



SLUGS DESCENDING ON MUCUS THREADS

EVGENIJ V. SHIKOV

Kalinina 37–21, Lyubertsy, Moscow Region, 140002, Russia (e-mail: e_v_schik@mail.ru)

ABSTRACT: At night and during rain slugs crawl up trees and bushes. In the morning, as the air humidity decreases, they do not retrace their track but just crawl downwards. If the branch is bent down, the slug will crawl to its end and then continue the downward movement on a thread of mucus. The mucus thread of *Deroceras reticulatum* (O. F. Müll.) gets up to 60 cm long with the slug descending at 10 cm per minute; that of *Arion fasciatus* (Nilsson) is up to 27 cm. Going down on mucus threads can be considered a behavioural feature of slugs as an ecological form. This method of descending has appeared in different families as a result of convergence.

KEY WORDS: *Deroceras reticulatum*, *Arion fasciatus*, mucus, locomotion

INTRODUCTION

Cases of slugs being suspended on mucus threads are known for some species of the Agriolimacidae, Ariolimacidae, Arionidae, Limacidae and Vaginulidae (LATHAM & ROMSEY 1798, KEW 1902a, b, LIKHAREV & WIKTOR 1980, RICHTER 1980, WIKTOR & STAWARCZYK 2010). During decades of studying gastropods in their natural environment, I have repeatedly observed slugs descending on their mucus threads. However, in all cases the observations were

incomplete as I was unable to see the very beginning of the slug's descent. Special observations were conducted to overcome this. The purposes were (1) to find out why slugs crawled down the tree trunks sometimes while in other cases they descended on mucus threads, and (2) to reveal the characteristics of the slugs' behaviour during their descent on the mucus threads.

MATERIAL AND METHODS

This paper is based on observations in the gardens of the Tver Region of Russia in August and September from 2001 to 2012. The observations were carried out in daylight as well as at night with the help of a flashlight. Those included 16 cases of adult *Deroceras reticulatum* (O. F. Müller, 1774) and four cases of adult *Arion fasciatus* (Nilsson, 1822) descending. All the observations of slugs going down on mucus threads took place after night time rains, in windless weather from 5 to 8 a. m. astronomical time. The ambient temperature was +8 to +15°C, and the relative humidity was 80–90%.

In 2011 and 2012 in a garden I did more than 60 experiments in order to reveal the characteristics

of the slugs' descending on their mucus threads. The garden plants included apple (*Malus domestica* Borkh.) and plum (*Prunus domestica* L.) trees and bushes of black currant (*Ribes nigrum* L.), raspberry (*Rubus idaeus* L.), and gooseberry (*Ribes uva-crispa* L.). *Aegopodium podagraria* L. and *Urtica dioica* L. were dominant in the herb layer. The latter was regularly cut down during summer.

Adult *D. reticulatum* and *A. fasciatus* taken out of moist litter were used in the experimental studies carried out in August and September from 8 to 12 a. m. astronomical time on rain-free windless days. The ambient temperature was +14 to +22°C, and the relative humidity was 70–90%. Individual slugs

were put onto slightly bent down gooseberry or plum tree branches 0.7–1.8 m above the ground. The slugs' movement was observed, and their descent on the mucus threads was photographed. Artificial lighting was not used for taking photos. The thread length was measured with a ruler. Drawings of the slugs' body positions were based on the photos.

RESULTS

At night, when dew falls and especially during rains, slugs crawl up the high grass, bushes and trees (KÜNDEL 1916, FRÖMMING 1954, SHIKOV 1980). *D. reticulatum* and *A. fasciatus* move up to 1–2.5 m above the ground. In the mornings and after rain in daytime, when humidity decreases, the slugs start moving down. They do not turn back to take the same way they have used for crawling upwards. Neither do slugs try to leave the branch immediately, performing any vertical movement straight down. They just gradually crawl downwards along the sloping branch. If the slug thus reaches the trunk of the tree, it will just crawl down along the trunk.

If the animal starts moving being on a bent-down branch, it will soon reach the end of it. Continuing its movement, it soon comes to hang on a mucus thread. The mucus covering the slug's sole contracts beyond the slug's body, due to the surface tension, thus turning into the mucus thread.

D. reticulatum and *A. fasciatus* observed in their natural environment went down from plum and apple tree branches 1.2 to 1.8 m high. The length of the mucus threads was 15–27 cm for adult *A. fasciatus* and 40–60 cm for adult *D. reticulatum*.

In the experiments, all the slugs put onto the branches soon began to move downwards. Having reached the end of the branch, the animals got into

DISCUSSION

Descending on mucus threads has been registered for slug species of different families distributed in different countries and on different continents. This suggests that this method of locomotion is characteristic of slugs in general. Slugs themselves are a polyphyletic, purely morphological group (LIKHAREV & WIKTOR 1979, 1980). Thus, the slugs' descending on threads of their mucus may also be considered a convergent form of behaviour. As a pre-adaptation for this, slugs have their mucus glands much stronger developed compared to snails. The vast amount of mucus lets slugs suspend on mucus threads.

