Water-extracting Tenebrionid Beetles from the Wahiba Sands, Oman

W. Büttiker and E. Anderson

CONTENTS

الخلاصة تم وصف سلوك إستخلاص الماء لثلاثة أنواع من الخنافس القاتمة المنتشرة حول الكثبان الرملية في الأقليم الشرقي لسلطنة عمان . وتبعا لكل نوع ، تختلف طرز بناء الأنفاق والتلال والخنادق المبنية حول الرمال الرطبة . تعد هذه المشاهدة الثانية من نوعها ، حيث تم وصف مثيلتها في صحراء ناميبيا قبل ١٠ سنوات . وأورد البحث معلومات حول البيئة المحلية ورطوبة الرملة والندى لبيئة الخنافس ، بالاضافة إلى وصف الأحوال البيئية للكثبان الرملية .

Summary Water-basking behaviour of three tenebrionids from the sand dunes of the Eastern Province of the Sultanate of Oman is described. Mounds, trenches and sub-surface tunnels in the moist sand are built in a specific manner for each species. This observation is the second of its kind described only for the Namib Desert some 10 years ago. Microclimatic data, dew and sand moisture records in the beetles' habitat are given, as well as description of the ecological conditions of the sand dune biotope.

Keywords: Oman, Tenebrionidae, water basking, microclimate, sand moisture, ecology.

Introduction

First field observations of three nocturnal tenebrionid beetles of the genus *Lepidochara* were reported by Seely and Hamilton (1976) from the Namib Desert. These species construct trenches perpendicular to fog winds. The beetles return along the ridges of trenches from which they extract free water increasing their weight by some 13.9%.

In the zoological survey of Saudi Arabia during 1975–1985 (Büttiker, 1985) members of the ultrapsammophilic genera *Ammogiton* and *Erodius* were mainly discovered in the barren sand dunes of the Dahna and Great Nafud deserts. The new species were described by Kaszab (1979, 1981–1982). Previous records of *Ammogiton* were known only from Morocco, Tunisia and the northwestern Sahara. However, the water extracting behaviour in the Saharan region and in Saudi Arabia had not so far been observed.

During the zoological survey of the Oman Wahiba Sands Project, organised by the Royal Geographical Society, a total of five water-basking tenebrionid species was found. A report on their water-extracting behaviour observed in all areas of the Sands visited is being prepared (Büttiker & Büttiker, in prep.). In this paper, observations made on three of them in an intensive study area are published. It is of interest to mention that all these Tenebrionidae are undetermined species.

As part of the geomorphological programme of the Project, measurements were made of dew, together with the moisture of the sand surface crust. The technique for accurately assessing the moisture content of thin layers of material was refined further for work on the tenebrionid beetles.

Physical Environment

The immediate environment for the work consisted of a complex assemblage of sand dunes, the area measuring some 2 km by 1 km situated at Qarhat Mu'ammar at the eastern fringe of the Wahiba desert (Figure 1). The dunes were almost totally bare of vegetation, mobile and of barchanoid form (Plate 1). They varied in height from 2m to 5m, and their shape, and particularly the aspect

