r = 0.51, for four days before r = 0.72. This dependence decreases in the following days.

5. The author distinguished six ,,types of weather" which describe the conditions prevailing during summer nights. These conditions would appear to be the most significant to the activity of small forest mammals, possessing a more or less nocturnal type of spontaneous activity. By applying these ,,types of weather" the author obtained results in agreement with results of field observations.

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STRESZCZENIE

W pracy niniejszej w całości potwierdzono poglądy Borowskiego i Dehnela (1952), dotyczące wpływu czynników meteorologicznych na odłowy *Micromammalia*. Autor na podstawie statystycznej analizy wyników odłowów w cylindry prowadzonych w latach 1953—55 i 1957 na terenie Białowieskiego Parku Narodowego, wykazał liczbowo wpływ deszczu, usłonecznienia, temperatury minimalnej i ochładzania na odłowy. Najsilniej działa na wynik odłowu deszcz. Z analizy statystycznej wynika dość duży wpływ temperatury minimalnej na odłowy. Temperatura maksymalna nie wykazuje wpływu. Stosując metodę trzech składników Olekiewicza (1956), stwierdzono, iż odłów leśnych gryzoni w warunkach Białowieskiego Parku Narodowego zależy od zachowania się pogody w ciągu dłuższego od-

cinka czasu. Czynniki określające pogodę grają drugorzędną rolę w stosunku do ogólnego poziomu tych czynników. Na odłów wpływa tylko zmienność usłonecznienia, natomiast nie wpływa na niego zmienność innych czynników meteorologicznych. Zależność pomiędzy ogólnym poziomem zmiany czynników a zmianą odłowu rośnie w miarę wzrostu odstępu czasu między dniem odłowu a rozważanym dniem. Obserwuje się to na pięciodniowych odcinkach czasu. W pracy tej autor wyróżnił 6 „typów pogody" mogących scharakteryzować warunki panujące w czasie nocy letnich. Warunki te wydają się być najbardziej istotne dla aktywności drobnych ssaków leśnych, które mają raczej nocny typ aktywności dobowej. Przy zastosowaniu tych „typów pogody" autor otrzymał wyniki zgodne z danymi z obserwacji terenowych.

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