Notes on thermo- and hygropreference in Leiobunum roseum C .L. Koch, 1839 (Opiliones: Sclerosomatidae) in a habitat of Hladnikia pastinacifolia Reichenbach, 1831 (Spermatophyta: Apiaceae)

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ABSTRACT Contrib. Nat. Hist. 12: 1111–1123.

On September 7th 2006, measurements of thermo- and hygropreference in *Leiobonum roseum* were carried out in the rocky-scree torrent gorge of Golobnica on the Trnovski gozd Karst Plateau in western Slovenia. This is one of the habitats of the endemic Slovenian Apiacean plant *Hladnikia pastinacifolia*, and the southernmost habitat of *L. roseum*. This species has been confirmed to be thermophilous – it is polythermophilous, and it was found to be a mesohygrophilous harvestman. In the hottest portion of the day, the preferred temperature range was 25.2–25.5°C and air humidity 49.6–52.2%. Females were more abundant in the eastern part of the gorge, possibly because it is warmer, but other reasons could influence the unequal distribution. There was no special relation between *L. roseum* and *Hladnikia*. Distribution maps of *L. roseum* and the related *L. limbatum* in Slovenia are presented.

Key words: Arachnids, *Leiobunum limbatum*, rock-scree habitat, thermopreference

Introduction

In memory of Prof. Dr. Konrad Thaler.

Hladnikia pastinacifolia Reichenbach, 1831 (Fig. 1) is a small, 20–50 cm (own unpubl. data) high monotypic herbaceous species in the Apiacean subfamily Apioideae, discovered in 1819 by Andrej Fleischman (Wraber 1990). The plant was named in honor of his teacher, the first Slovenian botanist Franc Hladnik (1773–1844), who founded the botanical garden in Ljubljana in 1810. It is the only endemic genus of vascular plants in Slovenia. Sušnik (1964) first made a valuable contribution to the knowledge of the species. It undergoes several vegetation stages before becoming a flowering plant, and

