NAT. CROAT. | VOL. 10 | No 3 | 133–140 | ZAGREB | September 30, 2001

ISSN 1330-0520
UDK 591.542˙595.43:591.5(931)

original scientific paper / izvorni znanstveni rad

SOME ECOLOGICAL AND ETHOLOGICAL OBSERVATIONS ON *HENDEA MYERSI CAVERNICOLA* (CHELICERATA: ARACHNIDA: OPILIONES), A SEEING TROGLOBITE

VICTOR BENNO MEYER-ROCHOW[1]* & ALAN ROBERT LIDDLE[2]

[1]Department of Biology (Animal Physiology Section) & Institute of Arctic Medicine, University of Oulu, P.O. Box 3000, FIN-90570 Oulu, Finland (e-mail: vmr@sun3.oulu.fi)

[2]Department of Biology, University of the Waikato, Private Bag, Hamilton, New Zealand

Meyer-Rochow, V. B. & Liddle, A. R.: Some ecological and ethological observations on *Hendea myersi cavernicola* (Chelicerata: Arachnida: Opiliones), a seeing troglobite. Nat. Croat., Vol. 10, No. 3., 133–140, 2001, Zagreb.

Data on the visual behaviour of *Hendea myersi cavernicola* (Forster) are provided which demonstrate that this harvestman can see. Since no specimens could be trapped outside the cave and the integument of this species displays a reduction in pigmentation, we have to conclude that we are dealing with a troglobite which not only possesses eyes, but actually uses them.

Key words: ecology, ethology, physiology, biospeleology, troglobite, Waitomo Cave, visual behaviour, photoreception, UV, glowworm

Meyer-Rochow, V. B. & Liddle, A. R.: Neka ekološka i etološka opažanja troglobita koji vidi, *Hendea myersi cavernicola* (Chelicerata: Arachnida: Opiliones). Nat. Croat., Vol. 10, No. 3., 133–140, 2001, Zagreb.

U radu se daju podaci o vizualnom ponašanju *Hendea myersi cavernicola* (Forster), a koji pokazuju da ovaj kosac vidi. Nije bilo moguće uloviti nijedan primjerak izvan špilje, a integument ove vrste pokazuje redukciju pigmentacije, pa moramo zaključiti da se radi o troglobitu koji ne samo da ima oči, nego ih i koristi.

Ključne riječi: ekologija, etologija, fiziologija, biospeleologija, troglobit, Waitomo Cave, vizualno ponašanje, fotorecepcija, UV, krijesnice

* Corresponding author, permanent address: International University Bremen IUB, Faculty of Engineering & Science, D-28725 Bremen-Grohn, Germany.

INTRODUCTION

MEYER-ROCHOW & LIDDLE (1988) have shown that the two New Zealand species of cave-inhabiting opilionids, the darkly pigmented *Megalopsalis tumida* (Forster) and the poorly or unpigmented *Hendea myersi cavernicola* (Forster), not only possess eyes, but that their eyes can register the changes in intensity and spectral content of the brief flashes of light that were delivered to them during experimental tests.

Since eyelessness or the degeneration of photoreceptors has frequently been advocated as a defining character for troglobitic species, especially when combined with depigmented integuments (BARR, 1968; PETERS & PETERS, 1973; CULVER, 1982), the question arose as to whether the two species of harvestman, not displaying obvious reductions in eye size and function when compared with epigeic species (CURTIS, 1970; JUBERTHIE, 1964), could be true troglobites or were primarily only troglophilic.

Another, related question concerned the purpose of vision in these cave-dwelling harvestmen, for although *Megalopsalis* seemed to be attracted to the light of the cave glowworm *Arachnocampa luminosa* and repelled by UV-radiation (MEYER-ROCHOW & LIDDLE, 1988), no such data had been made available to date for *Hendea myersi cavernicola.* The results on the absence of *Hendea*, which is a well characterised and geographically defined race (and not just a troglomorphised population of the species *H. myersi*), in traps outside the cave environment have already been published before (MEYER-ROCHOW & LIDDLE, 1988), but they are briefly repeated in this contribution in connection with the discussion about the status of *Hendea myersi cavernicola* as a troglobite and whether it, just like *Megalopsalis tumida*, uses vision to (a) detect and approach glowworms and (b) locate and avoid cave entrances.

