Notes on the behaviour and potential food plants of the snail, *Trigonephrus haughtoni* Connolly (Mollusca: Dorcasiidae), in the southern Namib Desert

Barbara Curtis

State Museum of Namibia, P.O. Box 1203, Windhoek

The behaviour of ten snails was observed over five days in winter. Snails were active at night and on calm, cold, wet mornings. The mean distance travelled during each activity period was 6.2 ± 3.1 (mean ± S.D.) m and the direct distance progressed each activity period was 2 ± 2.1 (mean ± S.D.) m. Twenty potential food plants were collected and their abundance and cover (14.17%) were estimated. Snails fed on *Othonna sparsiflora*, *Grielum sinuatum* and ?*Pentzia* sp. which were three of the six most abundant plant species present. After activity periods snails buried themselves just below the surface either in the open or under food plants. Sometimes they were not totally covered.

INTRODUCTION

The southwest arid region of southern Africa is home to four endemic genera of terrestrial snails (van Bruggen 1978). One of these, *Trigonephrus*, occurs in the winter rainfall region from the southwestern Cape to southern Namibia (Connolly 1931, 1939). The taxonomy of this genus is in need of revision (W. Sirgel, pers. comm.) and virtually nothing is known of its biology. Some preliminary work has been done on aspects of the physiology of *Trigonephrus haughtoni* (Dallas et al. 1991), which appear to be active only in winter. A conspicuous feature of the landscape in the dunes of the southern Namib Desert is the numerous, large accumulations of empty *Trigonephrus* shells (Dallas & Curtis 1991).

In the winter of 1989 I observed the behaviour of ten different *Trigonephrus haughtoni* snails in the southern Namib for five days. In addition, I made an assessment of the plant species available to these snails as potential food.

STUDY AREA

General

Roter Kamm (27° 46′S; 16° 17′E; altitude 540 m) is a meteorite crater in the sand dunes of the southern Namib Desert (Diamond Area No. 1). It is 2.5 km in diameter with the rim 150 m above the surrounding terrain. The crater and rim are covered by coarse aeolian sand with sparse vegetation, most of which is dormant in summer. In the winter (rainy season) perennials put out new growth and numerous annuals germinate (Figs 1 & 2). The mean annual temperature range for the area is 10.3°–25.1° C with mean temperatures in July (winter) ranging from 4.5°–19.0° C. Mean annual rainfall is 85.6 mm. Winter is the calmest period of the year, with wind direction being very variable (data for Aus, 110 km north of Roter Kamm, supplied by the Weather Bureau, Windhoek).

Study site

The area in which the snails were observed was on the outer, southern slope of the crater rim, about 10 m from the crest. It was about 45 m wide across the slope (west to east) and 70 m long down the slope (north to south), being naturally bounded on three sides by large clumps of *Euphorbia gregaria*. Plant ground cover in the area was 14.17% (line-transect method—see Methods) (Fig. 1).

METHODS

General

On two nights and subsequent mornings a large area on the southern side of Roter Kamm was searched for active snails. The only snails found were in the area described above and all observations were made on ten individuals within this study site. Some notes were made on direct observations of the active snails. Others were from indirect observations made of the distinct trails left by the snails and indications of plants having been eaten. Weather conditions were measured throughout the study period using a maximum-minimum thermometer, a standard thermometer, a sling psychrometer to determine humidity, and a rain gauge.

Vegetation transects

Three 60 m line transects at the study site ran roughly from north to south down the slope of