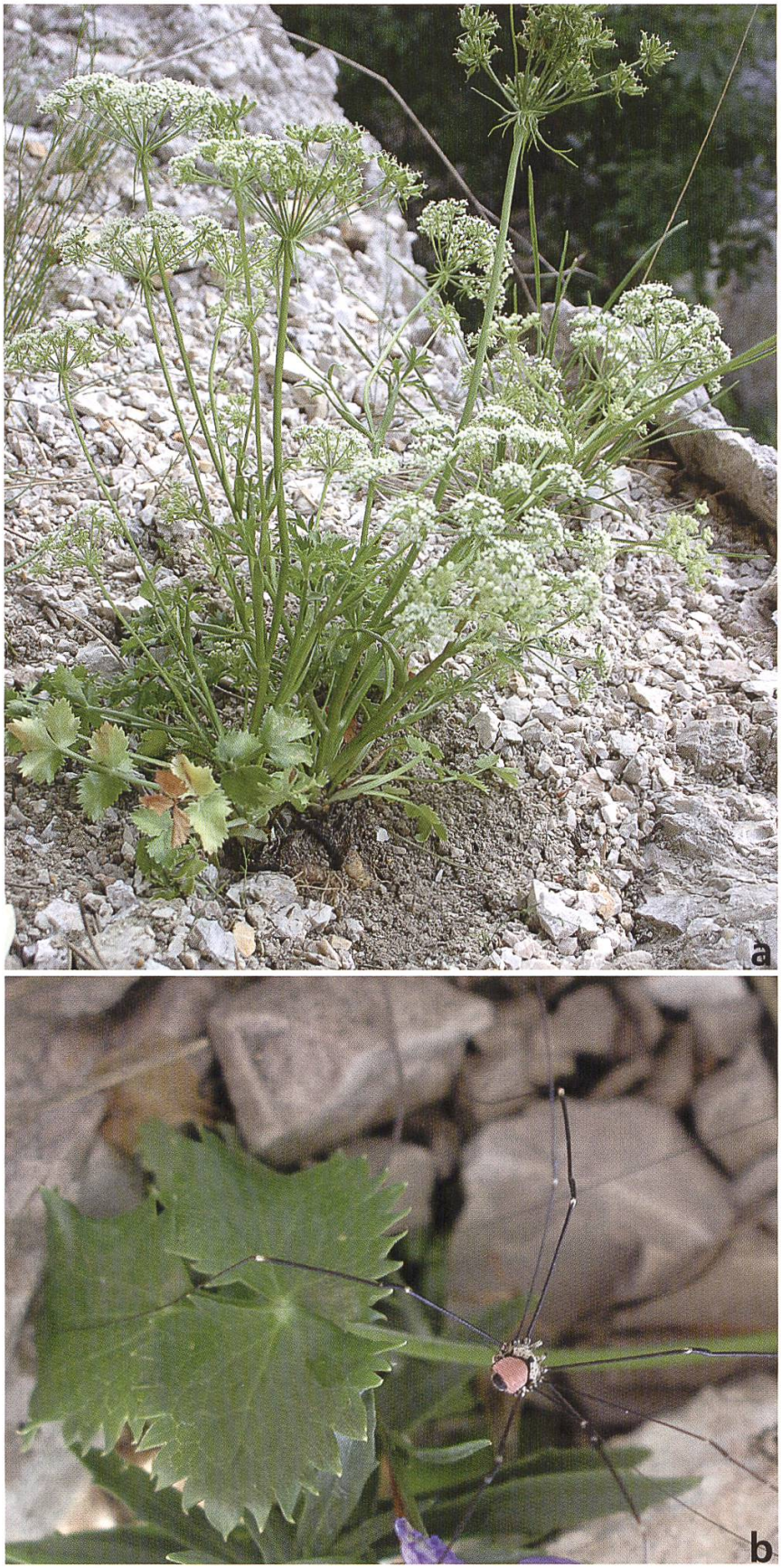


Fig. 1. A flowering *Hladnikia pastinacifolia* (1a) and a male of *Leiobunum roseum* resting on its leaf (Fig. 1b).

after that it dies (N. Šajna, own unpubl. data). In its early life stages the plant forms rosettes, gradually increasing the leaf area and changing the leaf shape from a simple to a lobate one. The flowering trigger is unknown. Flowers are insect pollinated, and seeding takes place from the end of August till the mid-

dle of September. The mericarps have no special dispersal adaptations like wings or hooks; therefore the species is poorly dispersed. It is a paleoendemic glacial relic dispersed within an isolated area of 4 sq km on southern and northern slopes of the Trnovski gozd Karst Plateau 15 km E of Nova Gorica in western Slovenia (Čušin 2004). This region represents a contact zone between the southern sub-Mediterranean and Dinaric biomes, and the northern Alpine one. The Trnovski gozd Karst Plateau is a montane area of natural forest stands and traditional farmland. Its habitat consists of pioneer and extreme habitats, such as very stony pastures, rock crevices and screes as well as other secondary habitats like rubble beds at the road verge. *Hladnikia* prefers carbonate, mainly dolomite bedrock. The entire distribution area of *H. pastinacifolia* is included in the Natura 2000 Network as a Site of Community Interest.

Leiobunum roseum C. L. Koch, 1839 was described according to specimens in the "neighbourhood of Trieste" (Koch 1839). It is an endemite of the Southeastern Calcareous Alps (Martens 1978), living in central southern Austria (Komposch 1999, Komposch & Gruber 2004), eastern Italy (Chemini 1994, Novak 2005) and northwestern Slovenia (Novak & Gruber 2000, Novak & al. 2006). *L. roseum* is a specialised inhabitant of vertical rocky walls, and can only rarely be met in other habitats, such as house walls (Martens 1978, Komposch & Gruber 2004). It is a diurnal species, preferring south-exposed slopes (Martens 1978). Although known for its thermophily in contrast to the closely related *L. limbatum* L. Koch, 1861, which prefers more cold and more humid places as compared to *L. roseum* (Martens 1978, Bliss 1990, Thaler & Knoflach 1995, Komposch 1999, Komposch & Gruber 2004), little is known about its ecological requirements.

In 2003 we started intensive investigations on selected habitats of *H. pastinacifolia* to provide better knowledge of its ecological and conservation purpose. One of these habitats is the rocky-scree torrent gorge of Golobnica, which was found to be settled by a relatively large population, the most southern recorded of *L. roseum*. This presented an opportunity to evaluate collected ecological data for this Alpine harvestman species also.

