

**Succession in the snail fauna of a rehabilitated limestone quarry  
near Maastricht, The Netherlands**

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The snail fauna of a limestone quarry rehabilitated in 1979 had been investigated in 1984 and was re-examined in 1996. Over this 12 year period the number of species collected increased from 10 to 18. For two of the three sites inspected succession in the snail fauna paralleled succession in the vegetation at these locations. Thanks to active ecological management, however, the vegetational aspect of one location had remained about the same. At this site the number of species collected increased from 8 to 15; for one or perhaps two out of these 15 species the number of specimens found in 1996 had markedly decreased as compared to 1984. The data for this site confirm that the snail fauna described in 1984 could be considered a pioneer fauna of dry, calcareous habitats. Provided the present ecological management is continued, eventually the snail fauna in the rehabilitated part of the quarry is expected to match that of calcareous grasslands in the vicinity of the quarry.

**Key words:** Gastropoda, Pulmonata, ecology, succession, faunistics, Limburg, The Netherlands.

## INTRODUCTION

In 1984 the snail fauna of a rehabilitated section of the limestone quarry in the Sint Pietersberg (a Cretaceous hill just south of Maastricht, The Netherlands) was investigated (Lever & Majoor, 1986). At that time, five years after the rehabilitation, eight snail species were determined to be inhabitants of the quarry, with three species quantitatively strongly dominating. At one locality on a south to south-east exposed slope *Helicella itala* was the dominant species accompanied by *Candidula intersecta* and *Trichia hispida*; at two localities on a slope facing north *Trichia hispida* and *Candidula intersecta* dominated the snail fauna. The geographical distribution of *Candidula intersecta* in The Netherlands is restricted to parts of the dunes along the North Sea coast and the Sint Pietersberg (Mörzer Bruijns et al., 1959; Gittenberger et al., 1984). Because this species is quite rare on the Sint Pietersberg beyond the quarry (Lever & Majoor, 1987) and because of the marked quantitative dominance of three species, we suggested the snail fauna of this area to represent a pioneer fauna of a dry, calcareous habitat.

To test the validity of this proposition 12 years later, we have re-examined the same localities for the occurrence of snails. Our hypothesis was that more species would be inhabiting the area with a less marked quantitative dominance of just a few species. Furthermore, because *Candidula intersecta* has been suggested to prefer ruderal habitats (Altena, 1958) we also presumed that *Candidula intersecta* would be less abundant in this rehabilitated part of the quarry.

## DEVELOPMENT OF THE LOCALITIES EXAMINED

The rehabilitated part of the quarry is an approximately 400 m long artificial valley with its longitudinal axis orientated south-west to north-east and with slopes reaching about 40 m above the bottom where the width of the valley is about 200 m. The three locations examined in 1996 for the occurrence of snails were the same as those selected in 1984.

Location 1 is about half-way a slope facing north. In 1984 this site was covered with a herb layer up to 1.5 m high. Twelve years later a young deciduous wood had developed with trees of about 9 m high. Common species included *Alnus glutinosa*, *Quercus robur*, *Acer pseudoplatanus* and *Cornus sanguinea*.

Location 2 is situated below location 1, close to the bottom of the valley. Due to manual removal of young trees and grazing by sheep for short periods during the winter, this locality had not developed into woodland but maintained a high herb layer with *Melilotus albus*, *Origanum vulgare* and *Lotus corniculatus* among the most common plant species.

Location 3 is situated on the south to south-east exposed slope of the valley, selected in 1984 because it was not yet fully covered with plants. In 1996 the whole slope was grown over with herbs akin to those found at location 2 and there were some scattered trees; ecological management at this location has been the same as specified for location 2.

## MATERIALS AND METHODS

The methods for collection of snails used in August 1996 were identical to those applied in July 1984. At each location each author collected all snails discovered at sight during half an hour. Thereafter, at each site each author assembled a soil sample of about one litre. Later these soil samples were passed through sieves, the last one having a mesh-width of 0.3 mm. Snails collected were identified on the basis of Gittenberger et al. (1984), if necessary with the aid of a Wild M3B stereomicroscope. Specimens are kept by one of the authors (GM). Nomenclature used is according to Bruyne et al. (1994).

## RESULTS

Taking all snails collected at the three locations together 18 species were identified, 8 more than found in 1984 (table 1). At location 1, 12 species were found as compared to 6 in 1984. *Cochlicopa lubrica*, *Cochlicopa lubricella*, *Vallonia pulchella*, *Merdigera obscura*, *Discus rotundatus*, *Aegopinella nitidula*, *Clausilia bidentata*, *Monachoides incarnatus*, and *Cepaea hortensis* were found in 1996 but not in 1984. On the other hand *Vallonia costata*, *Vallonia excentrica*, and *Oxychilus draparnaudi* found in 1984 at this site, were not recovered in 1996. Like in 1984 the quantitatively dominant species was *Trichia hispida*; of *Candidula intersecta*, that was co-dominant in 1984 with 132 specimens collected, in 1996 only 6 empty shells were recovered.

