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SOME RELATIVE HUMIDITY REACTIONS OF THE WOOD-LOUSE,
CYLISTICUS CONVEXUS (ISOPODA: PORCELLIONIDAE),
IN AN OLFACTOMETER

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INTRODUCTION

Generally, wood-lice are confined to habitats where the saturation deficit is low and damp surfaces are available. *Cylisticus convexus* (De Geer) is one of many species that are found in a relatively wet habitat (Edney, 1954). Allee (1926) was the first to report on some moisture reactions of *C. convexus*. When he supplied them with dry filter paper, they aggregated strongly to reduce water loss. When he supplied them with very dry paper in a dry atmosphere, the isopods all moved about frantically until they died. Those placed on moist filter paper, however, moved about slowly and remained apart--reacting very much as if they were in their normal habitat.

Since a colony of *C. convexus* was available to me, I proceeded to investigate further the moisture reactions of this isopod. Several experiments were undertaken to examine their behavior under different humidity conditions, and to determine their preferred range of humidity. All tests were made in an olfactometer.

THE OLFACTOMETER

The olfactometer used was a venturi-type described in detail by Wilson and Bean (1959) and modified after one developed by Willis and Roth (1950). Briefly, the alternative-choice-apparatus (i.e., test chambers) consists of two lucite cylinders with diameters of 4", connected by a small doorway so test organisms can move freely from one chamber to the other. Floor and ceiling of the test chambers are screened. Scented or humidified air can be pumped into the apparatus from above by a continuous circulating pump. Three-way valves permit various combinations of airflow between chambers; velocity of airflow is regulated by influent and exhaust flowmeters. Light and temperature can be regulated also.

This olfactometer has been previously tested with apparent success on several different organisms. Van Wyk (1958) obtained decisive reactions from the confused flour beetle, *Tribolium confusum* Duval, when offered choices between fresh and moldy grain. Tripathi (1959) tested the granary weevil, *Sitophilus granarius* (L.), and the rice weevil *S. oryzae* (L.), where a choice between odors of fresh and beetle-infested grain was provided. Both investigators obtained strong and highly significant reactions from their test specimens.

THE EXPERIMENTS

Full grown isopods were kept in a darkened terrarium and fed potato slices until used. At the start of each test, four isopods were placed in each of the two alternative chambers of the olfactometer. Humidified air was pumped through the apparatus for 2-3 minutes before and 1-2 minutes after introducing the isopods, in order to equilibrate the chambers and to accustom the isopods to their surroundings. The air with the lowest humidity was always pumped through both chambers first. The test started officially when the alternate humidified air was pumped through one chamber.

Preliminary tests showed that observations at one-minute intervals would be satisfactory. The airflow was alternated between chambers after each 10 minutes. Most experiments ran for 40 minutes. All tests were replicated two times; one was replicated three times. Except for five seconds of low intensity light, turned on at one-minute intervals to count specimens and observe their behavior, the tests were run in the dark at 31 ± 1 C.

Air was humidified by passing filtered air through various aqueous, acid, and salt solutions (Wexler and Hasegawa, 1954; Winston and Bates, 1960). Three pairs of checks were run first to standardize the test chamber readings. Comparisons were made between 0-0%, 75-75%, and 100-100% relative humidity. These and the test comparisons are listed in Table 1. In addition to the tests using untreated isopods, two tests were run with isopods kept in a desiccator with CaCl_2 for 45 and 60 minutes prior to testing.

RELATIVE HUMIDITY PREFERENCE

Paired relative humidities offered specimens of *C. convexus* and their preference ratios are listed in Table 1. In the six check tests



Table 1. Relative humidities offered *C. convexus* in an olfactometer and preference ratios (paired tests, eight isopods per test, and 40 or more counts made at one-minute intervals).

Relative Humidity Alternatives (%)	Preference Ratio Low:High	Relative Hum'dity Alternatives (%)	Preference Ratio Low:High
100:100 ^a	1.00:1.00	0:100 ^c	1.00:3.35
75:75 ^a	1.22:1.00	33:52	1.00:1.44
0:0 ^a	1.00:1.22	52:75	1:18:1.00
0:33	1.00:2.05	52:100	3.00:1.00
0:52	1.00:2.61	75:91	1.29:1.00
0:100	1.00:2.13	75:100	1.32:1.00
0:100 ^b	1.00:2.82	91:100	1.43:1.00

a/ Checks (alternative humidities were the same in both chambers).

b/ Isopods in desiccator for 45 minutes before tests.

c/ Isopods in desiccator for 60 minutes before tests.

