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Ewa Teresa MYSTKOWSKA & Jerzy SIDOROWICZ

Influence of the Weather on Captures of *Micromammalia*. II. *Insectivora*

Wpływ pogody na odłowy *Micromammalia*. II. *Insectivora*

[with 7 tables]

I. INTRODUCTION

This paper is a continuation of the work by Sidorowicz (1960) on the influence, investigated by statistical methods, of weather on captures. The author in his work confirmed the views held by Borowski & Dehnel (1952) on the influence of weather on captures, analysing the results obtained by trapping rodents in 1953, 1954, 1955 and 1957 in the Białowieża National Park.

Borowski & Dehnel found that climatic conditions exert a considerable influence on captures, an influence so great that it not infrequently masks variations in population numbers. In the summer a fundamental factor is the kind and amount of rainfall, and in the winter fluctuations in temperature. Rainfall affects captures not only on account of the amount and kind of rain, but also the time at which rainfall occurs is of importance.

It must be mentioned that the question of the effect of weather on captures has not been dealt with extensively in literature. A review of this literature and also a description of methods are given in Part I (Rodents) of this work.

The present paper is based on an analysis of results of captures of *Soricidae* made by the Mammals Research Institute in the Białowieża National Park from 1953—55 and in 1957, in June, July and August. Shrews were caught in metal cylinders placed in the permanent capture areas. A total of 3869 specimens was caught, belonging to the species *Sorex araneus* Linnaeus, 1758, *Sorex minutus* Linnaeus, 1766 and *Sorex caecutiens* Laxmann, 1788. On account of the great similarity in the biology of these species they were considered jointly for purposes of analysis.

We should like to take this opportunity of expressing our thanks to Professor Dr A. Dehnel for his most valuable advice and suggestions which he so freely gave us during the preparation of this work.

II. EFFECT OF DIFFERENT METEOROLOGICAL FACTORS ON CAPTURES

a. Rain

Over a period of four summer seasons (June — August) the percentage of days without rain was 57%. 44.6% of the shrews were caught during these days, while 55.4% of the captures as a whole were made on rainy days, which constituted 43% of the whole period. The average number for one rainy day is about 13.6 specimens, and for days without rain only 8.2, that is, rain causes an almost double increase in the number of animals captured, which is in agreement with the data obtained by Sidorowicz (1958) for rodents (respectively 10.3 and 5.9). This is somewhat astonishing, since insectivores and rodents not only form groups systematically distant from each, but are also characterised by completely separate biology.

It would therefore seem that we have grounds for accepting that rain is a „capture regulator" acting through the changes taking place in the micro-climate of the floor of the forest on the *Micromammalia* fauna.

The differences between insectivores and rodents do not become apparent until analysis is made of the time of occurrence of rainfall. In the first part of the work a description is given of the diurnal distribution of rainfall under the conditions obtaining in the Białowieża Forest and the mechanics of the action of rain, which is as it were „delayed" in its effect on the floor of the forest. This time shift is due to the partial retention of the rain in the treetops.

Significant ecological differences between rodents and the shrews of the genus *Sorex* forming the subject of this work spring

from the differences in their diurnal activity. These differences of course result from their different physiological structure. There is a great deal of literature devoted to this problem (Crowcroft, 1954; 1957; Tupikova, 1957) and many others. Shrews are in general active through the whole of the twenty-four hours, their activity being slightly greater from dusk to dawn. There is not, however, so distinct a division here as there is in the case of *Apodemus flavicollis* (Melchior, 1834), or *Clethrionomys glareolus* (Schreber, 1870), where we have a typical example of nocturnal activity. The diurnal activity of shrews is shaped by their very rapid metabolism. To put it simply, it may be said that they are constantly active in search of food. As this consists during the summer period chiefly of invertebrates (insects), which take shelter during rain, the data contained in table 1 can be explained in this way as showing how rain affects captures with

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	18.0	18.3	14.3	5.1	13.4
5.1 - 10.0	19.0	23.3	16.0	5.8	17.3
over 10.1	29.4	29.7	14.9	8.2	19.4

varying degrees of intensity. This was the explanation put forward by Borowski & Dehnel. The differences are very distinct here. These authors considered that the increase in numbers captured was due to rainfall, that it is connected with the activity of insects during this time — when rain falls the insects take shelter and are therefore more difficult for the shrews to find. The heavier the rain (or the longer it lasts) the more difficult it becomes for the shrews to find food, and when they run along the paths within the capture area, the chances of their falling into the cylinders are greater.