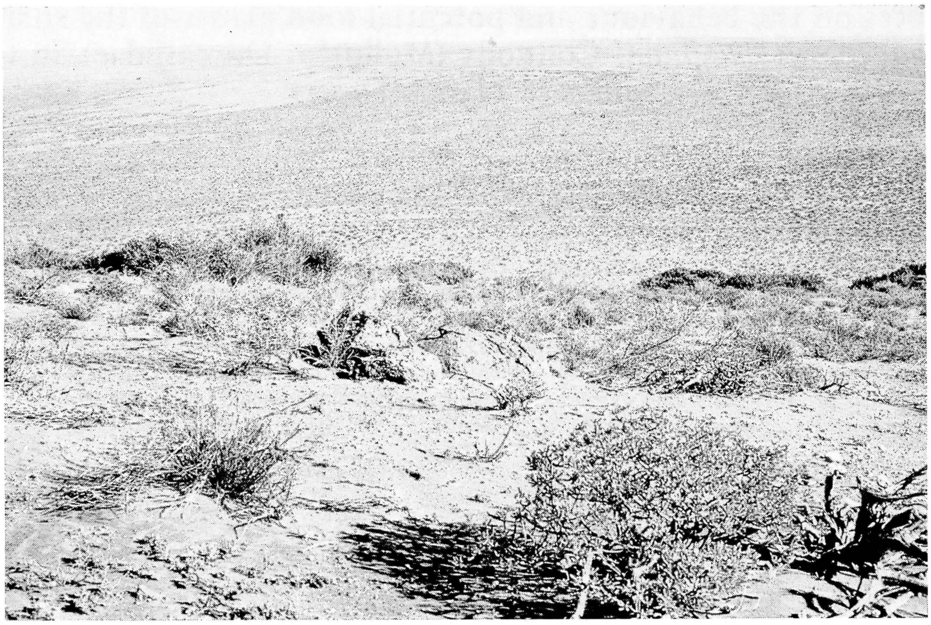


Figure 1. Habitat of *Trigonephrus haughtoni* at Roter Kamm in the southern Namib Desert.

the crater. The first transect began where the first snail had buried. The second and third were about 12 and 29 m to the east respectively. The portion of the transect covered by each individual plant was noted and the results for the three transects were combined. Twenty plants were collected from the area for identification.

RESULTS

Weather

During the study period (25—30 June 1989) the weather was cool and damp, with 1 mm rainfall on the first night. The minimum relative humidity (RH) at midday was 32%. The minimum temperature recorded was 4° C, while the maximum was 22° C. Mornings were calm and clear (except for one which was calm and foggy). In the evenings there was generally a light to fairly strong southerly wind blowing.

Activity

Snails were active only at night and in the morning. Table 1 summarizes the weather conditions and number of snails active each night and morning. Both mornings on which snails were active RH was 100% and ambient temperature was 6° C. One was a clear morning after the rain, when snails remained active until 10h00, at which time air temperature was 16° C and surface temperature was 13° C. The second was a morning of heavy fog, when a few individuals were still active at noon, by which time it was clear with a strong wind blowing. Air temperature was only 14° C.

Table 1. Weather conditions and number of *Trigonephrus haughtoni* snails active each night and morning.

Night	At sunrise		Mininum	No. snails active	
	Humidity (%)	Temp. (° C)	Temp. (° C)	Night	Sunrise
1	100	6	5	2	2
2	92	5	4	5	0
3	70	10	–	1	0

As a general pattern of activity, snails would emerge some time during the night and meander over the sand. The number of snails active, duration of activity and distance travelled was very variable. Table 2 summarizes the actual distances meandered as well as the direct distance progressed from start of activity to end. Only half of the snail observations (8 of 16) included feeding. On two occasions snails moved over a food plant without feeding and on other occasions snails moved past or away from food plants. No unstaged encounters between snails were observed. Twice, when snails were put within 60 mm of each other, they moved away from each other in different directions without any apparent reaction to each other.

Table 2. Distances (m) moved by *Trigonephrus haughtoni* per period of activity.

	Mean	S. D.	Range	N
Trail length	6.2	3.1	1.8–13.9	14
Direct distance	2.0	2.1	0.2– 8.0	12

After activity the snails would bury themselves under the sand. They were never buried very deep—the apex of their shells being about 5—15 mm below the surface. Sometimes the apex was still visible when they ceased activity. Of 20 buryings observed, seven were in the open, 12 under plants (Table 3) and one between two rocks. This individual was not able to bury itself completely because the distance between the rocks was less than the size of its shell. The plant species under which the snails buried were mostly the three food species. Only on one occasion, however, did a snail bury itself under the plant on which it had been feeding. On another, the snail emerged and then started to feed on the plant under which it had been buried.

Table 3. Plant species occurring in Roter Kamm study area. Abundance (number of individuals) and cover (% of total 180 m) were recorded along three transects (see Methods). The number of observations of a plant species being eaten or buried under by *Trigonephrus haughtoni* are also given. The two records in the last column with .5 are due to one snail burying itself under two species which were growing together. ---- represents plants present in the area but not occurring on the transect.

