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Field observations on the influence of low water velocities on drifting of Bulinus globosus

H.P. Marti[1] & M. Tanner[1,2]
[1]*Swiss Tropical Institute Field Laboratory, P.O. Box 53, Ifakara, Tanzania;* [2]*Current address: Swiss Tropical Institute, Socinstr. 57, CH-4051 Basel, Switzerland*

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Abstract

The influence of water velocities of less than 30 cm/s on drifting of *Bulinus globosus* in a natural stream was investigated. It is shown that although a low water velocity does not sweep away adhering snails, it carries away snails releasing their hold and crawling along the water surface in search of new food sources. A low water velocity therefore assists considerably to the spreading of a snail species. Vegetation was found to have a decisive impact on local water velocity conditions by reducing the current and creating protected pockets. Upstream migration was found not to be common among *Bulinus globosus*.

In addition, evidence for snail drifting under natural conditions within well established *Schistosoma haematobium* transmission sites is presented.

Introduction

So far, most experiments describing the influence of water velocity on aquatic snail populations were either carried out in rivers with quite a strong water velocity (Azim & Ayyad, 1948), or in irrigation channels (Rahman & Sharaf, 1961; Dazo *et al.*, 1966; Fenwick & Amin, 1982). In addition many authors' emphasis was more focussed on determination of maximally tolerated velocities rather than on investigating the influence of comparatively low velocities on snail populations (Jobin & Ippen, 1964; Appleton, 1975). However, especially in relation to transmission of schistosomiasis a better understanding of the influence of low water velocities on snail-vector populations would be desirable. It would allow a better planning of control measures directed against the snails in situations where transmission occurs in slow flowing water systems.

Consequently, the present study aimed at an evaluation of the role of low water velocity on snail drifting in a small stream some 350 km SW of Dar es Salaam/Tanzania, in an area well known to be endemic for urinary schistosomiasis (Zumstein, 1983; Marti *et al.*, 1985).

Materials and methods

The experiments were carried out in a stream some 18 km NE of Ifakara, in the village of Kikwawila. The chosen stretch was 120 m long, with a water depth varying between 6 and 50 cm and a width between 35 and 180 cm. The banks were partly covered by vegetation (undergrowth of the Brachystegia woodland 'miombo'), as were some parts of the stream itself. Besides the vegetation many natural obstacles were present in the water, such as trees or branches from the last flood.

The snails used for the experiments originated from a nearby pool. They were all *Bulinus globosus* with a size between 4 and 10 mm. For marking, the shells were carefully cleaned with a piece of soft paper and a drop of blue Rucopren[R] cement paint (Rupf & Co. Ag., Glattburgg, Switzerland) was applied with a small brush. The paint was allowed to dry for 20 minutes.

All snails (300 – 450/run) were released into the water simultaneously. The releasing-point was marked with a stick (site 0). Every 10 m another stick was placed with the consecutive number. Between sticks no. 10 and 12 (100 – 120 m) the water was completely covered with snailtraps made out of palmleaves according to Marti (1984).

The area, including 10 m upstream of the releasing point, was searched by two men 6 hours, 1, 3, 5, 7 and 10 days after release of the snails. The search was started at the site of the palmleaf-traps and was carried out moving upstream in order to avoid view disturbing mud-turbulences and double counts of drifting snails. All snails found within the marked 10 m intervalls were counted. Much attention was paid not to set the snails in motion artificially by removing them from their substrate. In addition, every 10 m the water velocity was measured at the time of the search with a C2 current meter (A. Ott GMBH, Kempten, FRG).

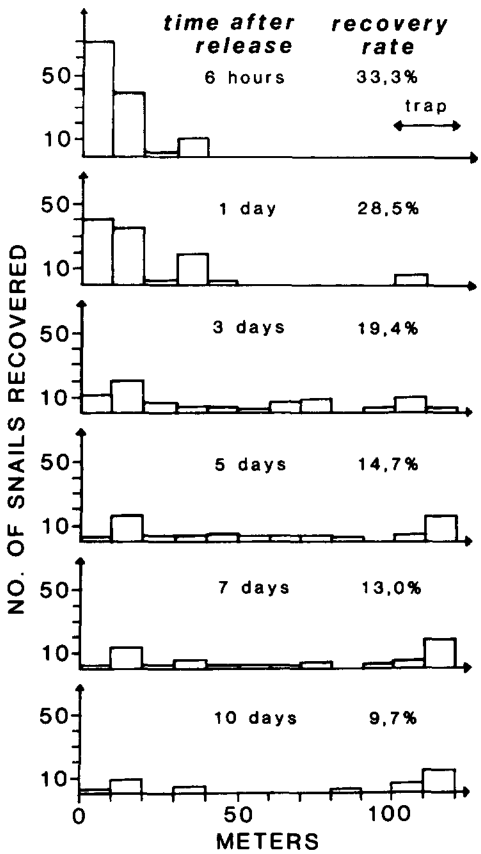

Fig. 1. Distribution of *Bulinus globosus* in the stream at different time intervals after release of 361 snails at 0 m. One column represents the number of *Bulinus* found within one marked 10 m interval.