(i.e., when paired humidities were the same in both chambers throughout the tests) preference ratios did not exceed 1.00:1.22 (Table 1). This appeared to be reasonable variation for 40-minute tests with eight isopods. These tests also indicated there was no appreciable bias in either of the test chambers.

Striking reactions were obtained when 0% R. H. was paired with any other percentage above 0%. The 0% R. H. was always rejected and the alternate R. H. highly preferred. Isopods desiccated for 45 minutes before the tests and offered a choice between 0 and 100% R. H. preferred the higher R. H. to a stronger degree than non-desiccated ones; those desiccated for 60 minutes gave even stronger preference for the higher R.H. These latter organisms gave the strongest preference ratio of any test (Table 1).

When 100% R.H. was paired with other percentages, the lower R.H. was always preferred-except when 0% R.H. was the alternate. The iso-

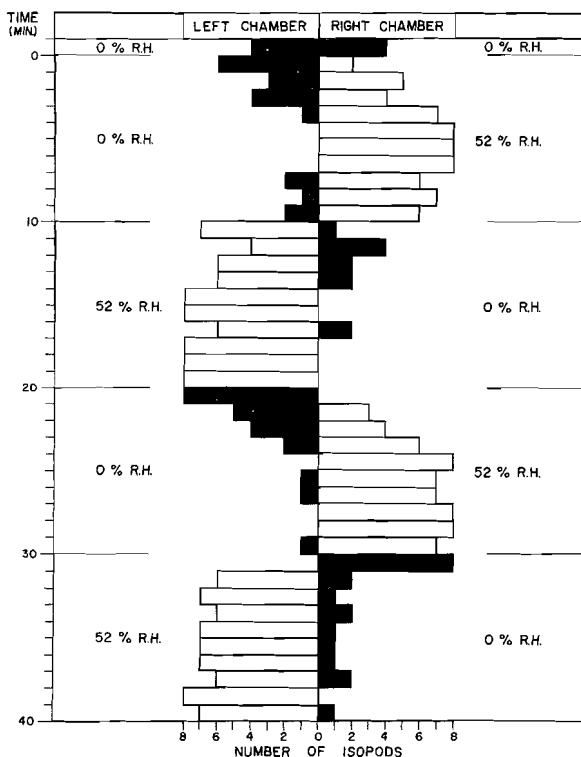


Fig. 1. Responses of *C. convexus* in paired olfactometer test chambers when subjected to 0% and 52% relative humidities. Humidities were alternated between chambers at 10 minute intervals. Note delay of 1-3 minutes after alternating humidities before isopods find, and nearly all remain in, alternate chamber.

Pods could apparently distinguish between 91 and 100% R.H. and 75 and 100% R.H. but preferences were weak in both pair of tests.

Strongest preferences of non-desiccated isopods occurred when 0% vs. 52% R.H. and 100% vs. 52% were paired. In all tests, 52% R.H. was strongly preferred, indicating that 52% R.H. was easily detected from the extremes, and suggesting that 52% might be near the optimal R.H. Typical responses for one complete test between 0 and 52% R.H. are depicted in Fig. 1.

Isopods given a choice between 33 and 52% R.H. preferred the latter. When 75% was paired with 52%, however, there was a slight preference for 52%, but the preference ratio did not differ from the check ratios. The optimal R.H. range, then, probably lies somewhere between 52 and 75%.

ISOPOD BEHAVIOR

The test isopods reacted differently when exposed to different R.H. percentages. Alternating the humidities between test chambers invariably caused behavioral changes if the alternate R.H. was markedly different.

Isopods subjected to 0% R.H. always moved about frantically--a response which is indicative of extremely adverse conditions. The isopods presented with dry paper and dry air in Allee's (1926) tests elicited similar responses. In the presence of high humidities (91-100%), the isopods moved about as if the conditions were unfavorable, too. Movements, however, were not as frantic as those in the dry situations. Grouping was common under both high and low humidities, but it lasted longer under the low humidities. Grouping at low humidities probably occurred to reduce the rate of water loss.