Material and Methods

The torrent gorge of Golobnica (centroid 13° 52′ 28″ E, 45° 56′ 33″ N, 800–850 m) slopes towards the East, and is composed of more or less steep bare rock walls with smaller rubble deposits in between and a scree in the central lower part. A concrete road bridge traverses the gorge, making this place rela-

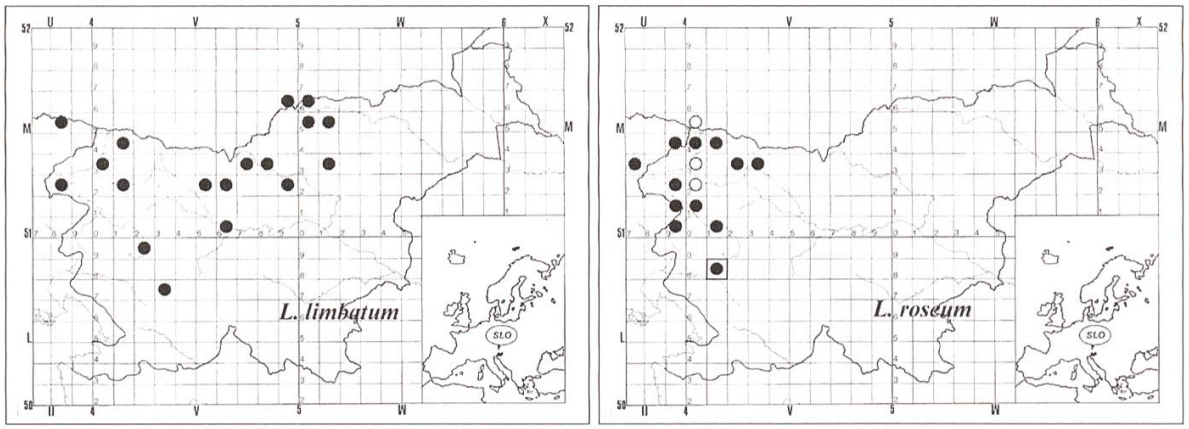


Fig. 2. Recent knowledge of the distribution of *Leiobunum limbatum* and *L. roseum* in the UTM map of Slovenia. ○ = Literature data, • = Novak & Slana Novak Collection data, □ = The study area.

***L. limbatum*: – UL82: Podbela, 300 m; – UM85: Ugovizza/Ukve, 800 m, Italy; – VL29: Idrija, 350 m; – VL37: Postojna, 550 m; – VM03: Triglavska jezera valley, 1680–2000 m; – VM12: Polje, 520 m; – VM14: Ribčev Laz, 530 m; Mojstrana, 640 m; – VM52: Stražišče, 390 m; Kranj, 390 m; – VM60: Ljubljana, 300 m; – VM62: Kamnik, 390 m; – VM73: Podvolovjek, 600 m; – VM83: Radmirje, 600 m; – VM92: Ločica, 370 m; – VM96: Sveti Urh, 980 m; – WM05: Slovenj Gradec, 430 m; – WM06: Dravograd, 360 m; – WM13: Paka, 400 m; – WM15: Mala Kopa, 1520 m; Pungart, 1370 m.**

***L. roseum*: – UM73: Stolvizza/Stolbica, Resia valley, 570 m, Italy; – UM90: Lepenka valley, Doblar, 260 m; – UM91: Sleme, 1100 m; – UM92: Mrzli vrh Mt., the peak at 1358 m (Marcellino 1973: Monte Merzli); Kamno, 200 m; – UM94: Koritnica valley–Mangrt Mt., 800–2679 m; – VL18: Golobnica gorge, 800–820 m, Predmeja; – VM01: Doblarec valley, Doblar, 140 m; – VM02: Komarča, 660–1360 m (Hadži 1931); – VM03: Dolina Triglavskih jezer valley, 1780–2000 m (Hadži 1931); Triglav Mt., the peak at 2864 m; – VM04: Pri Cerkvi, 850 m, Trenta (Hadži 1931, Di Caporiacco 1949: Santa Maria di Trenta); – VM04: Vršič, 900–1611 m; the Soča river spring, 1000 m (Hadži 1931, Martens 1978); Prisojnik Mt., the peak at 2547 m (Hadži 1931); – VM05: Gozd Martuljek, 720 m (Hadži 1931), Planica; – VM10 Stopnik, 350 m; – VM14: the waterfall Peričnik, 860 m (Hadži 1931), Vrata valley, 900–1000 m; – VM23: Babji zob Mt., 860 m; – VM33: Bled, 500 m; Begunje, 590 m; Draga valley, 650 m.**