MATERIAL AND METHODS

For sampling the epigeal fauna of the bush surrounding the (stream) entrance into Waitomo Cave (New Zealand) pitfall traps of the design shown in Fig. 1 had been chosen as they satisfied the criteria of easy preparation, minimum impact on surrounding bush and its fauna, inconspicuousness, and easy maintenance over many months of sampling. They may not have allowed a reliable quantitative assessment of the invertebrate fauna (GREENSLADE, 1964), but since the purpose was to confirm absence or presence of *Hendea mysersi cavernicola* from outside the glowworm cave this drawback was deemed to be of little consequence.

Six pitfall traps were chosen, three in a clearing in close proximity to the outside jetty 12 m from the cave entrance, while the other three were established further into the bush (18 m from the cave mouth). All traps were on rather level ground and protected against the rain. Approx. 100 ml of Galt's odourless solution (i.e. 5g NaCl, 1g $NaNO_3$, 1g CCl_3 $CH(OH)_2$, 0.5 ml glycerol, 1 ml detergent, and 200 ml aq. dest.) were used in the container and the traps were inspected regularly (at least weekly) for approx. 22 weeks, starting in spring and ending in late summer. Inside the cave, monthly collecting trips, in which harvestmen were located visually, were organized almost throughout an entire year.

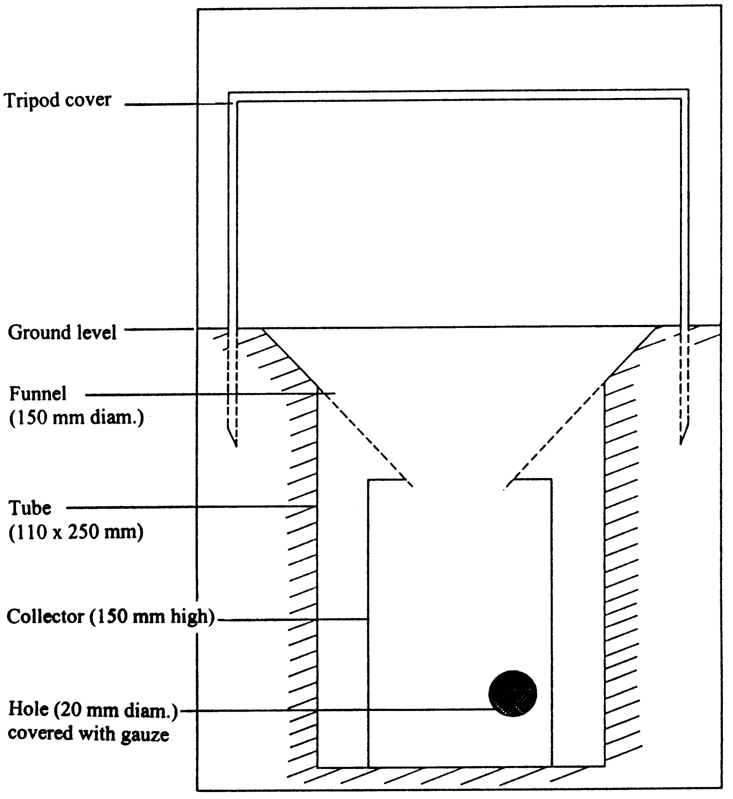

Fig. 1. Schematic design of the pitfall traps used outside the cave entrance to collect harvestmen.

For observation on the visual behaviour of *Hendea myersi cavernicola,* the same set-up that had previously proved useful in studies on the behavioural reactions to light by *Megalopsalis tumida* (cf. MEYER-ROCHOW & LIDDLE, 1988) was employed. Animals of both sexes were taken as no apparent difference in habitat preference, food or behaviour was evident. Firstly, the movements of ten different animals were traced under very dim red light (known from electrophysiological observations to excite the eyes of *Hendea* minimally: MEYER-ROCHOW & LIDDLE, 1988) when released facing four different directions on the 1.0×0.7 m large experimental arena in the absence of any other light.

