MEASURE OF STRESS ON GASTROPODS

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ABSTRACT: Mucus trails of gastropods on copper sheets placed on the inner wall of terrariums give information about stress in snail populations. From the exponential regression curve $y = Ae^{-Bx}$ (y = number of trails, x = trail height on the sheet) we calculated the estimates ×50, ×l0 and ×5 at which respectively 50, 10 and 5 trails were attained. These values reported on vertical line segments made it possible to compare the antagonistic behaviour between species as a function of population densities or other disturbing factors. The method was tested on 4 Zonitidae species: *Zonitoides nitidus*, *Z. arboreus*, *Oxychilus draparnaudi* and *O. cellarius*. In the light of these results we discussed the measure of inter and intraspecific disturbance in molluscan populations and the impact of the disturbance on the predation capacity of the snails.

KEY WORDS: Gastropoda, Zonitidae, mucus trail, species antigonism, stress behaviour
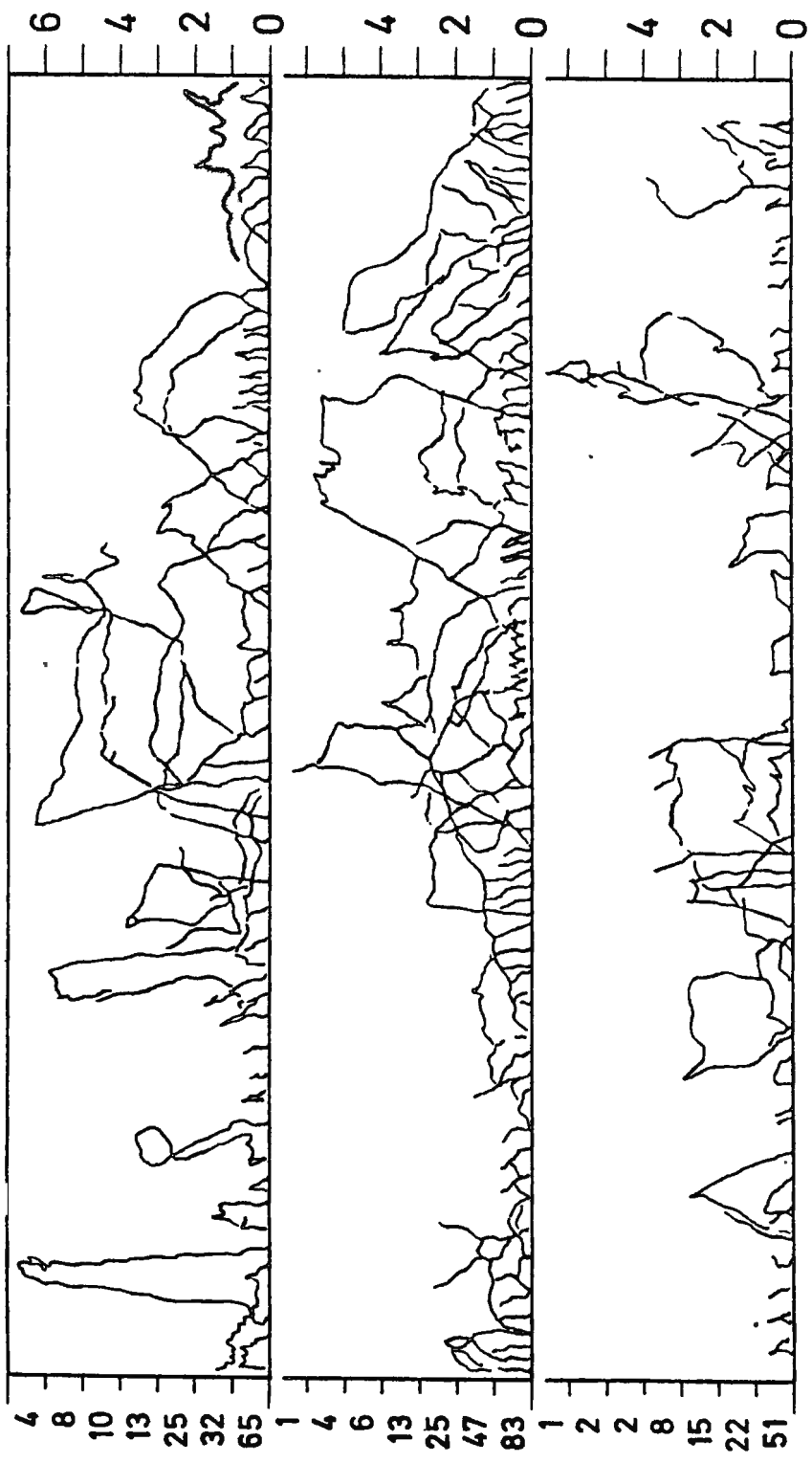
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Abstract: Mucus trails of gastropods on copper sheets placed on the inner wall of terrariums give information about stress in snail populations. From the exponential regression curve $y = Ae^{-Bx}$ (y = number of trails, x = trail height on the sheet) we calculated the estimates $\hat{x}50$, $\hat{x}10$ and $\hat{x}5$ at which respectively 50, 10 and 5 trails were attained. These values reported on vertical line segments made it possible to compare the antagonistic behaviour between species as a function of population densities or other disturbing factors. The method was tested on 4 Zonitidae species: Zonitoides nitidus, Z. arboreus, Oxychilus draparnaudi and O. cellarius. In the light of these results we discussed the measure of inter and intraspecific disturbance in molluscan populations and the impact of the disturbance on the predation capacity of the snails.