tively easily accessible. The examined gorge area measured 105 m in length, and about 20 m in width in the lower, and up to 33 m in the upper part, yielding around 2500 m^2 (Fig. 2: VL18). Within this area, the following geomorphological habitats were distinguished: the bridge concrete, the western rocky wall, the rock blocks in the scree, the western rocky ridge, the superior rocky wall, the eastern rocky wall, the eastern rocky ridge and the scree gravel. The two most extreme habitat types of *H. pastinacifolia* – screes and rocky ridges rich in crevices – are present in its lowest altitude. The sparse accompanying flora on screes is mainly composed of *Kernera saxatilis*, *Scabiosa silenifolia*, *Biscutella laevigata*, *Asperula cynanthica*, *Valeriana saxatilis* and *Linum catharticum*. Scree areas with larger stones are overgrown with *Ruta divaricata*, *Petasites paradoxus* and *Eupatorium cannabinum*. More stable substrates support woody species like *Salix waldsteiniana*, *Frangula rupestris*, *Pinus nigra*, *Ostrya carpinifolia* and *Fraxinus ornus*. The dominant vegetation in the rock crevices is represented by *Potentilla caulescens*, *Phyteuma scheuchzeri*,

Primula auricula, *Paederota lutea*, *Sesleria juncifolia*, *Carex mucronata*, *Asplenium ruta-muraria* and *A. trichomanes*.

Investigations took place at the end of August and at the beginning of September 2006. The temperature (T) was monitored 1 cm deep within the rubble of the central (sensor 2) and the eastern part (sensor 1) of the gorge with the StowAway® TidbiT® XT loggers (Onset Computer Cooperation, USA), recording values every 12 minutes. The data set was evaluated with BoxCar® Pro 4 software (Onset Computer Cooperation, USA). We used a quantum sensor (Apogee Instruments Inc., USA) to measure the solar photon flux in μmol $m^{-2}s^{-1}$, since in plant ecology the number of photons incident in time unit is more relevant than the energy content of the radiation (Jones 1995). In converting these values into radiometric units (Wm^{-2}), we used an approximate conversion factor of 0.2174 for daylight (Hall & Scurlock 1995). The pH of the substrate was measured in sieved (grid 1 sq mm) ground material mixed with distilled water in a volume ratio of 1:1 after 30 min, using a portable pH Checker® (Hanna Instruments, USA).

The measurements of thermo- and hygropreference in *L. roseum* were carried out on September 7th 2006, which was one of the hottest days in the late summer. For the investigation, this period was chosen because only adults can be found. In the resting placement of each specimen, T and relative humidity (RH) was measured 1–2 cm from the specimen's body, using a hand-held aspiration psychrometer (Ahorn FN 864, Germany), and the descriptive characteristics of the microhabitats were recorded. The measurements were executed in accordance with the most intensive insolation of different parts of the gorge parts: from 9:15 to 11:45 (the 1st series) the western and the middle parts, and from 11:45 to 13:30 (the 2nd series) in the eastern part. Details concerning the placement of individuals, such as fissures, flora etc., were also recorded.

The basic descriptive statistics and the non-parametric Mann-Whitney U test for comparison of means were performed through data analysis. In evaluating the meteorological data in the gorge, the corresponding data from the meteorological station in Otlica village on the Trnovski gozd Karst Plateau – the meteorological station nearest to the Golobnica gorge – were taken into account as a reference. In testing differences in frequencies and sex ratios, between the western and central, and the eastern part of the gorge, data were arranged according to the T from the meteorological station into 5 classes (I: T=19.3°C; II: T=20.6°C; III: T=22.1°C; IV: T=23.6°C; V: T=23.9°C). The abundance of females in relation to different T was analysed with the non-parametric Kendall Tau correlation (τ). Since males were much more prevalent than females in the western part of the gorge as compared to the eastern part, we com-

Substrat	*H. p.*	N ♂	N ♀	N total
Bridge concrete	–	12	4	16
Western rocky wall	–	16	2	18
Rock blocks in the scree	+	1	2	3
Western rocky ridge	+	16	0	16
Superior rocky wall	–	2	1	3
Eastern rocky wall	+	11	3	14
Eastern rocky ridge	+	5	5	10
Scree gravel	+	0	0	0

Tab. 1. Number of *Leiobunum roseum* in different microhabitat types in the Golobnica gorge on 7th Sept. 2006. *H. p.* = *Hladnikia pastinacifolia* present.

pared T means and their confidence intervals. Later, we tested whether there were differences in the frequency of females, and in sex ratios in the five T classes depending on the meteorological station. The statistical analyses were performed with SPSS 12.0.1 for Windows.

Results

Occurrence of individuals

The individuals of *L. roseum* were found in the parts of the gorge presented in Tab. 1. Some other habitat types that are not known to be inhabited by the species, like grass patches and areas overgrown with *Pinus nigra* in the upper part of the gorge, were checked for specimens but not included in the Table. The side rock-walls, the western rocky ridge and the bridge were found to be the favoured habitats.