Results

The experiment was carried out 4 times at the beginning of dry season. As all four runs showed similar results, only the results of two of them are presented.

Figure 1 shows an experiment carried out with 361 *Bulinus globosus*. The maximum water velocity reached 41 cm/s, while the minimum was less than 3 cm/s. After releasing the snails into the water, most of them sank immediately to the bottom, while some floated away with the current. After 5 minutes these snails had drifted 12 m. After 25 minutes the first snails arrived at 40 m where they came to a halt (cf. Fig. 1, 6 hours). The blue cement paint contrasted perfectly with the background and allowed an easy identification of the snails. The recovery rate was 33.3% after 6 hours and dropped to 9.7% after 10 days.

After 1 day nearly all the snails were still found on the first 40 m downstream of the releasing point, either attached to the vegetation or on the bottom of the river, but a few (5) could already be found on the traps. From the 3rd day onwards the snails were more or less evenly distributed over the whole experimental area. The number of snails found on the traps at the end of the experimental area rose with time. After 10 days more than half of the snails recovered were found attached to the traps.

Figure 2 shows an experiment carried out with 430 *B. globosus*. The maximum/minimum current was 29 cm/s and less than 3 cm/s, respectively. The recovery rate of the snails was 60% after 6 hours and

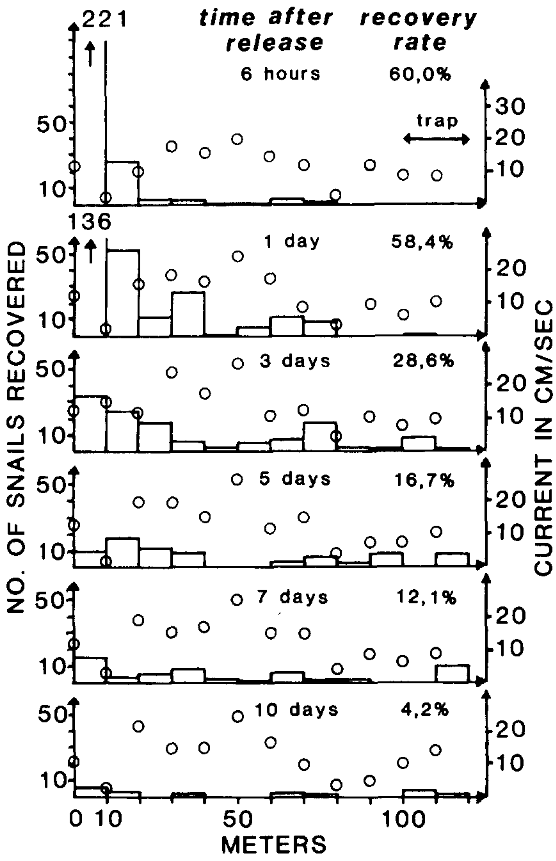

Fig. 2. Distribution of *B. globosus* in the stream at different time intervals after release of 430 snails at 0 m. One column represents the number of *Bulinus* found within one marked 10 m interval. o = water velocity.

4.2% after 10 days. The results show a very similar distribution pattern as the one shown in Fig. 1. After 6 hours the snails were concentrated on the first 20 m, but already after 1 day larger numbers of them could be found 80 m downstream of the releasing point and the first snail was found on the traps at the end of the experimental area. After three days one marked *B. globosus* was found 50 cm upstream of the releasing point. This was the only time during all drifting experiments that a snail was found to have moved against the current. From the 3rd day onwards the snails were found in constantly declining numbers all along the river, with a clear minimum between 40 – 60 m, where the current was highest.

The water current showed only slight variations during the experiment (Fig. 2).

Evidence for snail drifting under natural conditions

By the end of dry season, a regular determination of size frequency distribution of a *B. globosus* population was undertaken in a nearby streamhabitat according to Marti (1984). During this period of the year the stream at the searching site had disintegrated into three pools (distances A – B and B – C: 50 m each). In each pool a separate size frequency distribution was established. In site A (farthest upstream) a rather old population with hardly any young snails was found, while in sites B and C young populations with hardly any adult *B. globosus* were present (cf. Fig. 3a). Three weeks later the next investigation was carried out. In the meantime the first rains had started and the water level had been rising. The three sites were now connected by a small passage where the current was 12 cm/s. The size frequency distribution at the three sites now showed quite a different pattern (cf. Fig. 3b). In the sites further downstream (B and C) a considerable number of large snails was found. It is impossible that the young population of three weeks before could have grown to reach the size of the large snails of site A. Thus, these large snails must have been swept in from site A (distance A – C: 100 m) or from other sites even further upstream. During the same time the young population at site C was drastically reduced, which at least partly can be attributed to a sweeping away of the small individuals.