INTRODUCTION

It was shown that gastropods can be held in terrariums by a copper sheet placed against the inner wall of the boxes (Moens 1984). In disturbed populations snails make attempts to escape and the stress intensity can be expressed by the number (y) of mucus trails revealed after 48 hrs at different heights on the copper screens. This technique was tested on four species of Zonitidae: Zonitoides nitidus (O. F. Müller), Zonitoides arboreus (Say), Oxychilus cellarius (O. F. Müller) and Oxychilus draparnaudi (Beck).

6 4 2 0
4 2 0
4 2 0
cm

4 8 10 13 25 32 65
1 4 6 13 25 47 83
1 2 2 8 15 22 51
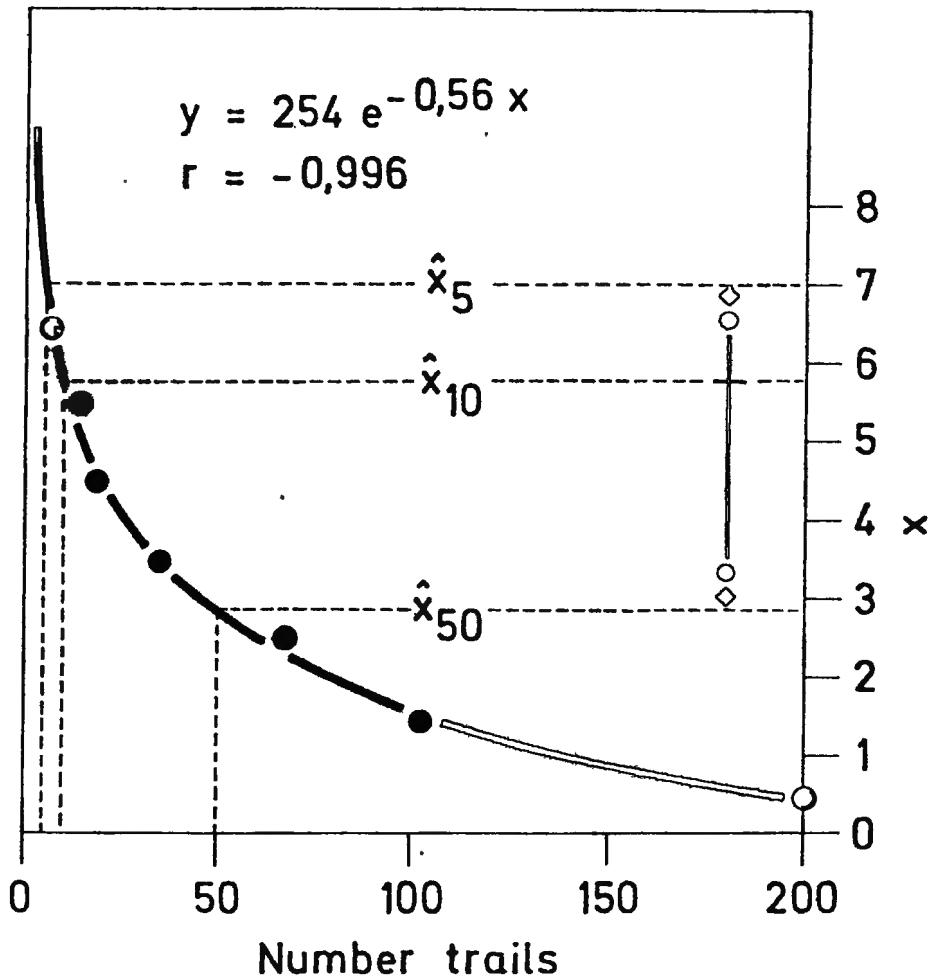
Number trails

