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MUCUS TRAIL FOLLOWING BY THE SLUG *DEROCERAS LAEVE* (MULLER)

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ABSTRACT

Mucus trails of the slug *Deroceras laeve* were marked on the underside of a glass plate as they moved across the top. Tracings were used to produce permanent records for analytical comparisons. Individual slugs were found to occasionally follow their own trails as well as the trails of conspecifics. However, the degree of following in the experiments was not significantly different from the control tests for this species, indicating potential effects of aggression and habitat utilization.

INTRODUCTION

The phenomenon of mucus trail following has been observed and studied in several species of gastropods. It may, in fact, be a common characteristic of most gastropods (Wells and Buckley, 1972). Some of the earlier studies examined the homing ability in limpets. Cook et al. (1969) postulated that the homing ability in members of the genus *Patella* may be due to absorbed proteins since washing of a trail on a rock did not seem to inhibit following. It was suggested that *Siphonaria normalis* may also be following some sort of chemical information (Cook, 1969).

Wells and Buckley (1972), in their well-known study, found that *Physa* traveled up the same arm of a Y-tube with a much higher frequency than would be predicted randomly. *Physa* followed its own trail as well as those laid down by other individuals. Another snail, *Biomphalaria glabrata*, will also follow its own trail and the trail of a conspecific with equal frequency (Townsend, 1974).

Following has been observed in the large terrestrial slugs *Limax grossui* Lupu. (Cook, 1977) and *L. pseudoflavus* (Cook, 1979). *Limax grossui*, in addition to following trails laid by members of its own species, also followed trails of *L. flavus*. It did not, however, follow the trails of *Deroceras reticulatum* or *Milax budapestiensis*, indicating trail discrimination between species exists.

This paper describes the results of an examination of trail following in the small slug *Deroceras* (=*Agriolimax*) *laeve*. Individual following as well as following between conspecifics was studied.

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MATERIALS AND METHODS

Specimens of *Deroceras laeve* were collected off sidewalks in December in West-Central Illinois. Beginning in late Oct., *D. laeve* can frequently be found on sidewalks at night and into the early morning. Rain may also bring them out during the day. Dozens of slugs can often be found in a small area. This type of behavior is typical of *D. laeve* (Cole, 1946; Getz, 1959). For the duration of the study slugs were kept in a large glass container in moist vegetation and detrital material. Raw potato was added as a food source. The mean length of the slugs used in the experiment was approximately 2 cm.

An observation surface was used to track trails formed by the slugs. The observation surface was a glass plate (42 cm X 25 cm) secured by clamps to four ringstands approximately 25 cm from a table top. In dim light, a slug, previously kept isolated in a small glass container, was allowed to crawl about on the plate for 5 minutes. As the mucus trail was laid down it was traced on the underside of the plate with a wax pencil. After 5 minutes the slug was placed back at the starting point in the middle of the plate. This procedure was repeated twice for each slug; resulting in 3 trails produced over 15 minutes. Slugs were turned away from the edge of the plate if they strayed too close. After each test the mucus trails as well as the wax tracings were washed off with detergent and water. A total of ten slugs were tested in this manner.

To examine conspecific following 4 tests were run using 4 slugs in each test. Each slug was allowed 5 minutes crawling time on the glass plate. Control experiments were also performed where the plate was thoroughly washed before each 5 minute run. Trails from all tests were traced onto paper. Total trail lengths and lengths of followed sections were measured with a cartometer.

A trail was designated as being followed if another trail was superimposed on it for 1 cm or more. This distance was appropriate for the size of *D. laeve* (Cook, 1977). The percent of the trails followed was calculated for each experiment. Kruskal-Wallis nonparametric analysis of variance was used to analyze the data. The number of contacts between trails that led to following is also important (Cook, 1977), and was analyzed using the same method.

RESULTS

Interaction Between a Slug and Its Own Trail

An example of trails laid down by an individual slug is shown in Figure 1. With only two exceptions, all slugs traveled over 100 cm in a 15 minute period. The mean distance traveled in 15 minutes was 131 cm ± 38.9 cm ($\bar{X}$ ± s.d.). A maximum of 6.1% of the new trails created by a slug were followed (slug #6). The mean percentage followed was 2.44% ± 2.08% (Table 1).

For individual slugs, the number of trail contacts are given in Table 2. The percentage of contacts that led to following varied from 0% (slugs 3 and 5) to 100% (slug 2, with only 1 contact).

Interactions Between a Slug and the Trail of a Conspecific

An example of the trails laid down by different slugs is given in Figure 2. The mean distance traveled was 145 cm ± 11.17 cm. The total length of new trails was 568 cm (Table 1). A maximum of 3.8% of total trail length was

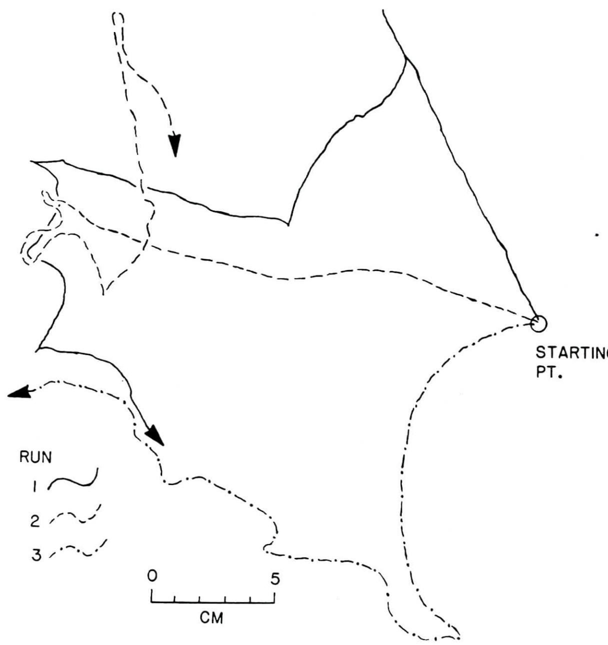

FIG. 1. *Trails laid down by slug No. 10* (Deroceras laeve) *during 3, 5-minute runs.*

followed in one case. The mean percent followed was 1.23% ± 1.79%. In two cases none of the contacts led to following. The highest percent of trail contacts in the conspecific testing that led to following was 25%.