Habitat temperatures

A three-days section of the habitat T measured with the loggers 1 cm below the gravel surface is presented in Fig. 3. Both sensors showed the lowest temperature at 6:00 in the morning. On the sunny days (7th and 9th Sept.), the western rock wall was not exposed to sunshine at all, while the central part of the gorge started warming up at 7:40 from solar radiation. Between 9:00 and 11:00, T diminished by ca. 1°C because the vegetation on the western edge of

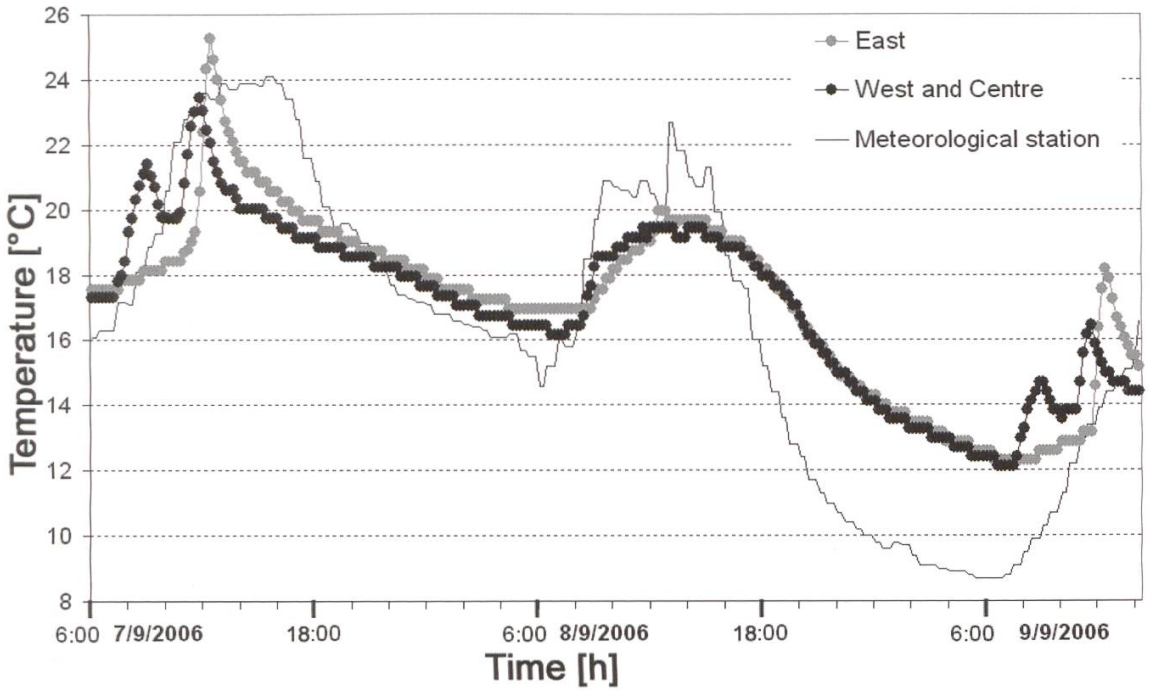


Fig. 3. The temperature profile in the Golobnica gorge (East: sensor 1; West and Centre: sensor 2) and at the Otlica meteorological station from 7th to 9th September, 2006.

the gorge blocked the radiation. Warming in the eastern part of the gorge was delayed by almost 4 hours (at 11:30), but then higher T were reached than in the central part. After 14:00 the whole area of the gorge was in shade. In the central part, the maximal T was 23.5°C at noon, while in the eastern part, the maximal T of 25.3°C was achieved 30 min later. In the eastern part, throughout the rest of the day until the next morning, T remained slightly higher (Mann-Whitney U test; $Z=2.59$, $p=0.095$). On a rainy day (8th Sept.), the T was almost equal for both parts of the gorge (Mann-Whitney U test; $Z=0.15$, $p=0.907$). On sunny days, the highest T exceeded the meteorological values in Otlica, and on rainy days they did not, while the night T in the gorge was above the values measured in the meteorological station for both days.