At location 2, 15 species were collected, six more than in 1984. As compared to 1984 *Cochlicopa lubrica*, *Vallonia pulchella*, *Discus rotundatus*, *Aegopinella nitidula*, *Clausilia bidentata*, *Clausilia rugosa parvula*, and *Cepaea hortensis* were new inhabitants of this site. In 1984 one specimen of *Zonitoides nitidus* was found at this location; in 1996 this species was not detected in the quarry. Also at this site *Trichia hispida* was the quantitatively dominant

Species	Locations					
	1		2		3	
<i>Cochlicopa lubrica</i> (Müller, 1774)	13	(—)	14	(—)	25	(—)
<i>Cochlicopa lubricella</i> (Porro, 1838)	2	(—)	1	(8)	—	(—)
<i>Cochlicopa</i> spec. (juvenile)	16		31			
<i>Vallonia costata</i> (Müller, 1774)	—	(19)	41	(8)	107	(6)
<i>Vallonia excentrica</i> Sterki, 1892	—	(1)	—	(—)	41	(3)
<i>Vallonia pulchella</i> (Müller, 1774)	1	(—)	25	(—)	38	(—)
<i>Vallonia excentrica/pulchella</i> (juvenile)	—		6		35	
<i>Merdigera obscura</i> (Müller, 1774)	1	(—)	—	(—)	—	(—)
<i>Punctum pygmaeum</i> (Draparnaud, 1801)	—	(—)	10	(1)	2	(—)
<i>Discus rotundatus</i> (Müller, 1774)	6	(—)	3	(—)	—	(—)
<i>Vitrina p. pellucida</i> (Müller, 1774)	13	(12)	3	(12)	8	(2)
<i>Aegopinella nitidula</i> (Draparnaud, 1805)	9	(—)	12	(—)	—	(—)
<i>Oxychilus draparnaudi</i> (Beck, 1837)	—	(5)	2	(2)	—	(—)
<i>Zonitoides nitidus</i> (Müller, 1774)	—	(—)	—	(1)	—	(—)
<i>Clausilia bidentata</i> (Ström, 1765)	11	(—)	11	(—)	—	(—)
<i>Clausilia rugosa parvula</i> Férussac, 1807	—	(—)	19	(—)	—	(—)
<i>Clausilia</i> spec. (juvenile)	—		11		—	
<i>Candidula intersecta</i> (Poiret, 1801)	6	(102)	6	(33)	—	(143)
<i>Helicella itala</i> (L., 1758)	—	(—)	7	(3)	61	(126)
<i>Monachoides incarnatus</i> (Müller, 1774)	2	(—)	—	(—)	—	(—)
<i>Trichia hispida</i> (L., 1758)	58	(132)	203	(411)	209	(32)
<i>Cepaea hortensis</i> (Müller, 1774)	7	(—)	1	(—)	—	(—)
Total number of species: 18 (10); per loc.:	12	(6)	15	(9)	8	(6)

Table 1. Numbers of specimens of snail species collected in 1996 and (between brackets) in 1984 at three locations in the rehabilitated part of the limestone quarry in the Sint Pietersberg. Description of the locations is given in the text.

species. In 1996 only 6 empty shells were found of *Candidula intersecta*, in 1984 represented at this site with 33 specimens. Furthermore, at this location juvenile specimens of *Cochlicopa* spec., *Vallonia* spec., and *Clausilia* spec. were collected.

At location 3, eight species were found; two more than in 1996. *Vallonia excentrica* was exclusively recovered from this site. *Cochlicopa lubrica*, *Vallonia pulchella* and *Punctum pygmaeum* were found in 1996 but had not been collected in 1984. On the other hand, of *Candidula intersecta*, the quantitatively dominant species in 1984 with 143 specimens collected, none was detected in 1996. Also here *Trichia hispida* was quantitatively dominant, but in addition considerable quantities of *Vallonia costata* and *Helicella itala* were collected.

## DISCUSSION

The snail fauna present in 1984 in a limestone quarry rehabilitated five years earlier had been considered by us as a pioneer snail fauna of a dry, chalk-rich habitat (Lever & Majoor, 1986). This study aimed to monitor whether 12 years later succession in the snail fauna had occurred and if so, in what respect.

The standardized collection procedure allowed for comparison of the quantitative data among the localities and between the data of 1984 and 1996. However, collection of snails in July (1984) or in August (1996) may have affected the numbers of living snails sampled (Reinink, 1979).