The same animals were then used to monitor their responses to (a) artificial glowworm light (wavelength 498 ± 20 nm; intensity 0.6×10^{-2} W/m^2) presented to them in four different locations and (b) ultraviolet radiation (wavelength 348 ± 20 nm; intensity 1.8 W/m^2). The dimensions of the lights were approx. 35×10 mm, simulating size and intensity of a large glowworm and sunlight entering the cave through a crack, respectively. Before being used for any series of experiments, the specimens were isolated for a minimum of two days in dark, cave-like terraria maintained at 11–13 °C and prior to each presentation of the lights the experimental animal was given a three minute period in total darkness to become accustomed to the experimental arena.

The statistical treatment of the data followed methods outlined by ZAR (1984) and the data analysed from the trace diagrams are presented in the form of rose diagrams. Watson's U2 test (BATSCHELET, 1981) was used to determine statistical differences. The letters GW and UV in the figures relate to the positions of the artificial glowworm light and the UV-source, respectively, and the notations 0°, 90°, 180°, and 270° indicate the orientation of the released test animals.

RESULTS AND DISCUSSION

Sampling outside the cave, the pitfall traps were successful in capturing a large number of epigeal invertebrates, including three immature *Megalopsalis*. The effectiveness of pitfalls in the cave, where *H. myersi cavernicola* is positively present, is unfortunately not known, but, as stated earlier by MEYER-ROCHOW & LIDDLE, (1988) not a single *Hendea myersi cavernicola*, mature or immature, was obtained in the outside samples. Although no definitive proof that *Hendea myersi cavernicola* would never under any circumstance venture outside Waitomo Cave (because they could be regular surface dwellers in a more favourable place), the data did provide addi-

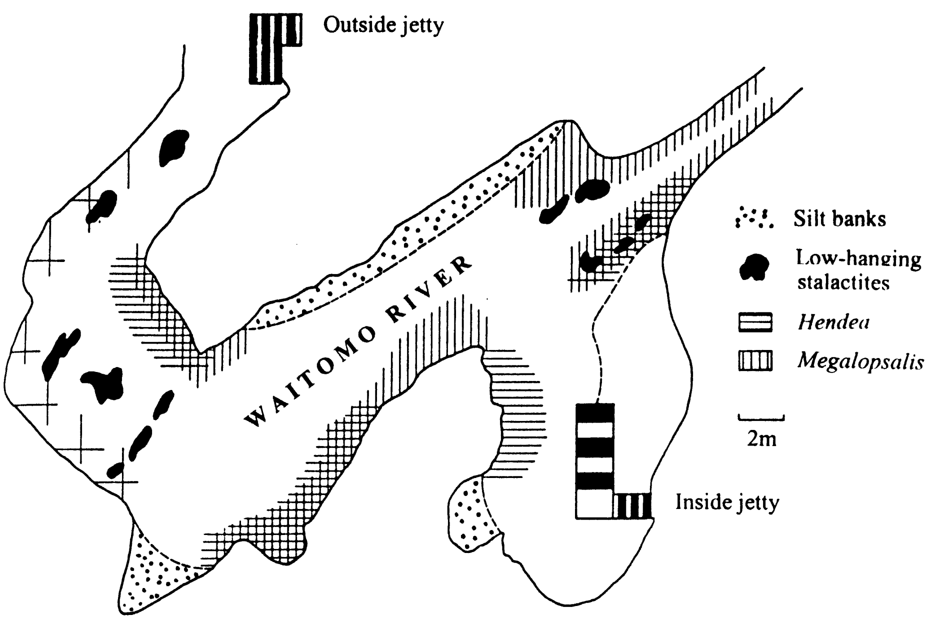

Fig. 2. Distribution of the two harvestmen *Megalopsalis tumida* (Palpatores), and *Hendea myersi cavernicola* (Laniatores) in Waitomo Cave, showing that despite some places of overlap there are considerable areas of the cave in which one or the other species dominates.

tional support for the view (MAY, 1963) that *Hendea myersi cavernicola* is likely to be a troglobite. The distribution of the two species of harvestman inside Waitomo Cave was as shown in Fig. 2. Although some overlap occurred, the distribution seemed to indicate that *Megalopsalis tumida* and *Hendea myersi cavernicola* operated mostly in somewhat different regions of the cave.