It would be possible to agree fully with the above explanation if rain increased the captures of shrews only. The work by Sidorowicz (1960), however, also establishes that rain increases the captures of rodents, which are herbivorous, in exactly the same way. We are therefore of the opinion that the chain of

consequences — rainfall — search for shelter by insects —activity of the shrews increases — increase in numbers captured — is of secondary importance.

The time of occurrence of rainfall is connected with captures in the same way as in the case of rodents. The greatest change in numbers is caused by rain falling continuously throughout the whole period of 24 hours, or throughout the afternoon and at night. This confirms our assumption that rain is a „capture regulator".

Table 2.

Connection between trapping and the time of rainfall.

Time of rainfall	AM	PM	N	AM - PM	PM - N	AM - N	AM - PM - N
Result of trapping	12.3	10.1	13.3	11.4	19.1	14.5	19.4

Table 3.

Correlation table of the rainfall and trapping increments.

Increments of rainfall /5 day s sum/	Increments of trapping during five days								
	-90	-60	-30	0	30	60	90	120	150
-180			4	1					
-120		1	3	3					
- 60		1	11	13	13	3			1
0			5	6	4	3	1	1	
60				1	2	2	1		
120				1					1
180						1			
240				1					
300							1		
360					1			1	
420									

When analysing the connection between the increase in numbers captured and rainfall over a period of five days it is clear that here there is a distinct, positive dependence, the coefficient of correlation being 0.36. It is also clear that the result of capture is affected not only by rain falling the previous day, but also by rain falling over a certain period of time. This is in agreement with the results obtained for rodents and confirms the observations of Borowski & Dehnel (1952).

b. Insolation.

The problem of insolation and its influence on the micro-climatic conditions in the habitat was fairly extensively discussed in the first part of this work. As in the case of rodents, no connection was found between insolation and captures of shrews. There is, however, distinct negative relation between variance of insolation and increases in captures. The coefficient of correlation here is 0.31.

An explanation of this fact can be found, as in the case of rodents, not in the direct action of the degree of insolation on the shrews, but in the changes thus brought about in the moisture of the ground vegetation and litter, and in the changes in the moisture content of the atmosphere. At the same time it must be borne in mind that captures were carried out in the very specific conditions prevailing in the Białowieża Forest, which on account of the great amount of shadow and dense undergrowth differ fundamentally from the conditions found in cultivated forests. Also the biotopes in which captures were chiefly made (*Querceto-Carpinetum* and *Fraxineto-Piceeto-Alnetum*, acc. to Matuszkiewicz 1952) are among the most shady in the forest. On this account sunny intervals affect captures to a greater extent by their occurrence during a very changeable period of rainy days, on which as we know captures depend, than do sequences of sunny days during which Borowski & Dehnel observed lesser numbers of animals to be captured.

c. Temperature.

Temperature is one of the most important factors stimulating the activity of small mammals. In our case, taking into consideration the summer period, the most important of these are the minimum and maximum temperatures, which to a certain extent define the micro-climatic conditions prevailing during the 24 hours. From tables 4 and 5 it will be seen that the activity of the shrews, expressed in the numbers captured, is greatest in certain ranges of temperature. These temperatures are 13.1 — 16.0 for minimum and over 27.1 for maximum. The increase in the activity of shrews with the increase in maximum temperature is very marked and differs from analogical comparisons for rodents. The minimum

temperature, has, however, a uniform effect on the activity of rodents and shrews, i.e., they are most active in the same thermal conditions. It must be added here that we took into consideration only rainless days, in order to obtain material as far as possible uniform, the results of which would not be obscured by the action of rain.