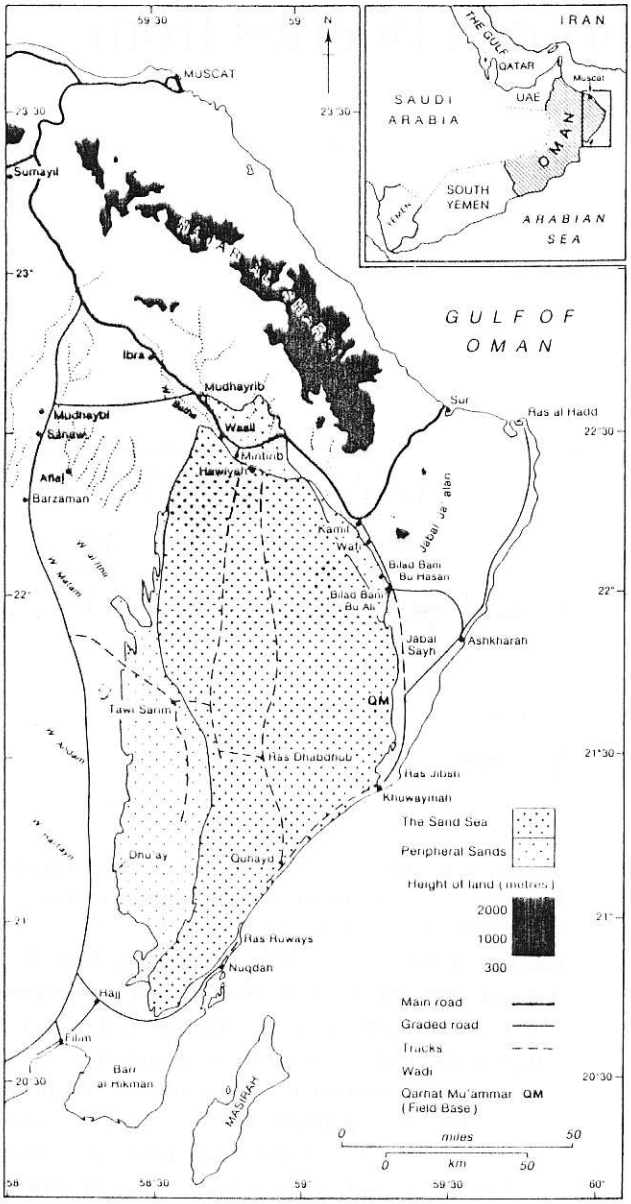

FIGURE 1. Map of Wahiba Sand Desert and adjoining districts.

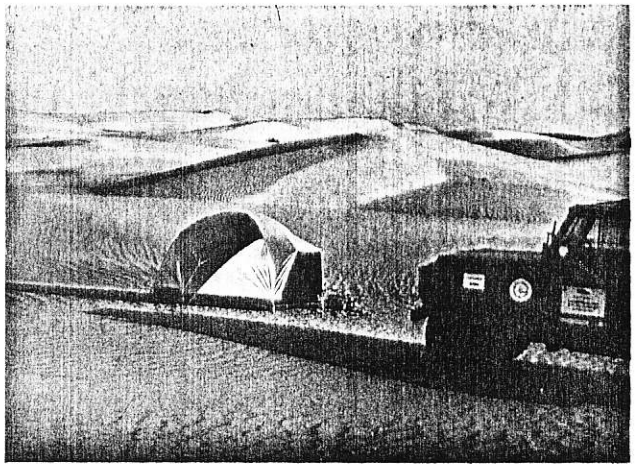

PLATE 1. Biotope of the Wahiba barchanoid sand dunes at Qarhat Mu'ammar south of Bilad Bani Bu Ali, a typical area where water basking from dew condensation by *Ammogiton* and *Erodius* is very common. (Photograph by W. Büttiker)

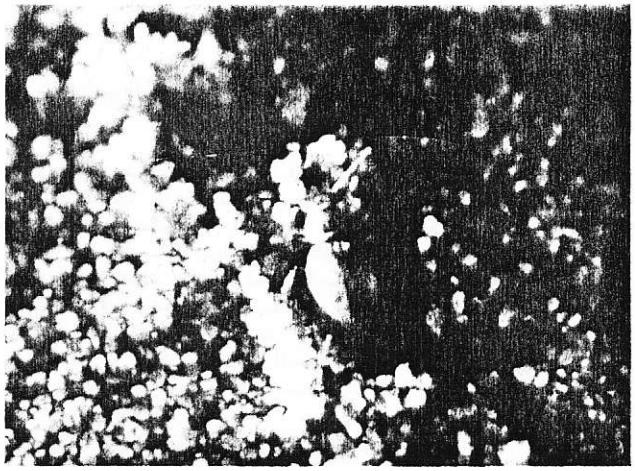

PLATE 2. *Ammogiton* sp. basking free water in a sand track, fully saturated by dew. (Photograph W. Büttiker)

of the slip-face, changed constantly, according to the dominant wind direction (Warren, 1988, this volume; Embabi, 1982).

Climatically, the area displays the general characteristics of a hot desert, with a comparatively small annual shade temperature range of some 25°C (approximately 25°C in December, 50°C in June and July), but a rather larger daily range. Thus, while the relative humidity is generally very low, night-time cooling facilitates dew formation. Rainfall is highly variable and appears to follow a three to six year cycle. Since in the intervening years there is virtually no rain, statistics for the mean have little validity. Between March and October the prevailing wind direction is from the southwest, but during the remainder of the year it is markedly more variable, with a northerly bias.