Being the smaller species of the two, *Hendea myersi cavernicola* feeds mainly on the (weakly) luminescent eggs and more brightly luminescent early instar glow-

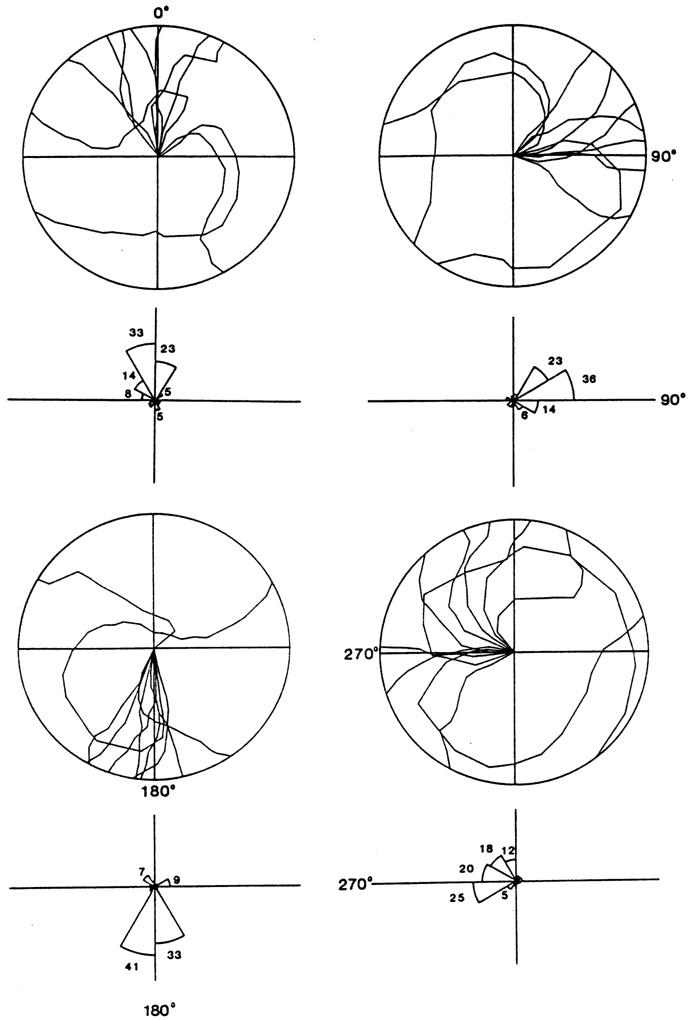

Fig. 3. Trace diagrams, with corresponding rose diagrams and percentages underneath, of the movements of 10 *H. myersi cavernicola* specimens in the absence of the artificial glow-worm light and UV-radiation, when released in four different directions indicated by the numbers 0°, 90°, 180° and 270°.

worm larvae, but being smaller and slower it also seems to prefer to be close to its prey, for it occurs in the areas of highest glowworm density where it is surrounded by food. Fully grown *Megalopsalis tumida*, on the other hand, have little to fear from even the largest glowworms and their sticky threads and are known to see pretty well, but nevertheless rarely venture right into the centre of a large glowworm colony; they prefer to linger at the periphery, probably raiding exposed or careless