Having got rid of the shells, slugs gained in mobility but lost the means of protecting themselves from drying out as well as from numerous predators. Thus,

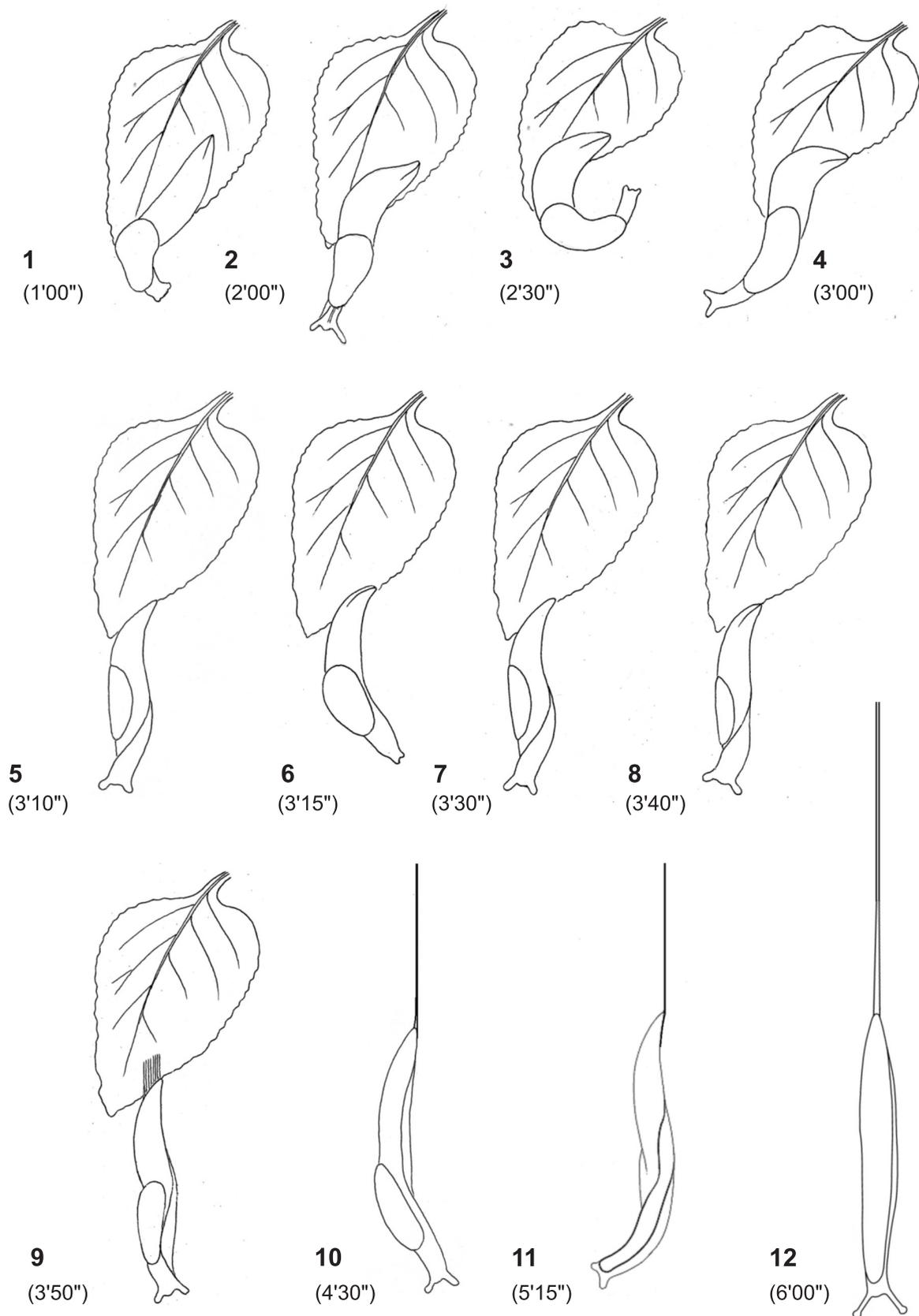
Besides, several dozen of tests of dropping *D. reticulatum* and *A. fasciatus* slugs from the height of 2 m down onto the grass or fallen leaves covering the ground were undertaken in the morning from 5 to 8 a. m. astronomical time, i.e. in the hours when the slugs tend to go down on their own. At that time of the day, the grass and the fallen leaves were wet.

a half-body hanging position and showed seeking movements (Figs 1–9). They did not stop moving downwards however and soon got beyond the last leaf of the branch. Despite the four cases of adult *A. fasciatus* going down on their mucus threads in the natural environment, in the experiments I had no success in trying to observe this type of descent in this species. In all the tests those slugs fell down soon after their descent on the mucus thread had started.

Adult *D. reticulatum* hung on a thread of their mucus. During the first minutes of moving down on the thread, the slugs bent their bodies longitudinally (Figs 9–10). Later they continued their descent without any bending or bending only very slightly (Figs 11–12). The mean descent velocity was 10 cm per minute. The mucus thread got as long as 40–60 cm. The slugs did not go all the way down to the ground on the threads; the threads broke, and the animals fell down. Once in the grass, the slugs immediately crawled into the litter. If even a very slight wind arose during the experiments, the mucus thread was broken at once.