Out of 236 cm of new trails created by slugs in the control tests, 1.27% were superimposed. Since the glass plate was carefully washed after each slug, such superimposition was purely random.

Comparison of Results

For individual slugs following their own trails, the proportion of trails followed is higher than either the conspecific following or the control. In addition, the proportion of contacts that led to following is also higher for individual slugs. However, Kruskal-Wallis one-way analysis of variance indicates no significant difference in percent of trails followed between the three groups (p=0.2325); there is no significant difference between the three groups concerning proportion of trail contacts that led to following (p=0.2663).

DISCUSSION

There are two primary reasons for trail following: 1) Homing and 2) Food finding. Following a previously laid trail will generally minimize the time required to find food or a resting site (homing) (Cook, 1979). Food finding generally refers to locating a desirable plant since slugs are basically herbivores. However, cannibalism is not unknown in slugs (Rollo and Wellington, 1977). I observed members of *Deroceras laeve* feeding on conspecifics. It is also common to see *D. laeve* feeding on earthworms which are found in abundance on sidewalks after a heavy rain.

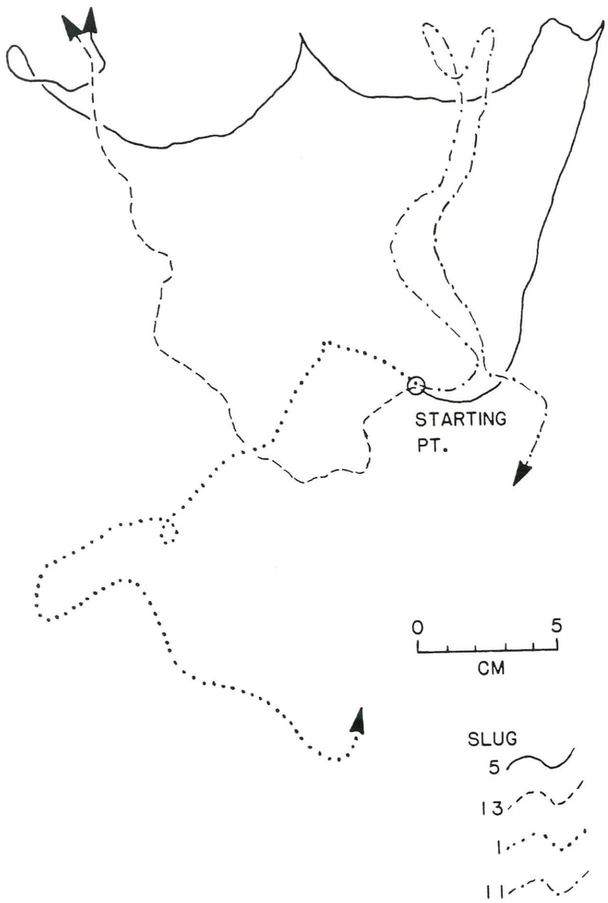

FIG. 2. *Trails laid down by 4 different slugs* (Deroceras laeve) *during 5-minute runs.*

Such feeding, however, is more an indication of scavenging rather than actual predation.

It is doubtful that *D. laeve* consistently seeks out other slugs to prey upon, although aggressive behavior is well-known. *Limax maximus* is extremely aggressive and has been seen to attack conspecifics even if there is a surplus food supply (Rollo and Wellington, 1979). *D. laeve* was also described as being extremely aggressive, although a related species, *D. reticulatum*, was not.

It is likely that trail following is more directly linked to homing behavior, and not to the aggressiveness of the animal. The homing behavior of slugs is closely related to the size of the slug. Large slugs, such as *Limax* spp., have a limited number of resting sites or 'homes' they occupy during the day (Cook, 1979; 1981). They also have a greater trail-following tendency (Cook, 1977; 1979), which is in apparent response to a strong homing instinct. Small species, such as *D. laeve*, simply bury themselves in soil or litter, or seek shelter in food plants (Cook, 1981). There is no need to follow a trail 'home', since one may not exist.

TABLE 1. *Total distance traveled, distance followed, and percent of total for all tests of* Deroceras laeve.

	Total new Trails (cm)	Distance Followed (cm)	Percent
Individual Following	1310	32	2.44
Conspecific Following	568	7	1.23
Control	236	3	1.27

TABLE 2. *Total trail contacts made, contacts resulting in following, and percent of total for all tests of* Deroceras laeve.

	Total Contacts	Initiated Following	Percent
Individual Following	86	16	18.60
Conspecific Following	39	3	7.69
Control	15	1	6.67

In addition, the slugs remain on or very close to their food source.

Following may also be linked to the ability to withstand environmental stress. *D. laeve* has been shown to survive much lower temperatures than some other slugs (Getz, 1959). *D. laeve* may not need to return to a resting site which is more sheltered and where an aggregation of animals will produce some excess heat. Therefore, the lack of significant trail following in the slug *D. laeve* may represent adaption to aggressive behavior, but more probably is related to its ability to tolerate harsher environmental conditions, thus limiting a need for a resting site.

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