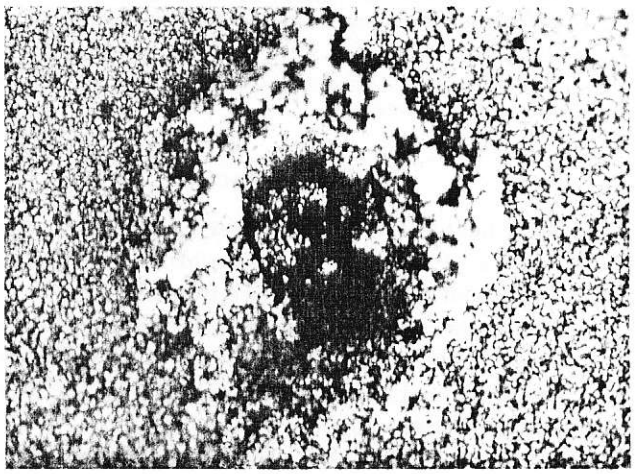

PLATE 3. A specimen of *Erodius* sp. in a mound on a sand dune crest extracting free water. (Photograph W. Büttiker)

Methods

Sampling of nocturnal sand dune dwelling tenebrionid beetles was very tedious and time consuming in the past due to the large volume of sand to be searched for beetles. The situation drastically changed with the discovery that a certain proportion of the adult tenebrionids make their way to the dune surface during the night when dew, fog or rain produced a wet crust. They construct the typical mounds and trenches which are amply visible in the early morning hours (Plates 2 and 3). The beetles are then collected *in situ* from these vantage points or, if already penetrated into the sub-surface, by means of an ordinary sieve of some 25 cm diameter. Depending on the degree of dew formation and suitability of the biotope, it was possible to sample up to 30 specimens in one hour.

Soil moisture was measured by the Speedy Moisture Tester which, with one operator, has an accuracy of 0.1% (Anderson & Cox, 1984). For the vertical moisture gradient, a fine paintbrush was used to collect the sample, millimetre by millimetre.

Results

At the beginning of the Expedition water basking by *Ammogiton* and *Erodius* was discovered on the barren sand dunes at Ras Dhabdhub, situated in the centre of the Wahiba Sands. Further field observations soon followed at other locations and additional behaviour up to the end of the field inspections. It was revealed that this behaviour was very common with all species, but the number of specimens per surface unit varied according to the amount of organic debris blown into the sand dunes. The highest number of beetles is near vegetated areas or where *Prosopis cineraria* is part of the sand dune plant ecosystem. On the other hand, large barren sand dune complexes with a plant cover of below 1% and with little organic debris harbour very few water-basking tenebrionids.

Sand crust moisture measurement, giving as accurately as possible a mean value for the top 5 or 6 mm, were made at 1m intervals along a series of transects across the dunes. With the constraints imposed by time before evaporation and the incidence of dew itself, six such transects were completed (see Figures 2 and 3) and in each case the value for the crest was significantly higher than that elsewhere. It varied from 1.5% to 2.0% wet weight, while the mean for the dune faces ranged from 0.9% to 1.2% wet weight.

To establish the moisture gradient at the crest line, the content of each millimetre layer through the crust was measured. In each case, there was a sharp decline from between 1.7% and 2.2% wet weight for the surface millimetre to 0.1% for the lowest millimetre of the crust. The decrease was generally regular, although, in one case, the figure for the second millimetre was only half that for the first.

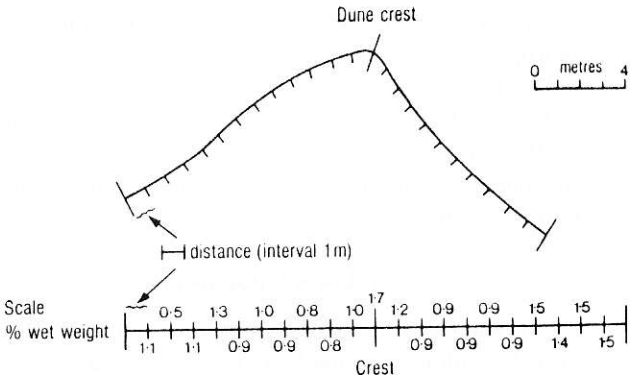

FIGURE 2. Sand crust moisture transect (March 25, 1986).