In comparison with the data from the meteorological station, the data provided by sensors in the gorge generally showed lower amplitudes because they were buried 1 cm deep in the substrate. In the morning (7:30–10:00) when T in the central part reached its first peak, it was higher than in Otlica (Mann-Whitney U test; $Z=3.26$, $p=0.001$ for 7th and $Z=4.33$, $p<0.001$ for 9th Sept.). In the eastern part, T did not differ on 7th Sept. (Mann-Whitney U test; $Z=-0.59$, $p=0.556$), but the differences were significant on 9th Sept. (Mann-Whitney U test; $Z=4.34$, $p<0.001$). Around noon (11–14:00), T measured with sensors exceeded the highest day-time values in Otlica (Mann-Whitney U test; $Z=-2.22$, $p=0.026$ for sensor 1, and $Z=-4.47$, $p<0.001$ for sensor 2 on 7th and

Gorge part	Sex	N	T [°C]	RH [%]
			Mean±StD (Min–Max)	
W+C	♂	44	21.2±1.2 (19.2–23.6)	72.5±7.2 (57.9–83.3)
W+C	♀	6	20.4±1.2 (19.2–22.5)	75.2±7.7 (61.7–83.3)
E	♂	19	25.2±1.5 (23.4–27.3)	49.6±5.1 (43.5–59.0)
E	♀	11	25.5±2.2 (23.5–29.3)	52.2±5.8 (44.7–58.7)

Tab. 2. Descriptive statistics of *Leiobunum roseum* in the western and central (W+C, 1st series), and eastern part (E, 2nd series) of the Golobnica gorge on 7th Sept. 2006. Note: The difference in absolute values between W+C and E is partly the consequence of measurements carried out at different times of day.

Z=2.34, p=0.019 for sensor1 and Z=2.56, p<0.011 for sensor 2 on 9th Sept.), while on the rainy day, the day-time T in Otlica was lower (Mann-Whitney U test; Z=4.82, p<0.001 for sensor 1 and Z=-4.50, p<0.001 for sensor 2). Overnight (18:00–6:00), the T measured with sensors was always above the values at the meteorological station (Mann-Whitney U test; Z=4.88, p<0.001 for sensor 1 and Z=4.25, p<0.001 for sensor 2 for both nights).

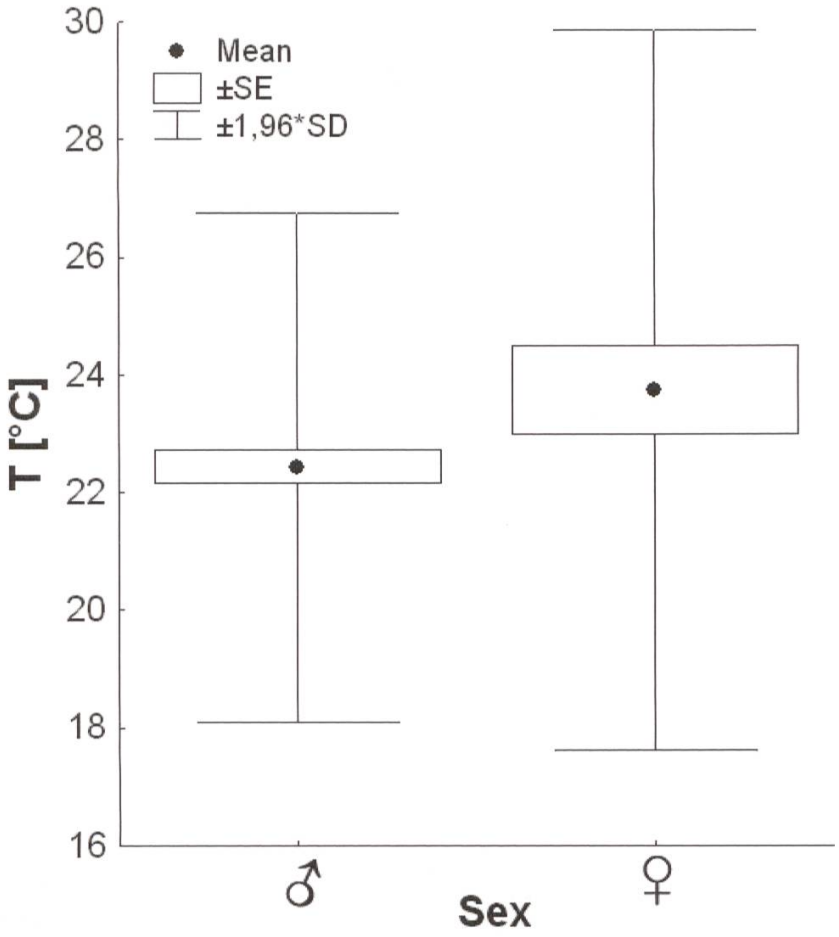
T- and HR-preferences of *L. roseum*

Descriptive statistics of T and HR are presented in Tab. 2. Males prevailed in the gorge as a whole, but the sex ratio in the western part of the gorge was much more in favour of males in comparison to the eastern part (W=1:7.3 against E=1:1.7). No significant correlation was found in the confidence interval of T means between the western and central, and the eastern part of the gorge (Mann-Whitney U test; Z=-1.58; p=0.114) (Fig. 4). There were no statistical differences in T between sexes either in the western and central part, T_{W+C} (Mann-Whitney U test; Z=1.16; p=0.107), HR_{W+C} (Z= -1.00; p=0.317), or in the eastern part, T_E (Z=-0.34; p=0.731), HR_E (Z=-1.57; p=0.116).

