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Nests of Small Terricolous Mammals as the Environment of Nidicolous Ectoparasites*)

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Abstract. The paper gives a survey of results obtained during ecological studies of nest ectoparasites (Gamasoidea) of small terricolous mammals in forest biotopes of Czechoslovakia. The ten-year studies were accomplished in two directions: 1. faunistic analysis of members of the nest biocenoses, their classification according to hosts and environment relationship, 2. studies on the character of nest microclimate, of its changes and influence upon the development of nidicolous ectoparasites in long-lasting field experiments. The studies were focused to epidemiological aspects of natural foci infections, resulting from the character of components of the nest biocenosis.

The study of biocenoses of nests, mainly of the ecology of nest ectoparasites is of theoretical as well as of direct practical importance, especially as regards the epidemiological aspects of some natural foci infections. Communities of nidicolous parasites can be reservoirs of a pathogenous agent which, under certain circumstances, may penetrate into the biocenosis outside the nest. On one hand, the nest represents a closed system which is separated from the surrounding biotope by certain physical factors, but on the other hand, the character of the nest environment and its changes are closely correlated with the surrounding nature and this correlation undergoes dynamic changes, for example during the season of the year etc.

Most papers dealing with nidicolous communities give lists and classifications of nests organisms and if elements of nest environment are recorded in them, they are only static records taken at the moment of the nest discovery. This method, however, does not solve the problem in full scope, but at the first stage of investigation it is necessary and that is why we have also started our work in this way. The results obtained served as a basis for further work on the main theme, i.e. the investigation of the influence of microclimate upon the fauna of nest parasites and their development.

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At the first stage we directed our attention to the nests of free living small mammals in the mountainous region of northeastern Moravia (MRCIAK, DANIEL, ROSICKÝ 1966). The nests were evaluated not only according to the animal species which inhabited them but also according to the season, biotopes, location of the nest (i.e. its situation under, on or above the ground) and according to material used as bedding. An assessment of the achieved results made it possible to draw the following main conclusions, concerning primarily the mites of the superfamily Gamasoidea:

a) The fauna of mites in the nests of individual species of small terricolous mammals in the given region is very similar. The acarinia zones of small mammals are uniform and there is no great difference between the acarinia of small insectivores and those of the mouse-like rodents. (The term acarinium designates a community of mites living on separate host species.)

b) According to our analyses the biotope itself does not exert any decisive influence upon the settlement of nest by the mites. This settlement, however, is affected by the location of the nest and by the nest building material. (The underground nests and those situated on the ground which are in contact with the soil surface, were inhabited by a far greater number of mites. Grass proved to be the most suitable bedding.)

The abiotic factors therefore appear to have a determining character. From this aspect we conducted a series of experiments at the second stage of our investigation carried out under conditions of the inundated forest in southern Moravia. *Clethrionomys glareolus* was used as experimental animal and conditions in its nests were studied. For taking exact and continuous measurements of the nest microclimate (temperature and humidity) and for checking the number of ecto-

Table 1. Average temperature and humidity in experimental area and nests

		Temperature (°C)			Humidity (% RH)		
		arithmetic average	dispersion variance	mean error	arithmetic average	dispersion variance	mean error
Exp. area (forest)	mesoclimate	16.90	4.60	0.182	81.31	6.35	0.251
	microclimate layer near the ground	17.16	3.77	0.597	no measurements taken		
Experimental nests	10 cm deep under the surface	16.79	1.08	0.024	no measurements taken		
	20 cm deep under the surface	15.44	1.11	0.0256	55.55	1.74	0.043
	in the tree-stump	16.28	1.81	0.0417	99.90	1.08	0.027

parasites in nests certain methods were developed in these field experiments, based on the following principles:

1. All observations are conducted in enclosures placed in the biotope characteristic for the experimental animal which is induced to built its nest in a spot selected beforehand.

2. Only sterile material (hay) is used for the construction of the nest by the small mammals following their desinsection.

Table 2. Maximal and minimal temperatures of air layer near the ground and in experimental nests

		maxima			minima		
		arithmetic average	dispersion variance	mean error	arithmetic average	dispersion variance	mean error
Experimental area microclimate		21.71	4.20	0.664	12.69	2.61	0.415
Experimental nests	10 cm deep under the surface	17.97	1.62	0.257	15.73	0.99	0.156
	20 cm deep under the surface	16.32	1.61	0.255	14.89	0.73	0.120
	in the tree-stump	17.86	1.94	0.291	14.71	1.73	0.274

3. The temperature and humidity measurements are taken by means of thermistores and resistance thermometers and continuous recordings are made at a considerable distance to avoid any disturbance of animals in their activities. All methods used were described in detail by Daniel (1965).

The nests of *Clethrionomys glareolus* were studied in the summer season (June-July), for two consecutive years. The nests were located under the ground 10 cm and 20 cm deep and above the ground in a tree-stump, where the nest bottom constituted the soil surface. In addition (without measuring the microclimate), the development of fauna in nests near the soil surface under a fallen tree trunk was investigated. Each type of nest was investigated parallelly in three enclosures. At the beginning of each experiment mites belonging to the most common component of acarofauna of nests, such as *Haemogamasus nidi* (5 females and 5 males per nest) and *Haemogamasus hirsutus* (the same number per nest), fleas of the species *Ctenophthalmus agyrtes* (10 females and 5 males) and in one case *Megabothris turbidus* (14 females and 7 males) were introduced into the nests. In each enclosure a pair of *Clethrionomys glareolus* was placed, of which the female was in the last few days of gravidity. The experiments were carried out for 6 weeks, i.e. for a length of time necessary to produce a first filial of small mammals. After each experiment the nests were processed in thermoeeclectors and the final result was confronted statistically with the initial counts and microclimatical recordings. For control purposes also the nests from the surrounding free nature were collected.