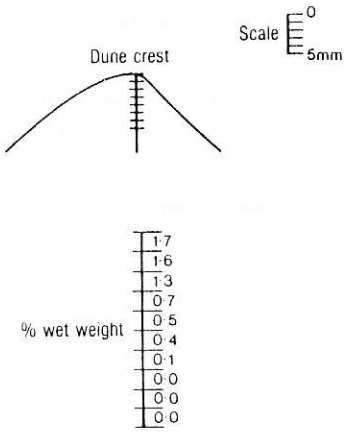

FIGURE 3. Crestline moisture gradient (March 25, 1986).

Thus, it is clear that for a very small surface area of dune, crest line and its immediately adjacent area, there is a clear moisture maximum. Along the crest, dew is effectively settling on two faces but the main factor producing this effect may be the coarseness of the sand grains, which allows greater pore space. This very limited area of dune is therefore the only one with, under normal circumstances, free water available.

Conclusions

In these first records outside the Namib observation area (Seely & Hamilton, 1976), it has been shown that tenebrionid beetles of several genera and species are able to make use of dew and rain in a superarid environment. The constructed small sand mounds and trenches on the sand surface contain enough free water for active intake during the early morning hours. The extraction of water ends before or just after sunrise when the mounds and trenches start to disintegrate. The beetles return to the dry subsand to a depth of 10 to 20 cm avoiding therefore the extreme sand surface temperature. It seems to be obvious that this behaviour allows the survival of small and medium-sized insects in

an extremely dry and almost vegetationless sand biotope.

Evidence for the sand moisture measurements indicates strongly that the tenebrionid beetles surface in the zone of peak moisture values. The governing mechanism to find the areas with the optimum moisture contents remains still to be explained.

Acknowledgements

The Royal Geographical Society, the Corporate Patrons and the Sultan of Oman's Armed Forces are gratefully acknowledged for their facilities and support. The best thanks are extended to Mrs. S. Büttiker who enthusiastically and efficiently assisted in the field work.

References

ANDERSON, E.W. & COX, N.J., 1984. The relationship between soil creep rates and certain controlling variables in a catchment in Upper Weardale, Northern England. In Walling, D.E. & Burt, T.P. (eds.), *Catchment Experiments in Fluvial Geomorphology*. Geo. Books.

BÜTTIKER, W., 1985. Zoological Survey in Saudi Arabia. *Fauna of Saudi Arabia* 7: 5–14 (with references to previous reports).

BÜTTIKER, W. & BÜTTIKER, S. Water basking Tenebrionidae (Insecta) from sand dunes in the Eastern Sands of Oman. *Fauna of Saudi Arabia*. In preparation.

EMBABI, N.S., 1982. Barchan of the Kharga depression. In El-Baz, F. & Maxwell, T.A. (eds.), *Desert Landforms of Southwest Egypt: A basis for comparison with Mars*, 141–155. Washington, DC: National Aeronautics and Space Administration.

KASZAB, Z., 1979. Insects of Saudi Arabia. Coleoptera: Fam. Tenebrionidae. *Fauna of Saudi Arabia* 1: 257–288.

1981–1982. Insects of Saudi Arabia. Coleoptera: Fam. Tenebrionidae (Part 2). *Fauna of Saudi Arabia* 3: 276–401 and 4:124–243.

SEELY, M.K. & HAMILTON, W.J., 1976. Fog catchment sand trenches constructed by tenebrionid beetles, *Lepidochara*, from the Namib Desert. *Science* 193: 484–486.

WARREN, A., 1988. The dunes of the Wahiba Sands. *Journal of Oman Studies, Special Report* No. 3: 131–160

Address for correspondence

PROF. W. BÜTTIKER, Lanzenberg 21, CH-4312 Magden, Switzerland.

DR E. ANDERSON, Department of Geography, University of Durham, Science Laboratories, South Road, Durham DH1 3LE, UK.