Ratio of females

During the observations, T was increasing, as well as the ratio of observed females from 5% in the morning up to 50% at noon. A strong positive correl-

Fig. 4. Difference between sexes in preferred T.



ation of the female ratio was found with the T sensor 2 (τ=0.94; p=-0.02), while the number of observed females correlated with the T sensor 1 (τ=0.95; p=-0.02).

Microhabitats

At 9:00 in the morning, most parts of the gorge were in shade, except the upper middle part with a solar flux of 279.2±11.7 Wm^{-2}. At that time, microhabitats of *L. roseum* were in the shade with low light intensity of 19.1±0.6 Wm^{-2}. At midday, in the un-shaded central part of the gorge the values rose to 358.4±2.6 Wm^{-2}. Some microhabitats in the western part of the gorge became sun-exposed (309.7 ± 12.4 Wm^{-2}), while in shaded habitats the light intensity was low (22.3 ± 0.5 Wm^{-2}).

The substrate was moderately basic (pH 8.14–8.76).

Discussion

Although *L. roseum* was cited for Trieste and Ljubljana (Koch 1839, 1848, Doleschal 1852, Roewer 1910, 1923, sub *Liobunum* and *Lejobunum*), Hadži (1931: 141) noted that Trieste and Ljubljana (Laibach) are certainly the museum cities where Roewer acquired *L. roseum*. Afterwards, Novak et al. (2002) erroneously cited the species in Postojna and Slovenj Gradec instead of *L. limbatum*. The maps here presented of both species in Slovenia are based on revised material; it is reasonable to exclude uncertain data from further citations.

L. roseum has been recorded only in calcareous areas (Martens 1978, Komposch 1999, Komposch & Gruber 2004), probably because these bedrocks provide relatively warm substrate. Higher T in the gorge are quite evident in comparison to T from the meteorological station of Otlica. A basic reaction of the ground material was expected within the carbonate substrate, but this probably plays no role in the bedrock preference. *L. roseum* inhabits the habitat of *Hladnikia* by chance; there is no special relation between the two species.

Within different species of *Leiobunum*, different sex ratios occur, and they sometimes differ greatly between various localities (Martens 1978, Tsurusaki 1986). The preference for the eastern parts of the gorge by females seems not to be accidental, and can be explained by their preference for higher T in the gorge during the investigation period. For this, egg growth and the quest for the most appropriate substrate for oviposition are the most probable reasons. On the other hand, females are generally less active in many harvestmen species, *Leiobunum* included (Edgar & Yuan 1968). Besides, one must expect that at heights of over 4m on the walls, which were not inspected for harvestmen, different data concerning the sex ratio could possibly be provided. In conclusion, *L. roseum* has been confirmed to be a thermophilous – a polythermophilous – species, and it was found to be a mesohygrophilous harvestman.

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References

Bliss, P. (1990): *Leiobunum limbatum* (Arachnida, Opiliones) in der DDR: Verbreitungsmuster, Synanthropie und Arealexpansion. — Bulletin de la Société Européenne d'Arachnologie, hors série 1: 31–35.

Chemini, C. (1994): Arachnida. Scorpiones, Palpigradi, Solifugae, Opiliones. — In: Minelli, A., Ruffo, S. & La Posta, S. (eds.), Checklist delle specie della fauna italiana 21, pp. 1–42, Calderini, Bologna.

Čušin, B. (2004): *Hladnikia pastinacifolia* Rchb. – rebrinčevolistna hladnikija, hladnikovka. — In: Čušin, B., Jogan, N., Leskovar, I., Kaligarič, M. & Surina, B. (eds.), Natura 2000 v Sloveniji – Rastline (Natura 2000 in Slovenia – Plants), pp. 107–113, Znanstvenoraziskovalni center Slovenske akademije znanosti in umetnosti.