The mathematical-statistic evaluation was done by means of a digital computer (Minsk) after the recorded curves had been expressed in digits (by machine of the type Oscar—48 values daily). The given values were converted to grades of Celsius

Table 3. Significance of differences in comparing the temperatures of various types of experimental nests

Pair of nests tested	Significance level of temperature differences		
	average temperature	maximal temperature	minimal temperature
10 cm – 20 cm	1 %	1 %	1 %
10 cm – tree stump	5 %	IN*)	1 %
20 cm tree stump	1 %	1 %	IN*)

*) IN = insignificant.

and percentage of relative humidity (RH) and the basic statistical characteristics (average, dispersion variance, mean error) and the regression analysis (regression and correlation coefficients between all pairs of curves investigated and variance of these coefficients) were determined. The significance of differences was estimated by a test after Tuckey.

The results of microclimatic investigations are given in absolute values in Tab. 1 and 2. Table 3 contains test results on the significance of differences among various nest types and explains the mechanism of the effects of nest location upon living conditions of the fauna of nidicolous animals. Statistically significant are the temperature differences between the nest built in a tree-stump and that situated 20 cm deep in soil and likewise between the nests built 10 cm and 20 cm deep in soil: these differences reach a level of 1 %. The differences between the nest location in a tree-stump and the depth of 10 cm are insignificant (only reaching a level of 5 %). Especially significant are also the differences in humidity which reach the level of 0.1 %, if a comparison is made between a nest built in a tree-stump and that situated 20 cm deep in soil. Hence it may be concluded that the influence of the nest location manifests itself primarily in the influence of different humidity. Also the data were accumulated on the microclimate of the experimental area (i.e. the temperature of the layer 10 cm above surface), on the mesoclimate of forest (by means of apparatuses in a standard meteorological box stationed in forest) and on the macroclimate of the area studied (the data of the nearest observation post of the State Meteorological Service). The results of comparative tests show that in the summer season the nest temperature was closely associated with the microclimate of forest. Considering all nests investigated, the temperature in the nest situated 10 cm deep in soil reached similar values as the temperature near the ground. In other types of nests there were small, but statistically significant differences.

The basic data on the evaluation of the resulting state of fauna ectoparasites are given in Tables 4 and 5. The results obtained from the individual types of nests were tested primarily from the aspect of homogeneity, because the various

Table 4. A survey of nidicolous animals found in 12 experimental nests of *Cl. glareolus*

Pseudoscorpionidea	1	Heteroptera	1
Aranea	7	Coleoptera	158
Acarina:		Diptera	14
Parasitiformes	1837	Aphaniptera adult.	85
Trombidiformes	3	larvae	379
Acaridiae	1803	larvae of various	
Oribatei	177	groups of insects	146
Diplopoda	4	puppae of various	
Chilopoda	1	groups of insects	24
Collembola	1138	Lumbricidae	4

nest types could be mutually compared only where no disturbing factor occurred. As for the mite species introduced into nests, it was established that the species *Haemogamasus nidi* preferred the conditions above the ground and its numbers were maximal in nests built in tree-stumps. The same applied to the species *Haemogamasus hirsutus*—both species were practically absent in underground nests. On the other hand, their sex ratio in nests was different. The females of *H. nidi* predominated in the ratio of 2.8 : 1, while the proportion of males of *H. hirsutus* to females was 0.7 : 1.

Other species of mites may be regarded as elements which actively migrate to the nests. Two of them can be estimated statistically: *Haemolaelaps fahrenholzi* and *Eulaelaps stabularis*. This corresponds with the results obtained after analysing

Table 5. A survey of Parasitiformes mites found in experimental nests of *Cl. glareolus*

Species	Number	Species	Number
Haemogamasus hirsutus	340	*Eugamasus kraepelini*	27
Haemogamasus nidi	467	*Eugamasus remberti*	2
Haemolaelaps fahrenholzi	767	*Eugamasus* sp.	16
Eulaelaps stabularis	93	*Pergamasus* sp.	14
Hypoaspis heselhausi	2	*Parasitus* sp.	16
Eviphis ostrinus	1	*Ologamasus* sp.	1
Ololaelaps sp.	1	*Veigaia cervus*	2
Proctolaelaps pygmaeus	73	*Veigaia nemorensis*	1
Kleemania sp.	4	*Veigaia* sp.	1
Hirstionyssus isabellinus	7	*Macrocheles glaber*	2

nests taken from free nature, where the two mentioned species predominated besides the representatives of the genus *Haemogamasus*. No significant differences were found either in testing the diversity of nests under experiment and those in the surrounding nature on the occurrence of *H. fahrenholzi* and *E. stabularis*. Due to the character of data (one-time collection) it was necessary to use the method of logarithmic transformation and variance analysis. All differences among separate nest types with regard to *H. fahrenholzi* proved to be insignificant, with regard to *Eu. stabularis* the nests 20 cm deep in soil were an exception. It may be concluded that species of the genus *Haemogamasus* are more sensitive to the location of the nest and more closely associated with it. The mechanism of this sensitivity may be seen in the requirements of air humidity. Quite the opposite are the species *Haemolaelaps fahrenholzi* and *Eulaelaps stabularis* which spread by active migration and are less demanding as regards the environment. In *Eu. stabularis* only the females seem to have a greater affinity to nests built in at least partial contact with wood. Less specific requirements of environment are apparently one of the factors which promote active migration.

The occurrence of fleas was also evaluated (by method of logarithmic transformation and variance analysis) but their migration is so great that all differences (which were statistically insignificant) were erased.

Finally it must be noted that the presented conclusions apply to the summer season. Analogous experiments in the winter season were already carried out, but they have not been estimated statistically.

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