Plant species	Abundance	Cover	Eaten	Buried under
Stipagrostis garubensis (Pilger) de Winter	27	2.77	-	1
Othonna sparsiflora (S. Moore) B. Nord	22	3.69	3	5
Lebeckia multiflora E. Meyer	19	3.03	-	1.5
Capparis hereroensis Schinz	----	----	-	-
cf *Hermannia gariepina* Ecklon & Zeyher	1	0.06	-	-
cf *Hermannia comosa* Burch ex. DC	----	----	-	-
Pentzia albida (DC) Hutch.	26	0.43	-	-
Grielum sinuatum Licht. ex Burch.	26	2.69	3	3.5
? *Pentzia* sp.	25	0.48	4	1
Arctotis fastuosa Jacq.	----	----	-	-
Indigofera cf *argyroides* E. Meyer	3	0.03	-	-
Limeum cf *fenestratum* (Fenzl) Heimerl	2	0.01	-	-
Sutera sessilifolia (Diels) Hiern	----	----	-	-
Dischisma spicatum (Thunb.) Choisy	2	0.02	-	-
Zygophyllum sp.	5	0.52	-	-
Hermannia pfeilii Schumann	----	----	-	-
Salsola sp.	1	0.24	-	-
Crotalaria colorata Schinz	----	----	-	-
cf *Ornithogalum glandulosum* Oberm	1	0.02	-	-
Unidentified grass	4	0.18	-	-

Total plant cover along transects: 14.17%

Food and plant cover

Table 3 lists the plants occurring in the study area and gives the abundance of the 14 plants encountered along the transect as well as ground cover. Three species, *Othonna sparsiflora, Grielum sinuatum* and *?Pentzia* sp. were eaten by the snails (Fig. 2). These species were amongst those most commonly encountered, although the cover of *?Pentzia* sp. was not very high. *Othonna sparsiflora* (Fig. 2a) is a small, neat shrub with succulent leaves, which the snails sometimes climbed into to eat. This is totally dormant in summer. *Grielum sinuatum* (Fig.2b) is a prostrate annual with fairly large, yellow flowers. The snails grazed the leaves and flowers as they passed over the plant. Sometimes they moved over the plant without grazing. ?Pentzia (Fig. 2c) is also an annual with a semi-prostrate habit. The snails grazed the leaves which lay on the surface.