$$y = 254\ e^{-0.56\ x}$$

$$r = -0.996$$

Fig. 1. Mucus trails obtained on copper sheets from 3 terrariums each charged with 10 Z. nitidus and 10 O. dragarnaudi. The number of trails (y) (sum of 3 repetitions) in function of the height (x) is given by the regression curve, from which we deduced the values $\hat{x}_{50}$, $\hat{x}_{10}$ and $\hat{x}_5$

MATERIAL AND METHODS

The trials were carried out in laboratory conditions (18°C and 90% R.H.) in PVC cylinders (diameter $\pm$ 10 cm) filled to 9 cm below the rim with sand covered by a substrate (1.5 cm) of sterilised soil on which 5 carrots slices served as refuges and food. After placing the cylinders in a basin containing 4 cm of water, moisture content of the soil was stabilised at 3 degrees depending on the height of the sand column above water level:
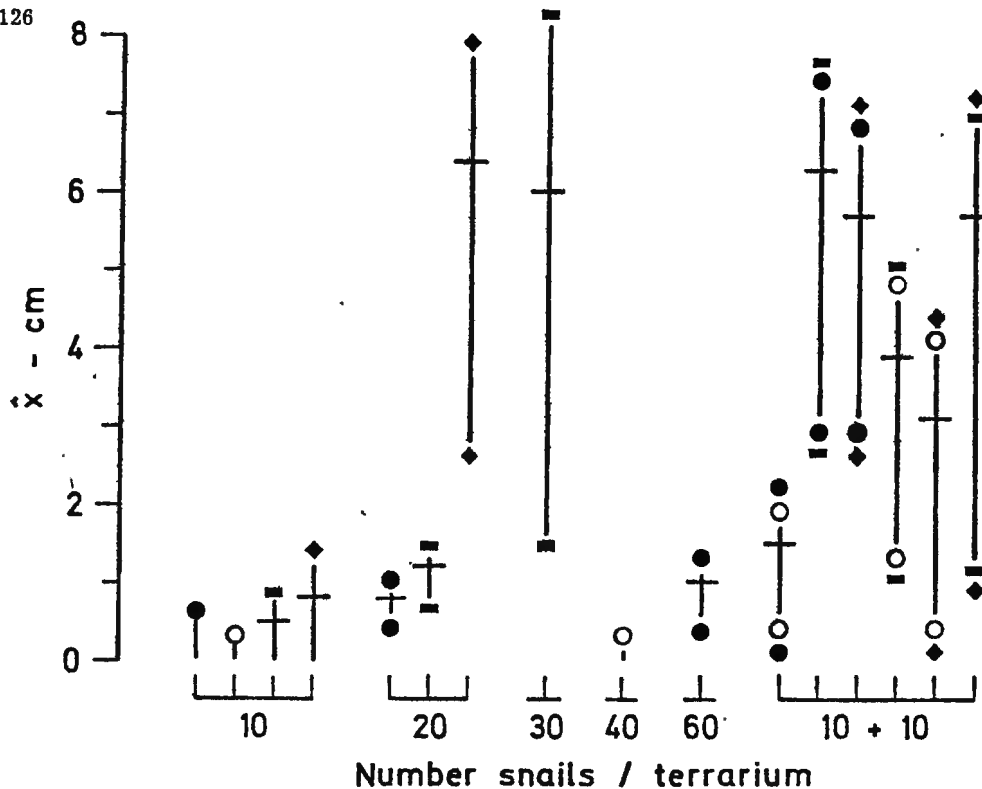
Number snails / terrarium

Fig. 2. Vertical line segments indicating the values $\hat{x}_{50}$ (inferior limit) $\hat{x}_5$ (superior limit) and $\hat{x}_{10}$ (horizontal line) revealed on the copper sheets from 16 terrariums of the first experiment; population densities are given by the number of snails per terrarium. Species are indicated by conventional signs: ● = Z. nitidus, ○ = O. draparnaudi, ◆ = Z. arboreus, ■ = O. cellarius

