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Notes on the Mites of an Iowa Cave

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Abstract. An investigation was made of some of the environmental factors which are most important in determining the distribution of Acarina in caves. Because of the relative stability of the environment, Bogus Cave, Jones County, Iowa, was selected for the study. A moistened camel's hair brush, an aspirator, and the flotation method were used to collect specimens. Three families of mites (Eupodidae, Ascaidae, and Belbidae) were found; none were troglobites. The data indicate that the mites in Bogus Cave are limited to areas of constant humidity and temperature, a good organic soil cover, relatively small soil particles (100μ to 150μ), and a minimum temperature above 42° F. In addition, it appears that the populatons are mutually exclusive, and that one species cannot readily invade the territory already occupied by another species.

Although acarology has within the last few years become a well-established field of specialized investigation within the general limits of zoology, it has barely progressed beyond the stage of classifying new species and genera, with the majority of papers published each year dealing with taxonomic problems. It has been the purpose of this research to shed some light upon the ecology of soil-inhabiting mites. The work was conducted during the summer of 1958 and the 1958-59 academic year.

It was decided to limit the investigations to those mites found in caves, since in these habitats an extremely stable environment is provided the year round. Bogus Cave, which lies some four miles northwest of Anamosa in west-central Jones County,[2] was selected for the research work since access to the cave (which lies across the property of Howard Coder of Anamosa) is relatively easy during all seasons of the year and since the cave itself provides no dangers for an investigator working alone. The cave, owned by Dean Vanamberg of Anamosa, is excavated in the Gower dolomite of the Niagaran Series (Silurian). It attains a total length of 275 feet, with a mean elevation of 930 feet above sea-level. The floor of the cave is covered with a coarse clay. (Iowa Cave Survey Reports, No. 1, 1958.)

Methods and Materials

Approximately thirty trips were made to the cave, with concentrated investigations falling into two periods—December 13, 1958

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[2]NW¼ section 29, R4W T85N, 1955 Iowa State Highway Commission "General Highway and Transportation Map"; 42°09′00″ N latitude, 91°20′30″ W longitude, 1900 United States Geological Survey Topographical Map "Farley Quadrangle".

to January 4, 1959, and March 22 to 31, 1959.

Four methods were employed for collecting specimens: the Berlese funnel, a moistened camel's hair brush, an aspirator, and flotation. The Berlese method did not prove helpful because the soil samples processed had been taken from areas of continual disturbance in the cave and contained no specimens. The method of extraction was not at fault. The camel's hair brush, moistened with distilled water, proved to be very good in picking specimens from loose soil when counting was being done; and both the brush, moistened with alcohol, and the aspirator were useful in collecting specimens for preservation. The flotation method, using a 2 percent solution of calcium chloride, was used to great advantage in helping to determine the presence of mites too small to be seen with the naked eye. A binocular microscope, set up in the cave, was used to examine the floating material to determine the presence or absence of mites.

Specimens were placed in shell vials containing 95 percent alcohol for identification in the Grinnell laboratories. They were mounted in Faure's medium, having first been cleared for 24-48 hours in lactophenol. Attempts to rear these animals in the laboratory were unsuccessful.

In preparing the cave for investigation, a series of reference points was arbitrarily established (Figure 1), depending upon natural landmarks found in the cave. A hygrometer, of the wet- and dry-bulb type, and a maximum-minimum thermometer were used in making measurements of the humidity and temperature at these reference points (Table 1). These measurements were taken not only at the

Table 1

Relative Humidity and Temperature Readings Taken During the Period of December 13, 1958 to January 4, 1959 in Bogus Cave, Jones County, Iowa

Reference Point in Cave	Temperature Max.-Min.	Dry Bulb	Wet Bulb	Relative Humidity
A	40°—n.d.	38°	36°	83%
D	36°—40°	37°	36°	91%
F	40°—n.d.	38°	37°	91%
K	39°—n.d.	38°	37°	91%
L	39°—n.d.	39°	36°	75%
H	40°—n.d.	39°	36°	75%
M	44°—n.d.	42°	38°	76%
N	47°—n.d.	46°	42°	72%
O	48°—n.d.	47°	43°	72%
P	48°—n.d.	48°	44°	73%
Q	50°—n.d.	51°	46°	68%

n.d. = no deviation.

floor of the cave, but at varying heights above the floor (1-5 feet), depending upon the height of the cave ceiling at that point. No recordable deviations were noted.