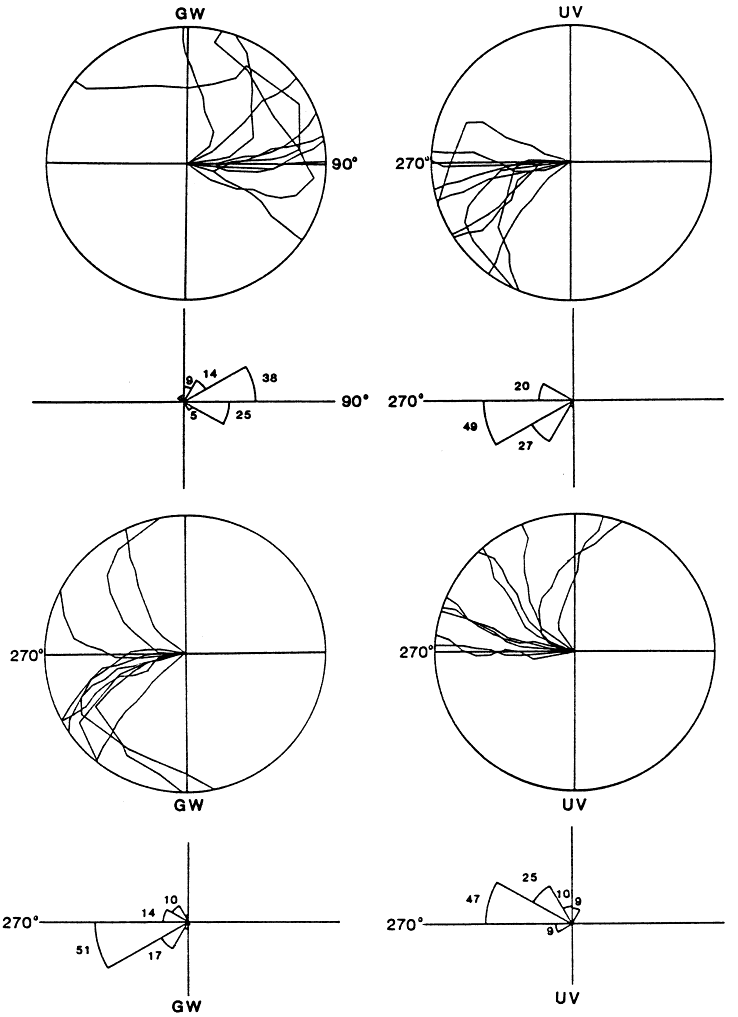

Fig. 4. Trace diagrams, with corresponding rose diagrams and percentages underneath, of the movements of 10 *H. myersi cavernicola* specimens in the presence of the artificial glowworm light (marked by GW) and UV-light source (marked by UV). A tendency of the harvestmen to veer towards the glowworm light, but shun the UV-source, is obvious and statistically significant in 63% of all cases tested.

glowworm individuals. Inside the cave neither harvestman species seems to have many natural enemies, the major threat probably being attacks from parasitic fungi like *Metarrhizium anisopliae* (LATCH, 1965) or *Tolypocladium* sp. (PUGSLEY, 1980).

Compared with the visual behaviour results of *Megalopsalis tumida*, those obtained by using individuals of *Hendea myersi cavernicola* (Figs. 3 & 4) displayed a greater dispersion of movement, indicative of slightly poorer directional vision. Whether that (in combination with *Hendea*'s shorter legs and lower travelling speed) can explain why *Hendea* occurs more frequently than *Megalopsalis* in the centre of dense glowworm populations (which it may be reluctant to leave, because of its poorer sight), is somewhat speculative. Yet, on the whole *Hendea* specimens showed very similar trends to those exhibited by the earlier tested *Megalopsalis* animals.

Irrespective of the direction under which the harvestmen were released, there was a clear preference for the direction that would take them to the glowworm light and a clear tendency to wander away from the ultraviolet light source. In the majority of the trials (63%), statistically significant differences (at $P < 0.1$) were found to exist between the movements of *Hendea* in the presence of either glowworm-mimicking or, alternatively, ultraviolet light sources. We interpret this to mean that *Hendea*'s photoreceptors are not only functionally intact visual cells, as shown earlier, but that the animal is making use of its visual capability in spite of being a cave-dweller and most likely being classifiable as a true troglobite.

ACKNOWLEDGMENTS

We wish to express our gratitude to Mr. D. Williams, Waitomo Cave's Manager at the time of the study, and his staff for their unfailing support and hospitality and we thank the Croatian Biospeleological Society, organizers of the 14th International Symposium on Biospeleology at Makarska, for an excellent meeting and interest in our research.

REFERENCES

BARR, T. C., 1968: Cave ecology and the evolution of troglobites. – Evol. Biol. **2**, 35–102.

BATSCHELET, E., 1981: Circular Statistics in Biology. – Academic Press, London.