DISCUSSION

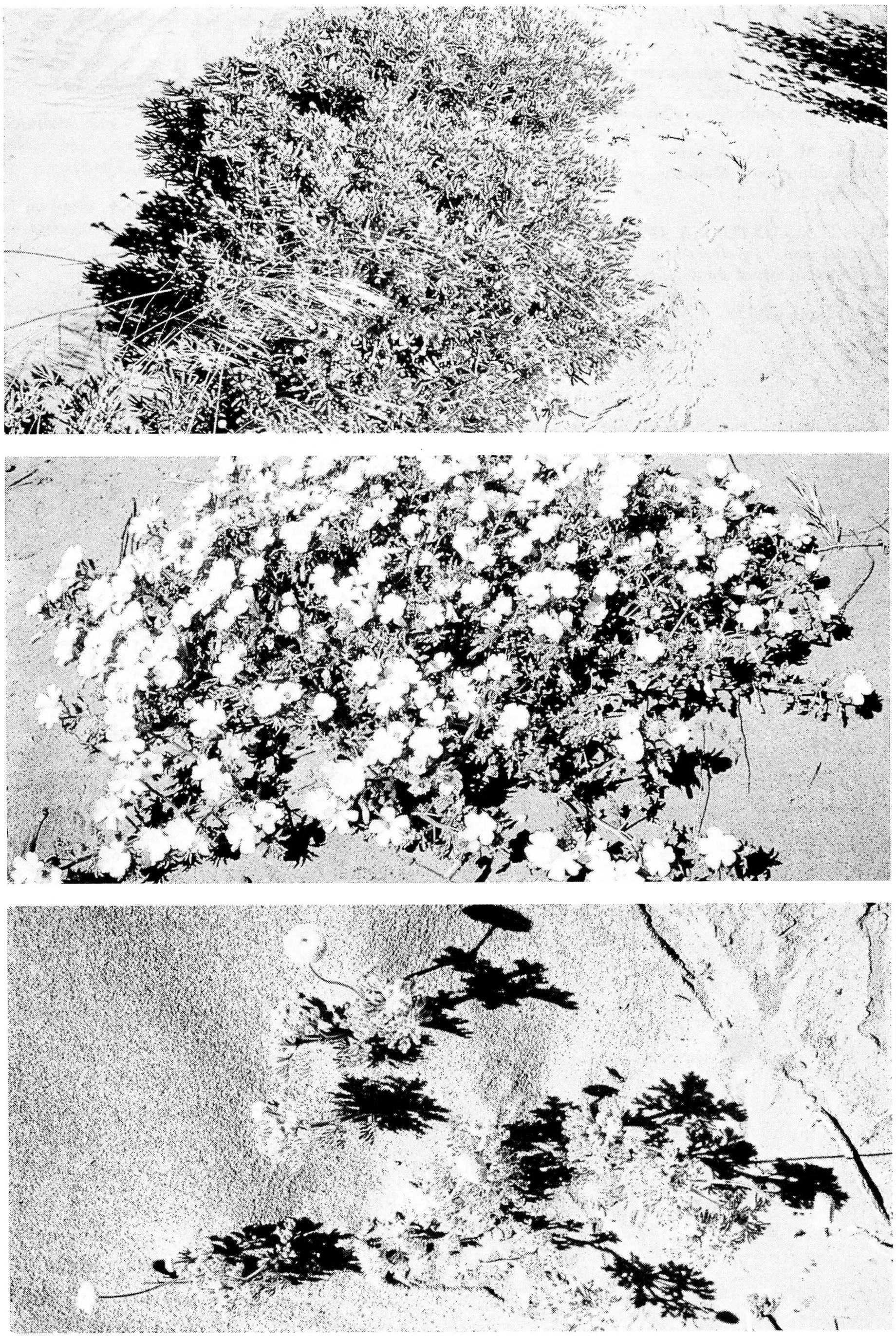
These few observations give tentative insight into the behaviour patterns and feeding of this little-known desert species and open up a number of avenues for further research. *Trigonephrus haughtoni* is apparently active only in winter (Dallas & Curtis 1991), lying dormant beneath the sand during the hot, dry summer months when little food is available. In the laboratory these snails were also active only in winter and formed an epiphragm across the shell aperture in the summer (pers. obs.; Dallas et al. 1991).

Humidity appears to have a strong influence on activity, since both mornings when snails were active RH was 100%. On other mornings when RH was less than 100% snails buried

sumed and only two of the four species with the highest ground cover. Although *?Pentzia* did not contribute much to ground cover, it grew up to 200 mm tall. Snails were not observed to climb into these plants to forage, but they may well do so, which would increase the amount of food available to them. Desert snails are known to eat lichens (Gilbertson 1969; Yom-Tov & Galun 1971), but although there were at least three different species of lichens which could be potential food for *T. haughtoni*, they were never observed to eat lichens.

Movement of the snails appeared to be random. One would expect snails to be looking for food and/or mates when active. The fact that snails moved past or away from food plants without feeding suggests that foraging was not always their objective during periods of activity. These snails have a low metabolic rate (Dallas et al. 1991) and presumably do not need to eat regularly. The mean distance between the centre of plants was 1.1 m, thus during an average meander of 6.2 m, a snail would be likely to encounter six plants, of which 2.6 may be one of its preferred food species. Thus the chances of finding food during an average foraging foray would be good. Some individuals moved over such short distances, however, that they were unlikely to encounter food or mates.

By contrast to foraging, the chances of encountering another snail would be extremely low. How such slow moving animals find each other in a vast area with widely dispersed individuals (10 in 3150 m^2) would be worth investigating. Having found another snail, what triggers copulation in these hermaphro-



(a)

(b)

(c)

Figure 2. Plants eaten by *Trigonephrus haughtoni*. (a) *Othonna sparsiflora* (b) *Grielum sinuatum* (c) ?*Pentzia*

vations on the snails; and to Consolidated Diamond Mines for permission to work in Diamond Area No. 1.

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