The number of snail species detected in the rehabilitated part of the quarry increased from 10 in 1984 to 18 in 1996. However, over the same period of time also the vegetation at locations 1 and 3 had changed considerably. Location 1 had developed from an area covered with herbs into a young deciduous wood. The largest change in the quarry's snail fauna is seen at this site: nine species were found that were not yet detected in 1984, and three species occurring in 1984 were not recovered in 1996. Among the latter three species *Vallonia costata* and *Vallonia excentrica* were considered characteristic for chalk grassland (Smith, 1980) which may explain their disappearance. The failure to recover *Oxychilus draparnaudi* is enigmatic since this species commonly prevails in moist woods (Hässlein, 1960). Six among the nine species newly collected in 1996 are considered common inhabitants of deciduous woods and forests (Hässlein, 1960): *Merdigera obscura*, *Discus rotundatus*, *Aegopinella nitidula*, *Clausilia bidentata*, *Monachoides incarnatus*, and *Cepaea hortensis*. These findings suggest that the succession in the snail fauna at this location occurred in parallel to the succession in the vegetation.

In contrast, thanks to the active ecological management including restricted grazing by sheep, the aspect of the vegetation at location 2 has remained about the same over the 12 years between the initial and the present inventory. Nevertheless, at location 2 the number of snail species collected increased from 9 to 15. Among the nine species collected in 1984 at this site were single specimens of *Punctum pygmaeum* and *Zonitoides nitidus*, which species were therefore by us not considered settled inhabitants of the quarry. The present data confirmed that decision for *Zonitoides nitidus* [which occurs along the borders of the nearby rivers Meuse and Jeker (Majoor & Lever, 1989) but not on the Sint Pietersberg enclosed by these rivers (Lever & Majoor, 1987)]. On the other hand, it is likely that *Punctum pygmaeum* had already settled in the quarry in 1984. Therefore, in reality the number of species at this site presumably increased from 8 in 1984 to 15 in 1996.

*Vallonia costata* and *Cochlicopa lubricella* occurring at location 2 were considered by Hässlein (1960) common for dry and cool grasslands and by Smith (1980) characteristic for chalk grasslands. Of the 11 snail species listed by Mörzer Bruijns et al. (1959) to occur on "Bromion erecti" grasslands on dry calcareous soils in The Netherlands, five were found at location 2: *Cochlicopa lubrica*, *Cochlicopa lubricella*, *Vallonia costata*, *Vallonia pulchella*, and *Vitrina p. pellucida*. Of the six remaining species *Vallonia excentrica* was abundant on location 3; *Pupilla muscorum*, *Cecilioides acicula*, *Vertigo pygmaea* and *Truncatellina cylindrica* were not found in the quarry but have been reported for chalk grasslands on the Sint Pietersberg beyond the quarry (Lever & Majoor, 1985; De Winter, 1985) whereas in 1984 *Columella edentula* seemed extinct on the Sint Pietersberg (Lever & Majoor, 1987). Of the other species collected at location 2 the occurrence of *Clausilia rugosa parvula*, and *Helicella itala* is particularly noteworthy as they prefer dry, calcareous habitats (Mörzer Bruijns et al., 1959; Gittenberger et al., 1984). Therefore, we interpret the data pertaining to location 2 to represent a developing snail fauna of a dry, calcareous grassland. Although the crude data indicate expansion of, rather than succession in, the snail fauna at location 2, it should be noted that the numbers of specimens of two species collected in 1996 had decreased considerably as compared to 1984: *Candidula intersepta* from 33 to 6 specimens and *Cochlicopa lubricella* from 8 to 1 (assuming all juvenile *Cochlicopa* specimens collected at this site to represent *C. lubrica*).

The appearance of the moisture-preferring species *Cochlicopa lubrica*, *Vallonia pulchella*, and *Punctum pygmaeum* in the snail fauna at location 3 as compared to 1984, the higher number of *Trichia hispida* specimens and the lower number of *Helicella itala* specimens found, may be due to the increased coverage of this site by high herbs. In 1984, parts of this area were still bare and the remainder only covered with low herbs. Therefore, as for location 1, also at location 3 the succession in the snail fauna is likely to be due to the changed vegetation.

Between the two investigations the number of specimens of *Candidula intersepta* collected at the three locations markedly decreased from 278 to 12. In 1996, two fresh and 10 weathered shells were collected. This decrease may be due to the further development of the vegetation in the rehabilitated part of the quarry. This finding corroborates Alena's (1958) suggestion that *Candidula intersepta* may prefer ruderal habitats. Consequently, we predict this species eventually to entirely disappear from this area. On the other hand, provided the present ecological management of this part of the quarry is continued at locations 2 and 3, the snail fauna may expand further eventually to match that described for the chalk grasslands on the Sint Pietersberg beyond the quarry (Lever & Majoor, 1985). A period of at least 30 years has been mentioned to reach a climax in the development of the malacofauna of a constant habitat (Boot, 1989).

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