Table 4.

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

Temperature	1953	1954	1955	1957	Average
4.1 - 7.0°C	1.58	1.11	2.04	1.68	3.25
7.1 - 10.0°C	1.39	2.07	2.16	2.79	4.82
10.1 - 13.0°C	1.96	1.56	2.12	1.73	4.97
13.1 - 16.0°C	2.20	2.60	1.91	2.24	6.16
16.1 - 19.0°C	2.38	1.99	-	2.93	4.98

Table 5.

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

Temperature	1953	1954	1955	1957	Average
below 18.0°C	-	-	1.87	2.19	2.61
18.1 - 21.0°C	1.27	1.66	2.53	2.62	4.58
21.1 - 24.0°C	1.90	1.69	2.14	2.49	5.02
24.1 - 27.0°C	2.10	2.96	1.89	1.91	5.93
over 27.1°C	2.29	1.96	1.69	2.53	5.94

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	5.3	37.9	31.8	15.5	9.5

When working on the material from the statistical point of view we found that minimum temperature affects captures (coefficient of correlation r = 0.24), while maximum temperature did not appear to do so (r = 0.16 and is a random value).

We can see here complete analogy with the data obtained by Sidorowicz in regard to rodents (respectively 0.23 and 0.14).

This is evidence of the similar reaction of rodents and shrews to the temperature conditions in the habitat. Maximum temperature does not, however, exert so great an influence on captures of shrews as it does with rodents. When we compare increases in captures with the maximum temperature of the previous day, the coefficient of correlation is 0.21. This is evidence not of the direct influence of maximum temperature on captures, but of the influence of the general state of the weather on the activity of shrews. The corresponding figure for rodents is — r = 0.32. The explanation of this fact can be found in the different type of diurnal activity of rodents and shrews.

d. Cooling.

This important bioclimatological factor has so far been almost entirely omitted in investigations of the ecology of mammals. In the first part of this work Sidorowicz included certain data on the effect of cooling on captures of rodents.

Data on shrews are also incomplete (table 6), but indicate that the activity of shrews, expressed in the numbers captured, is greatest under certain cooling conditions. These are, however, only preliminary data and require further investigation, but even so they show, as in the case of temperature, that there are certain optimum conditions for shrews, different from those for rodents.

III. THE INFLUENCE OF COMBINATIONS OF WEATHER CONDITIONS ON THE NUMERICAL RESULTS OF CAPTURES

From the data given above it appears that a whole set of meteorological factors affects the numbers of animals caught. In order to make it possible to analyse the whole set of these factors, we used the statistical method of three components used by Olekiewicz (1956). This method is described in Part I of this work. The three components described each day by means of six factors — rainfall a. m., rainfall p.m., rainfall night, maximum and minimum temperature and insolation.

We correlated component I, illustrating the variance of the general level of components and the total of II and III, depending on the specificity of the effect of the factors, with increases in the numbers of shrews captured, in relation to the previous day.

Our calculations showed that capture depends chiefly on the general level of the factors and not on separate factors, which in this case play a secondary role. Only rain produces an intensive increase in numbers captured.

When comparing increases in captures with the six previous days we found that the coefficient of correlation increases in a similar way to that in the case of rodents, the further back in time the comparison is made, that is, it depends on the weather over longer periods of time. On the other hand the variability of factors does not affect captures (with the exception of insolation). The increase in the coefficient of correlation is not, however, so great as in the case of rodents. For comparison of two days earlier it is 0.48, three days earlier 0.52, four and five days earlier 0.50. On the sixth day it falls sharply to 0.34.

Table 7.

Per cent of the whole trapping results of Shrews 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	1297	0.96	1.57	0.66	1.43	0.74
1954	1307	0.85	1.85	0.68	0.89	0.51
1955	866	0.93	1.77	1.14	1.68	0.83
1957	399	1.07	1.54	0.88	1.18	0.61
Total	3869	0.95	1.68	0.88	1.30	0.67

By applying the statistical method we were able to establish that there is a close connection between the variations in weather, that is, in the set of meteorological factors forming what is termed weather, and the activity of shrews expressed in the number of specimens caught.