Di Caporiacco, L. (1949): Aracnidi della Venezia Giulia. — Atti del Museo civico di storia naturale Trieste 17: 137–151.

Doleschal, L. (1852): Systematisches Verzeichnis der im Kaiserthum Österreich vorkommenden Spinnen. — Sitzungsberichte der mathematisch-naturwissenschaftlichen Klasse der Akademie der Wissenschaften Wien 9: 622–651.

Edgar, A.L. & Yuan, H.A. (1968): Daily locomotory activity in *Phalangium opilio* and seven species of *Leiobunum* (Arthropoda: Phalangida). — Bios 39(4):167–176.

Hadži, J. (1931): Opilioni Triglavskoga masiva. — Prirodoslovne razprave, Ljubljana 1: 107–154.

Hall, D.O. & Scurlock, J.M.O. (1995): Appendix C – Biomass production and data. — In: Hall, D.O., Scurlock, J.M.O., Bolhar–Nordenkampf, H.R., Leegood, R.C. & Long, S.P. (eds.), Photosynthesis and Production in a Changing Environment, pp. 425–444, Chapman & Hall.

Jones, M.B. (1995): Plant microclimate. — In: Hall, D.O., Scurlock, J.M.O., Bolhar–Nordenkampf, H.R., Leegood, R.C. & Long, S.P. (eds.), Photosynthesis and Production in a Changing Environment, pp. 47–64, Chapman & Hall.

Koch, C.L. (1839): Übersicht des Arachnidensystems. 2. — Z. H. Zeh'sche Buchhandlung, Nürnberg: 1–38.

Koch, C.L. (1848): Die Arachniden, 16. und letzter Band. — Lotzbeck, J.L., Nürnberg: 1–80 and 1–76+DLXI.

Komposch, C. (1999): Rote Liste der Weberknechte Kärntens. — In: Rottenburg, T., Wieser, C., Mildner, P. & Holzinger, W.E. (eds.), Rote Liste gefährdeter Tiere Kärntens. Naturschutz in Kärnten 15: 547–565.

Komposch, C. & Gruber, J. (2004): Die Weberknechte Österreichs (Arachnida, Opiliones). — Denisia, 12, 485–534.

Marcellino, I. (1973): Notizie su Opilioni (Arachnida) italiani e dell'Alto Isonzo. — Annali del Museo civico di storia naturale Genova 79: 192–205.

Martens, J. (1978): Weberknechte, Opiliones. In: Die Tierwelt Deutschlands 64. — 464 pp., Fischer Verlag, Jena.

Novak, T. (2005): Harvestmen of the Museo Friulano di Storia Naturale in Udine (Arachnida: Opiliones). Part 1. — Gortania 26: 211–241.

Novak, T. & Gruber, J. (2000): Remarks on published data on harvestmen (Arachnida: Opiliones) from Slovenia. — Annales, Series historia naturalis, Koper, 10(2/21), 281–308.

Novak, T., Lipovšek Delakorda, S. & Slana Novak, L. (2006): A review of harvestmen (Arachnida: Opiliones) in Slovenia. — Zootaxa 1325: 267–276.

Novak, T., Slana, L., Červek, N., Mlakar, M., Žmaher, N. & Gruber, J. (2002): Harvestmen (Opiliones) in human settlements of Slovenia. — Acta Entomologica Slovenica 10(2): 133–156.

Roewer, C.F. (1910): Revision der Opiliones Plagiostethi (= Opiliones Palpatores). I. Fam. der Phalangiidae. (Subfamilien: Gagrellini, Liobunini, Leptobunini.). — Abhandlungen aus dem Gebiete der Naturwissenschaft Hamburg 19(4): 1–294+VI.

Roewer, C.F. (1923): Die Weberknechte der Erde. Jena.

Sušnik, F. (1964): Taksonomska in horološka problematika taksona *Hladnikia pastinacifolia* Rchb. (Taxonomic and chorological problems in the taxon *Hladnikia pastinacifolia* Rchb.). — 69 pp., Unpublished Doctoral Thesis, University of Ljubljana.

Thaler, K. & Knoflach, B. (1995): Adventive Spinnentiere in Österreich – mit Ausblicken auf die Nachbarländer (Arachnida ohne Acari). — Stapfia 37: 55–76.

Tsurusaki, N. (1986): Parthenogenesis and geographic variation of sex ratio in two species of *Leiobunum* (Arachnida, Opiliones). — Zoological Science 3(3): 517–532.

Wraber, T. (1990): Čaven, ein botanisch berühmter Berg in Slowenien. — Carinthia 100: 195–210.

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