A bait composed of distilled water, agar, honey, and cane sugar was tried in the later stages of collecting but proved unsuccessful in attracting mites. A series of transplants, moving specimens from areas in which they occurred to ones where they were not found and/or to areas where they would have to compete with other mites, was tried during the period from March 22 to 31 but did not succeed. Plastic rings, 1.5 cm. in height and 10 cm. in diameter, were used as a means of restricting the movements of the transplanted specimens. Upon examination of these transplants two to three days after their establishment, all of the specimens were found to be dead.

Results

The three families of mites found in Bogus Cave were: Eupodidae Koch, 1842 (=Penthaleidae Oudemans, 1931), Belbidae Will-

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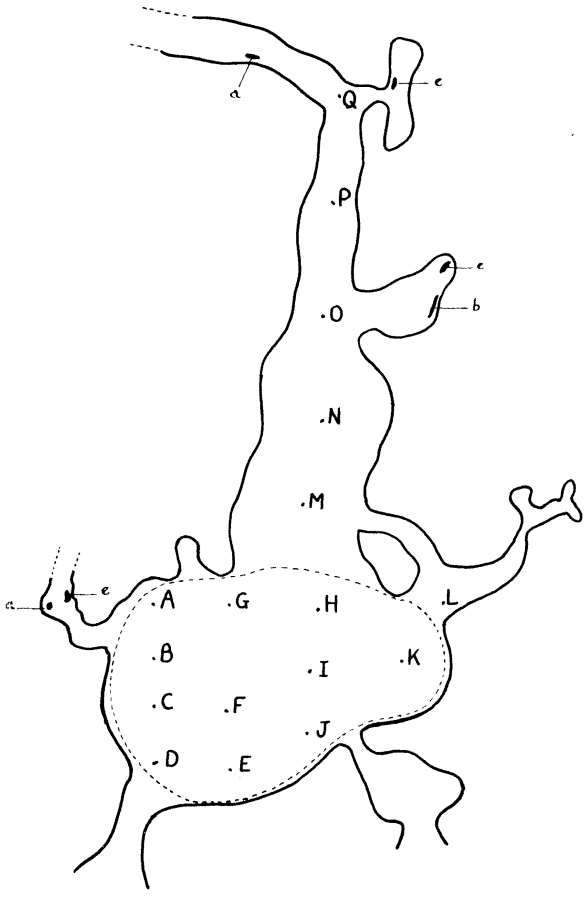

Figure 1. Bogus Cave, Jones County, Iowa. Capital letters indicate reference points. Small letters identify populations as follows: a, Ascaidae; b, Belbidae; e, Eupodidae. Broken line indicates boundary of the Entrance Room.

mann, 1931, and Ascaidae Oudemans, 1905. Specific identification was not possible, but the author is quite certain that each family was represented by only one species.

Although the Entrance Room was examined thoroughly upon more than one occasion, no mites were ever found. The mites were found in areas which were difficult to reach and removed from the main passageways of the cave. These areas were always characterized by having damp, loose, fine-particled soil with an abundance of organic debris in a state of partial decomposition forming a layer of ground cover.

The eupodids were found in moderate concentrations (100-150 individuals per square foot) in the areas so indicated in Figure 1. The belbids were found in light concentrations (50 or fewer individuals per square foot). The population of ascaids near reference point B was of light concentration and the population at Q was of heavy concentration (200-250 individuals per square foot). None of the families found in Bogus Cave were troglobites; all are found in similar habitats outside of caves.

Upon examination of the areas in which populations of mites occurred, few arthropods of any other type were found. It is interesting to note that none of the populations discovered and examined overlapped with one another.