Discussion

In order to get a high snail recovery rate which would allow a good monitoring of drifting these experiments were carried out in a relatively small stream. The careful release and the low water velocity resulted in a slow dispersal of the snails and almost all of them came to a first rest within the first 40 m of the experimental area. The further spread then occurred gradually, as the constantly declining recovery rate indicates. Additionally the palmleaf traps prooved to be quite effective for the detection of fast drifting snails as can be seen in Fig. 1. E.g. Dazo *et al.* (1966) recovered only 6.13% of the *Biomphalaria alexandrina* and 0.7% of the *Bulinus truncatus* released,

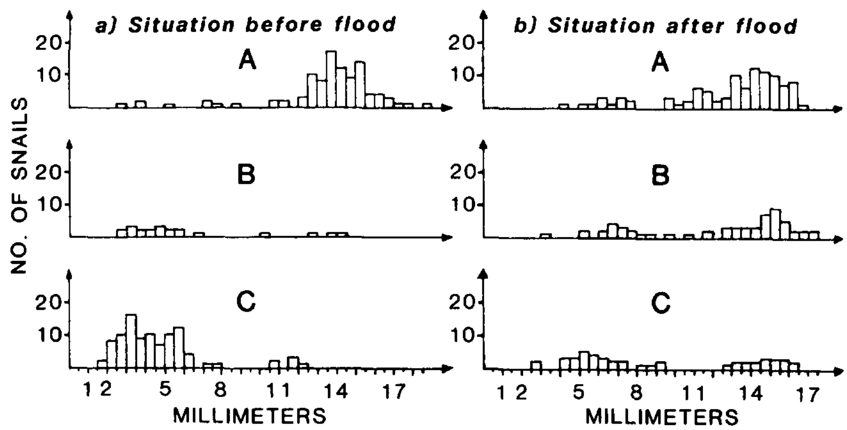

Fig. 3. Size frequency distribution of *B. globosus* in three neighbouring habitats situated in a stream. The stream flows in direction from habitat A to habitat C. The distances A–B and B–C were 50 m each. The investigations were carried out three weeks apart.

although there was no vegetation present in the investigated irrigation channel.

It is well agreed that *Biomphalaria* and *Bulinus* species do not occur in water bodies where the water velocity is above 30 cm/s for longer periods (Appleton, 1975). Laboratory experiment with *Bi. glabrata* revealed that the snails became immobile at about 33 cm/s and were swept away as soon as the velocity exceeded 65 cm/s (Jobin & Ippen, 1964). It should be pointed out that in natural habitats the vegetation is able to reduce the water velocity considerably. This allows the formation of suitable habitats for the snails even in streams with a relative high velocity (Mousa & Abou el Hassan, 1972). In our experiments similar observations were made. During the rainy season a water velocity of 66 cm/s was measured in the middle of the stream while behind some leaves of *Cyperus exaltatus* it was reduced to 9 cm/s. The peculiar crossectional M-shape of the leaves of this sedge may additionally protect attached snails against the current. This observation compares well with the one of McMullen (1973), who stated that snails in earthen channels can resist currents up to 60 cm/s when they are hidden behind protective vegetation.

A low water velocity will not sweep away attached snails, but snails frequently release their hold and ascend to the surface. Subsequently they will start drifting until they either seek hold on vegetation, are swept into a protected pocket or sink to the bottom of the river. Azim & Ayyad (1948) and Markowski (1953) observed that nearly all *Bulinus* spp. caught were drifting at the surface, except when there was a very strong current. In addition, Rahman & Sharaf (1961) demonstrated that screens reaching only 50 cm below the water surface proved to be very effective in preventing reinfestation of channels treated with molluscicide.

The question arises whether colonization of a habitat is also possible by snails moving upstream. This feature has very rarely been observed. Radke & Ritchie (1961) and Paulini (1963) reported observations of upstream migration of *Australorbis glabratus*, but similar observations for other species were never reported. In this study upstream migration could only be determined at the releasing point of the drifting experiments. Only once one snail was found to have moved 50 cm upstream. After two days it had disappeared and could no longer be detected upstream. The current at this point was constantly between 11 and 17 cm/s. This finding indicates that upstream migration of *B. globosus* is uncommon, at least as long as a slight current is present.

It can be concluded that a colonization of habitats by drifting over longer distances is well possible until the water becomes stagnant. Afterwards a further spread due to the snails' own movement will occur only over much smaller distances. On the other hand colonization of habitats by *B. globosus* migrating upstream seems to be unlikely.

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