During the test drops of the slugs onto the grass or fallen leaves from the height of 2 m those did not show any visible damage and immediately crawled away.

the slugs' behaviour is different from the snails' one. In the case studied, this difference is seen in comparing of their behaviour during migrations. Both go up the trees, bushes and high grass when dew falls at night, and also in any rainy or foggy weather. When the ambient humidity drops down, molluscs have to seek shelter to avoid drying out so they start to move downwards. However, snails of many species just attach themselves to the substratum and stay on trees, bushes or grass until the next humid period comes. This behaviour is typical of a number of species of many families, such as Bradybaenidae, Clausiliidae, Enidae, Helicidae, Vertiginidae, and others. The shell provides them with the possibility of surviving the low humidity periods in this way. Slugs cannot stay



Figs 1–12. Slug going down on its mucus thread. Time lapse since the observation started is marked in parenthesis. While the slug moved, the leaf changed its position so in Figs 3 and 4 it looks smaller. When the slug's body goes off the leaf, the band of mucus also disconnects from the leaf thus becoming more noticeable (Fig. 9). In Fig. 12, the slug is seen from its ventral side



outside of some kind of external shelter. These animals move downwards without any apparent difficulties (KÜNKEL 1916, FRÖMMING 1954, LIKHAREV & WIKTOR 1979, 1980, SHIKOV 1980).

There is no evidence to support the suggestion that descending on mucus threads is an adaptation for getting to the litter faster. The animals never even try to perform straight vertical movement downwards – though falling from 2 m height into the grass or fallen leaves does not do them any apparent harm (KEW 1902a, b).

Any other speculations, such as the slugs' descending from the ends of branches being an advantage for their dispersal or for efficient mixing of individuals in a population, or for saving their energy, etc., call for special experimental verification which was not among the purposes of this research.

The results obtained match those of other researchers (LATHAM & ROMSEY 1798, KEW 1902a, b, RICHTER 1980). These results confirm the earlier sug-

gestion by KEW (1902b) on the mucus threads emerging incidentally. KEW (1902b: 165) believed the slugs' thread-making to be “an accidental circumstance arising out of the possession, for ordinary locomotion, of a continuous supply of tenacious mucus.” This means that the formation of mucus threads just takes place when the slug crawls away from any support, with the slug simply starting to ‘crawl in the air’.

The descent of slugs on their mucus threads cannot be considered an unusual phenomenon. Descending like that happens regularly in the mornings after rainy or foggy nights. The rarity of records of this fact is due to the insufficient number of observations in the wild.

ACKNOWLEDGEMENTS

It is my duty to thank Dr HEIKE REISE of Germany and the anonymous reviewer for their help in refining this paper.

REFERENCES

- FRÖMMING E. 1954. Biologie der mitteleuropäischen Landgastropoden. Dunker & Humblot, Berlin.
- KEW W. 1902a. On the mucus-threads of land-slugs. *J. Conch.* 10: 92–103.
- KEW W. 1902b. On the mucus-threads of land-slugs. *J. Conch.* 10: 153–165.
- KÜNKEL K. 1916. Zur Biologie der Lungenschnecken. Carl Winters, Heidelberg.
- LATHAM J. M. D. F. R. S., ROMSEY L. S. 1798. Observation on the spinning *Limax*. *Trans. Linn. Soc. London* 4: 85–89. <http://dx.doi.org/10.1111/j.1096-3642.1798.tb00518.x>
- LIKHAREV I. M., WIKTOR A. J. 1979. Parallelizmy v stroeyenii i sistematicheskoye polozheniye slizney nadotryada Stylommatophora. *Tr. Zool. Inst. AN SSSR* 80: 70–86.
- LIKHAREV I. M., WIKTOR A. J. 1980. Fauna slizney SSSR i sopredelnykh territoriy (Gastropoda, terrestria nuda). *Izd. Nauka, Leningrad.*
- RICHTER K. O. 1980. Movement, reproduction, defense, and nutrition as functions of the caudal mucus in *Ariolimax columbianus*. *Veliger* 23: 43–47.
- SHIKOV E. V. 1980. Ispolzovaniye nazemnymi mollyuskami pochvy, travyanogo i drevesno-kustarnikovogo yarsov v biogeotsenozakh tsentra Russkoy ravniny. In: TOMASHEVSKIY K. E., ZINOVIEV V. I., SOROKIN M. G. (eds). *Fauna Nechernozemya, yeyo okhrana i ispolzovaniye*. *Izd. Kalininskogo Gosudarstvennogo Universiteta, Kalinin*, pp. 141–157.
- WIKTOR A., STAWARCZYK T. 2010. An unusual mode of locomotion of an Ecuadorian slug *Belocaulus* sp. (Mollusca: Gastropoda: Vaginulidae). *Folia Malacol.* 19: 277–278. <http://dx.doi.org/10.2478/v10125-011-0007-6>

Received: November 11th, 2013

Revised: January 28th/February 25th, 2014

Accepted: March 14th, 2014

Published on-line: April 30th, 2014