Discussion

Various authors (Blake, 1931; Glen, 1954; Snell, 1933) have indicated in previous work that physical factors such as temperature, humidity, and soil moisture are density-independent, all-pervading and often have a great influence on the composition of the invertebrate fauna of the area in question. These authors have also found that while organic debris provides food, it also makes the soil more porous and penetrable. Alterations in the humus layer often cause fluctuations in temperature and soil moisture. Therefore, for any understanding of the distribution of mites in Bogus Cave, it was necessary to consider the effects of fluctuations in the temperature and humidity and the presence or absence of soil cover.

Mite populations were found only in areas where there was no radical fluctuation of the environmental factors during the study period. In these areas, temperature and humidity remained stable. The soil was consistently damp, but not saturated.

The mites, with one exception, were always found in regions where the temperature was between 42°F. and 68°F. (the unvaryng maximum temperature of the cave). It has been reported (Dowdy, 1944) that invertebrates are extremely responsive to temperatures between 38° F. and 45° F., but especially to 42° F. The inverte-

brate forms seem consistently to migrate away from temperatures below this point and move toward ones above it.

The humidity readings in the areas of collections fell between the limits of 68 percent and 72 percent, with the readings at each site remaining the same throughout the period of investigation. In areas where higher percentages of relative humidities were recorded (the Entrance Room), other factors such as extreme fluctuations in soil moisture and organic debris were probably of more importance in preventing the occurrence of mites.

The mites were limited to areas where an abundance of organic debris formed a good soil cover which was in dense layers, quite moist, and in the process of decay. The great bulk of the organic debris was composed of rotting pieces of wood, some of which were fairly large in size. These were probably carried to these areas by visitors to the cave. One population (Ascaidae at point Q) was found in an abandoned nest, which was composed of bits of paper and grass. At all collection sites examination of the soil showed remains of arthropod exoskeletons.

In addition to its probable function as a food source, the organic debris absorbed most of the water present, enabling gradual evaporation and preventing the soil from being packed into a hard clay. Just one-half foot south of the population of Belbidae at O, an area was investigated which had no humus layer, the temperature and humidity being exactly the same, as at O. Here, the soil moisture fluctuated from extreme dryness in the early stages of the investigation to a saturated condition on the last visit to the cave. No mites were ever found at this site.

It should also be noted that the soil particle size was always smaller in the areas where the mites occurred. The size of these particles varied from 100μ to 150μ whereas those from areas where the mites did not occur ranged from 500μ to 900μ.

The floor of the Entrance Room was covered, in certain areas, with heavy layers of organic debris. Fires are often built in this outer room, using this organic debris for fuel and causing environmental conditions, such as water content and temperature of the soil, to vary greatly. The wide fluctuation of these physical factors and the formation of soil crusts, along with the large soil particles found here, probably precludes the existence of colonies of mites in these areas.

The species were apparently mutually exclusive (Figure 1). It is difficult to be certain, but the evidence favors competition rather than environmental incompatibility as the main reason for this separation. The mites were found under different conditions of rela-

tive humidity and temperature, but in every case more than one species was found in each environmentally different region. In addition to this, various attempts at transplanting one species into the region already occupied by another species were entirely unsuccessful.

A number of attempts were made to colonize mites in previously unoccupied areas within the cave. In some cases, food material was artificially furnished to the colony. All such attempts were unsuccessful. The largest totally unoccupied region of the cave was the Entrance Room (Figure 1). There were small pockets at the bases of the walls of this room which, upon casual examination, would appear to offer suitable sites for populations. The soil was not compacted and there was a good quantity of organic debris, but no specimens were found. There are several possible explanations for this; the extreme fluctuations of moisture may be one of the main factors. The hygrometer showed an atmospheric humidity of from 91 percent to 75 percent. It seems as if much of the moisture in the atmosphere comes from very slow seepage through the strata of the ceiling of the room. However, upon the last visit to the cave (March 31) the entire floor of the Entrance Room, even to the small pockets around the bases of the walls, had been flooded by the heavy spring thaw of the previous week, and the soil had become a thick mud. In addition, the soil particle size was, on the average, a good deal larger (500μ to 700μ) than that from areas where mites were collected. The effects of several different factors are probably responsible for preventing the occurrence of mites in the Entrance Room.

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