CULVER, D. C., 1982: Cave Life Evolution and Ecology. – Harvard University Press, Massachusetts.

CURTIS, D. J., 1970: Comparative aspects of the fine structure of the eyes of Phalangida (Arachnida) and certain correlations with habitat. – J. Zool. **160**, 231–265.

GREENSLADE, P. J. M., 1964: Pitfall trapping as a method for studying populations of Carabidae (Coleoptera). – J. Anim. Ecol. **33**, 301–310.

JUBERTHIE, C., 1964: Recherches sur la biologie des opilions. – Ann. Spéléol. **19**, 1–238.

LATCH, G. C. M., 1965: *Metarrhizium anisopliae* (Metschnikoff) Sorokin strains in New Zealand and their possible use for controlling pasture-inhabiting insects. – N. Zld. Agric. Res. **8**, 384–396.

MAY, B. M., 1963: New Zealand cave fauna, II. The limestone caves between Port Waikato and Piopio districts. – Trans. Roy. Soc. N. Zld. (Zool.) **3**, 181–204.

MEYER-ROCHOW, V. B., 1990: The New Zealand Glowworm. Waitomo Caves Museum Soc., Waitomo, New Zealand.

MEYER-ROCHOW, V. B. & A. R. LIDDLE, 1988: Structure and function of the eyes of two species of opilionid from New Zealand glow-worm caves (*Megalopsalis tumida*: Palpatores, and *Hendea myersi cavernicola*: Laniatores). – Proc. Roy. Soc. Lond. **B 233**, 293–319.

PETERS, W. & G. PETERS, 1973: Problèmes génétiques de l'évolution régressive des cavernicoles. Annls. Spéléol. **28**, 301–313.

PUGSLEY, C. W., 1980: Ecology of the New Zealand glowworm (*Arachnocampa luminosa*) in caves of Waitomo. – Ph. D.-thesis, University of Auckland, Auckland, New Zealand.

ZAR, J. H., 1984: Biostatistical Analysis. – Prentice Hall, New Jersey.

SAŽETAK

Neka ekološka i etološka opažanja troglobita koji vidi, *Hendea myersi cavernicola* (Chelicerata: Arachnida: Opiliones)

V. B. Meyer-Rochow & A. R. Liddle

Skupljajući beskralježnjake pomoću lovnih posuda, od proljeća do sredine ljeta izvan špilje Waitomo Cave, nismo nijednom ulovili primjerak *Hendea myersi cavernicola*. Zbog te činjenice, kao i redukcije u pigmentaciji tijela, smatramo da je ova vrsta troglobit. Ipak ima i dobro razvijene oči, a laboratorijski testovi ponašanja prema lažnim svjetlećim beskrilnim oblicima krijesnica pokazali su da otkriva i prilazi njihovim svjetlima. Naprotiv, radijacija iz izvora UV zračenja uzrokovala je da se *Hendea* okrene na drugu stranu i to nas je navelo da zaključimo da je sposobnost vida toj vrsti koja boravi u špilji korisna pri nalaženju hrane (ovi kosci hrane se beskrilnim oblicima krijesnica i njihovim jajima) i za prepoznavanje otvora u špilji (kosci izbjegavaju područja s UV zračenjem).

SUMMARY

Some ecological and ethological observations on *Hendea myersi cavernicola* (Chelicerata: Arachnida: Opiliones), a seeing troglobite

V. B. Meyer-Rochow & A. R. Liddle

Sampling invertebrates with pitfall traps from spring to mid-summer outside Waitomo Cave did not result in any captures of *Hendea myersi cavernicola*. Because of this and the reduction in body pigmentation, we consider the species to be a troglobite. Yet, it possesses well-developed eyes and behavioural tests in the laboratory with dummies of luminescent glowworms demonstrate that it detects and approaches the glowworm lights. Radiation from the UV-source, on the other hand, caused *Hendea* to turn away, leading us to the conclusion that the capacity to see in this cave-dwelling species is useful for the procurement of food (these harvestmen feed on glowworms and their eggs) and for the recognition of openings in the cave (the harvestmen avoid areas of UV-radiation).