The isopods moved about slowly in the mid-range humidities. Movements at 52% and 75% were reminiscent of their movements in their terrarium, suggesting a favorable environment. Grouping sometimes occurred but most frequently late in the tests. This may have been done to conserve moisture, but more likely it was a thigmotactic response due to a lack of hiding places. Some isopods settled against the curved side of the chamber, apparently also responding to a thigmotaxis. Allee (1926) points out that isopods will aggregate or utilize a surface to satisfy this reaction if hiding places are not available.

The time necessary for the isopods to move from one chamber to the other after alternating the R.H. percentages varied inversely with the apparent favorability of the R. H. When the two humidities were apparently favorable but different, this lag in time was very long as in the test between 52% and 75%. In contrast, the lag was very short when the alternate humidity presented the isopods was unfavorable. Fig. 1 shows the lag time to vary 1-3 minutes after each occasion on which the isopods were subjected to 0% R.H. and moved quickly into the alternate chamber. This is the reason their preference ratios were considerably higher than those of the non-desiccated ones.

DISCUSSION

The optimal R.H. for *C. convexus* appears to lie between 52 and 75%. Both the preference ratios and the isopods' behavior point this out. Perhaps the optimum range could have been determined more exactly by using modified procedures. For instance, Willis and Roth (1950) obtained better preference reactions after their test specimens were left for long periods in the same humidity. They found the beetle *Tribolium* could discriminate humidities differing by 15% throughout the humidity range and within 5% at the extremes. Preferences were very weak near the optimum, however. Gunn (1937) reported that the wood-lice, *Porcellio scaber* (Latreille) was able to detect R.H. differences as small as 2.5% (50.0 vs. 52.5%) after a long test period. *C. convexus*, on the other hand, may have a wider range of tolerance to moisture (euryhydric) than such wood lice as *Porcellio*.

Relative humidity does not explain the moisture requirements of isopods altogether because it appears they need some free water and are able to absorb it orally and anally (Spencer and Edney, 1954). However, the preferences and behavior of *C. convexus* in these tests, suggest that it prefers a moderately moist habitat with limited free water surfaces. Copious amounts of free water would saturate the atmosphere of its habitat, producing a condition apparently unfavorable for its existence.

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REVIEWS OF RECENT LITERATURE

WILD FLOWERS OF THE UNITED STATES: Volume 1, THE NORTH-EASTERN STATES (in two parts). Harold William Rickett. New York: McGraw-Hill Book Company, 1966. x, 559 pp. \$39.50.

Many entomologists are faced with the problem of identifying a plant that an insect has been gathering nectar from, feeding on, or pollinating. Unless he is armed with a working knowledge of botany, and can handle the cumbersome keys in our modern floras, he must resort to a specialist or a picture book.

This sumptuous folio, the first of a five-volume series for the United States, excels as the latter. It is even more than a picture book, however, for it includes numerous keys and excellent line drawings to aid in the identification of some 1700 of the 3000 species of flowering plants in the northeast (excluding grasses, sedges, rushes, woody plants, and "a number of unattractive weeds with small greenish flowers which are not likely to excite the interest of the amateur."), more than half again as many species as have been treated in any previous popular handbook on northeastern wild flowers. In addition to the excellent illustrations, Dr. Rickett has included comments on the distribution, habitat, and other information to aid identification of each species. He also includes substantial and interesting comments on each plant.

The coverage of this volume is from Maine to Minnesota, south to Virginia and Missouri. Virtually every herbaceous wild flower brought to one's attention in Michigan will be found here. From foreword to index, this publication of The New York Botanical Garden is a fine example of the book maker's art. The 180 color plates were printed in four to seven colors by offset lithography in England, where the special paper was also made.

Wild Flowers of the United States is an important addition to any entomologist's library, if he can afford the price. J.P.D.

THE WEB OF THE SPIDER. Laura Barr Lougee. Bloomfield Hills, Michigan: Cranbrook Institute of Science, 1964. 44 pp. \$3.50.