RESULTS

The number of trails (y) observed at different heights (x) on the copper sheets can be expressed by an exponential regression curve $y = Ae^{Bx}$ (where $B < 0$) with quite a good correlation (coefficients between 0.995 and 0.918). Fig 1 shows mucus trails obtained on copper sheets from 3 terrariums each charged with 10 Z. nitidus and 10 O. draparnaudi. The number of trails (y) (sum of 3 repetitions) in function of the height (x) is given by the regression curve: $y = 254e^{-0.56x}$ (R = -0.996). From this curve we deducted the values $\hat{x}_{50}$, $\hat{x}_{10}$ and $\hat{x}_5$, being the estimates of the heights at which the number of trails is respectively 50, 10, and 5. These values can be reported on a vertical line segment with the value $\hat{x}_{50}$ (inferior limit) and $\hat{x}_5$ (superior limit) at its extremities and between them the intermediate value $\hat{x}_{10}$ (indicated by a horizontal line). Vertical line segments from the 16 terrariums of the first experiment and from the 12 terrariums of the second experiment are given in Figs 2 and 3.

1) for 0 cm (cylinder height = 13 cm) the soil is sursaturated,

2) for 4 cm (cylinder height = 17 cm) the soil is at 100% field capacity,

3) for 25 cm (cylinder height- = 38 cm) the soil is at 80% field capacity.

In the first experiment observations were made on 16 terrariums at 100% field capacity. In 10 of these we introduced respectively 10, 20 and 60 Z. nitidus, 10, 20 and 30 O. cellarius, 10 and 20 O. draparnaudi, 10 and 40 Z. arboreus. The other 6 terrariums each received 10 individuals of two species.

The second experiment was carried out in 3 groups of 4 terrariums harbouring respectively 10 Z. nitidus, 60 Z. nitidus, 10 O. cellarius, 30 O. cellarius, each group being tested at 3 degrees soil moisture.

Trails on the copper sheets were revealed after 48 hrs by methylene blue (1%).
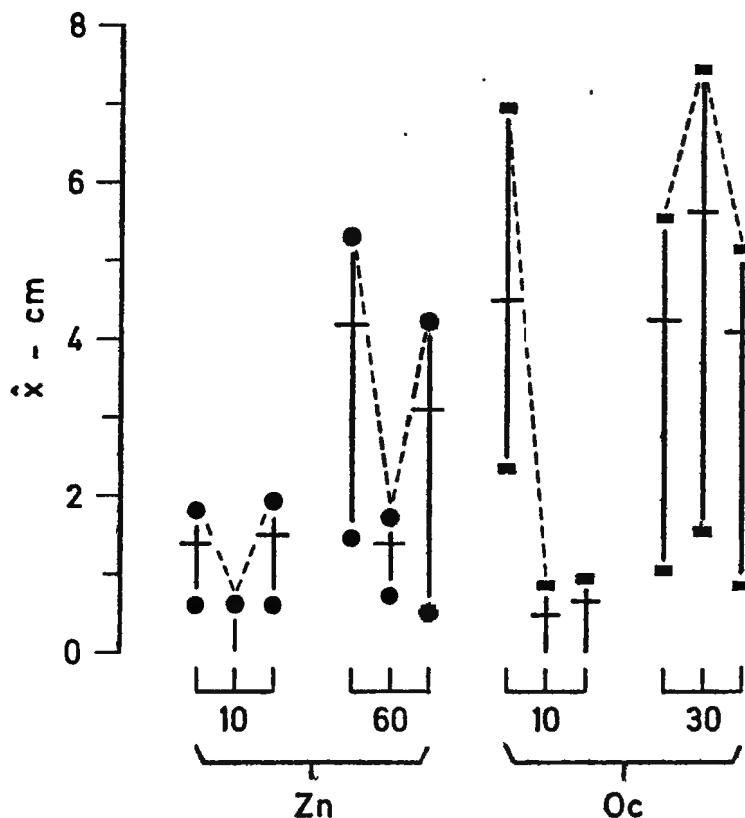