Weather affects captures not directly from day to day, but through the change in the general level represented by all the factors. Shrews, similarly to forest rodents, react by a change in their activity to the variations in the general level of these factors, but to a lesser degree than rodents. This is probably caused by the differences in their physiological structure.

IV. CAPTURE OF SHREWS DEPENDING ON THE TYPE OF WEATHER

Sidorowicz (1960) drew up a new classification of types of weather, used in connection with captures of *Micromammalia*. It consists in the differentiation of six types of weather, depending on occurrence of rainfall on a given day, the degree of atmospheric moisture content and minimum temperature, higher or lower than the mean minimum temperature in the month. Types B and E are rainy days, the remainder without rainfall.

As can be seen from table 7, the majority of the shrews were caught on days on which rain fell, which is in complete agreement with the data obtained by Borowski & Dehnel. It also agrees with the data obtained by Sidorowicz for rodents. This is the more interesting in that it concerns representatives of two orders, living in the same habitats but having completely different biology.

This method, which is very practical, would appear to be useful for application to the field ecology of Micromammalia.

V. SUMMARY

The work confirmed the conclusions reached by Borowski & Dehnel (1952) as to the influence of weather on the numbers of shrews captured under the conditions prevailing in the Białowieża National Park. The authors, on the basis of a statistical analysis of results of captures of shrews (n=3869) in 1953—55 and 1957, showed how rain, insolation, temperature and cooling affected the numbers of animals captured. Rain in particular strongly affects captures, the heavier the rain, the greater the effect. There are certain optimum temperatures for shrews at which their activity is greatest. Under the conditions in the Białowieża Forest these temperatures are 13.1—16.0 and over 27.1 for minimum and maximum temperatures.

The activity of shrews depends on the behaviour of the weather over a longer period of time. Capture depends on the general level of factors as a whole, single factors playing only a secondary role. Variations in factors do not exert such an influence on captures (with the exception of insolation).

When comparing the effect of weather on captures of rodents and shrews it was found that there is a great degree of similarity in the reaction of these two groups of mammals to variations in bioclimatic conditions. The relation described by Borowski & Dehnel (1952) between the activity of shrews and that of insects is of no decisive significance to the numbers of animals obtained by capture.

Polish Academy of Sciences,
Mammals Research Institute
at Białowieża

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STRESZCZENIE

Praca potwierdza wnioski Borowskiego i Dehnela (1952) co do wpływu pogody na odłowy ryjówek w warunkach Białowieskiego Parku Narodowego. Na podstawie analizy statystycznej odłowów ryjówek (n = 3869) w latach 1953—55 i 1957 wykazano wpływ deszczu, usłonecznienia, temperatury i ochładzania na ilość złowionych ssaków.

Wzrost odłowu uzależniony jest szczególnie silnie od deszczu, którego działanie wzrasta wraz z jego intensywnością. (Tabele 1—3). Ryjówki posiadają pewne temperatury optymalne, w których ich aktywność jest największa. W warunkach Puszczy Białowieskiej takimi temperaturami są 13,1—16,0 i powyżej 27,1° C, odpowiednio, dla temperatur minimalnej i maksymalnej (Tabele 4—5).

Aktywność ryjówek zależy od stanu pogody w ciągu dłuższego czasu. Na wielkość odłowu działa głównie ogólny poziom czynników, przy czym poszczególne elementy odgrywają drugorzędną rolę. Z wyjątkiem usłonecznienia zmienność innych czynników nie posiada takiego wpływu na odłów ryjówek. (Tabela 7).

Porównując wpływ pogody na odłowy gryzoni i ryjówek, stwierdzono istnienie dużego podobieństwa w reakcji tych dwóch grup ssaków na zmiany warunków bioklimatycznych. Opisana przez Borowskiego i Dehnela zależność pomiędzy aktywnością ryjówek i owadów nie ma decydującego znaczenia dla kształtowania się liczebności odłowów.

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