Fig. 3. Vertical line segments obtained on the 3 groups of 4 terrariums of the second experiment, with 10 and 60 Z. nitidus and 10 and 30 O. cellarius, each group being tested at 3 degrees of soil moisture: sursaturation (first line segment), 100% of field capacity (median line segment), 80% of field capacity (third line segment)

DISCUSSION

1. Measure of intraspecific disturbance and gregariousness; their impact on population densities in the field

It can be seen from the first 10 segments of Fig. 2 that populations of Zonitidae are not disturbed at a density of 10 snails per terrarium (78.5 cm^2), and this behaviour does not change noticeably for Zonitoides spp. at densities of 40 and 60 snails. On the contrary, for O. draparnaudi and O. cellarius an increase to respectively 20 and 30 shows a marked effect on population stress. This difference in behaviour between Oxychilus spp. and Zonitoides spp. can be related to the gregarious character of the latter. Both Z. arboreus and Z. nitidus can be a serious pest in orchids where they aggregate in a very high concentration (Moens, Fraselle 1980; Porcelli, Parenzan 1988). But Z. nitidus appears to be an efficient predator on emerged Lymnaea truncatula populations in ditches where they concentrate in high numbers in the proximity of the waterlevel following water retreat (Moens 1986). In this area, favourable conditions for predation are generally restricted in time and space, so that it is vital that predator snails aggregate in these places in high numbers in order to quickly destroy the lymnaeids and their eggs. Aggregation is also important for an estivation or hibernation in shelters such as rushes from which the snails can spread easily when field conditions become favourable.

2. Measure of interspecific disturbance or antagonism between species: their impact on the composition of molluscan populations

The last six segments of Fig. 2 give some indication of the antagonistic behaviour between species. Little antagonism was observed between the two Zonitoides spp., but heavy reactions were noted between Z. arboreus and each of the Oxychilus spp., killing some snails of the former species (on 3 x 10 individuals 4,7 and 4 specimens respectively were destroyed by O. cellarius). There was also an evident antagonism between Z. nitidus and each of the Oxychilus spp. but no destruction of snails was observed. This antagonistic behaviour can explain that in most molluscan populations Zonitidae are represented by a limited number of species depending on moisture and vegetation. So in gardens we found generally O. draparnaudi, while Z. nitidus is dominant in more hydromorphic conditons such as swampy depressions with a dense vegetation cover or fenced ditches and furrows draining moist pastures. In some cases (e.g. drainage furrows of popular grooves) Z. nitidus was replaced by Aegopinella nitidula and in less humid ditches by O. cellarius.

3. Research for optimal moisture conditions

Fig· 3 shows for Z. nitidus a minimum disturbance on soils moistened at 100% capacity (= median line segment of each group) and a maximum disturbance on sursaturated soils and soils dried up to 80% capacity (= respectively first and third line segment of each group).

For O. cellarius at population densities of 10 individuals per terrarium, little stress was measured even at 100% and 80% field capacity, while agitation was important on sursaturated soils. At densities of 30 individuals per terrarium agitation remains important for all moisture classes.

It can be concluded that moisture conditions are optimal at 100% field capacity for Z. nitidus and between 100% and 80% for O. cellarius, the latter species being less hydrophilic.

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MIARA STRESU U ŚLIMAKÓW

Streszczenie: Ślady śluzu, pozostawione przez ślimaki na mie-
dzianych blachach, umieszczonych na wewnętrznych ścianach terrariów, dos-
tarczają informacji na temat stresu w populacjach ślimaków. Z krzywej wy-
kładniczej regresji $y = Ae^{-Bx}$ (y = liczba śladów, x - wysokość śladu na
pokryciu z blachy) oszacowano wartości x_{50}, x_{10} i x_5, przy których uzys-
kano odpowiednio 50, 10 i 5 śladów. Wartości te, naniesione na segmentach
pionowej linii, umożliwiły porównanie międzygatunkowych zachowań antago-
nistycznych, jako funkcji zagęszczenia populacji, lub innych czynników
powodujących zakłócenia. Metoda ta została sprawdzona na 4 gatunkach Zoni-
tidae: Zonitoides nitidus, Z. arboreus, Oxychilus draparnaudi i O. cel-
larius. W świetle uzyskanych rezultatów przedyskutowano badaną miarę wew-
nątrz- i międzygatunkowych zakłóceń w populacjach mięczaków i ich wpływ
na wydajność drapieżnictwa badanych ślimaków.