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Daily activity patterns of *Australolacerta rupicola* (FitzSimons, 1933) (Sauria: Lacertidae) with comments on niche segregation within a syntopic lizard community

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Abstract. Daily activity patterns of the endemic Soutpansberg rock lizard (*Australolacerta rupicola*) and ecologically similar syntopic lizards were analysed to assess potential niche partitioning. Data to evaluate the temporal niche included time and temperature, and niche overlap was determined over three different sample plots using the Pianka-Index. Altogether, 11 other lizard species and four snake species were recorded at the sample plots. *Australolacerta rupicola* showed a large overlap in the spatial niche with *Trachylepis varia* and *Platysaurus relictus* and in the trophic niche with *T. varia*, however, the maximum activity period of *A. rupicola* fell into periods of low activity by *P. relictus* and *T. varia* and vice versa. These patterns were most pronounced when the different sample plots were analysed separately. The asynchronous activity cycles are probably the result of avoidance of competition for food in the case of the active foragers *A. rupicola* and *T. varia*, whereas different thermal preferences driven by physiological constraints appear to be more relevant when comparing *A. rupicola* and *P. relictus*. Individual numbers of the usually abundant species *T. varia* and *P. relictus* decreased in *A. rupicola* habitats and it is posted that the latter species resides in less climatically favourable habitats, thus avoiding competition with other rupicolous lizards.

Key words: Soutpansberg, South Africa, rock-dweller, autecology, synecology.

Introduction

Daily as well as annual activity cycles can vary strongly among lizards (e.g. Busack 1976, Carrascal & Diaz 1989, Foà & Bertolucci 2001, Rouag et al. 2007). Being ectothermic, a lizard's physiology depends on the surrounding thermal environment in its habitat (Bogert 1949), which is affected by air temperature, wind speed, relative humidity and solar radiation (Tracy & Christian 1986). However, lizards are able to regulate their body temperatures to some degree through behavioural activities (Busack 1976, Carrascal & Diaz 1989, Bauwens et al. 1990). Accordingly, a lizard's daily activity cycle is affected by thermal fluctuations within the available microhabitats, which can be used for active thermoregulation. Activity time, along with spatial habitat use and trophic niche, is often treated as one of the three major niche dimensions lizards may partition (Huey & Pianka 1983). Differences in daily activity patterns, which can often be observed between syntopic, ecologically similar species, can be caused by niche segregation driven by competition (Huey & Pianka 1983, Rouag et al. 2007). Consequently, the daily activity of a species may vary among populations depending on the syntopic lizard community (Kronfeld-Schor & Dayan 2003).

Within the framework of the present study we assess daily activity patterns of *Australolacerta rupicola*, one of the least known lacertid species worldwide (Kirchhof & Richter 2009) and endemic to the Soutpansberg mountain range in north-eastern South Africa (Kirchhof et al. 2010). Currently, *A. rupicola* is listed in the IUCN Red List as lower risk/near threatened (World Conservation Monitoring Centre 1996) and in the South African Red Data Book as restricted (Jacobsen 1988). However, these declarations are obsolete and in need of revision (World Conservation Monitoring Centre 1996). Data describing ecological as well as biological aspects of this species are rare. However, detailed knowledge of a species' autecology is basic background information pivotal for successful conservation efforts. The natural history of *A. rupicola* has been only vaguely described by FitzSimons (1933), Jacobsen (1989), Branch (1998) and Kirchhof et al. (in press). *Australolacerta rupicola* is a very small and flattened lacertid (40-50 mm, Branch 1998) and is referred to as diurnal, rock-dwelling species inhabiting scree and rocky outcrops at altitudes from 900-1600 m (Jacobsen 1989). If disturbed it can retreat rapidly into rock piles, cracks and even dense vegetation, where it is perfectly camouflaged with its brown ground colouration and the longitudinal dorsolateral yellow stripes (Kirchhof & Richter 2009).

For the purpose of this study the daily activity patterns of *A. rupicola* were recorded in different habitats at varying altitudes. Temporal activity patterns and corresponding environmental features of the species and syntopic lizards were measured and analysed to assess potential niche partitioning.

Material and methods

Daily activity patterns of *A. rupicola* were recorded during the cool dry season from April 28th to June 7th 2007 at the Lajuma Research Centre on the southern slopes of the western Soutpansberg within three sample plots (SP) each of approximately 5 ha in size and covering the range of the area's most common habitat types. Sample Plot 1 (-23.02200°dd, 29.43500°dd) is situated at an altitude of between 1560-1600 m in Soutpansberg Summit Sourveld (following Mucina & Rutherford 2006). The highest of the three plots, it includes east and west facing slopes with rock outcrops, bedrock and scree interspersed with patches of shallow sandy soil. Shrubs and small trees (e.g. *Englerophytum magalismontanum*, *Maytenus acuminata*, *Tarenna zimbabwensis*) are present, but the vegetation is dominated by the sedge *Coleochloa setifera*. Sample Plot 2 (-23.04200°dd, 29.44600°dd) is dominated by Soutpansberg Mountain Bushveld (following Mucina & Rutherford 2006) and is located at an altitude of between 1250-1260 m. The plateau is covered by rocky bushveld, its south and east facing scree slopes are characterised by mistbelt bush clumps with thicket-like characteristics and species such as *Mimusops zeyheri*, *Olea capensis enervis* and *Combretum molle*. The area also includes patches of evergreen Northern Mistbelt Forest (following Mucina & Rutherford 2006). Sample Plot 3 (-23.04000°dd, 29.43000°dd) is situated between 1280-1340 m altitude at the foot of a mountain. Along the eastern border, a small stream is fringed by riverine forest (characterised by tree species such as *Syzygium cordatum*, *Ilex mitis*, *Schefflera umbellifera* and *Cyathea dregei*). To the south, mountain bushveld with *Terminalia sericea and Acacia* species is dominant.

Over the study period, sunrise varied between 6:10 h (April) and 6:44 h (June) and sunset occurred between 18:02 h (April) and 17:28 h (June). Accordingly, mean day length ranged between 10:44 h and 11:52 h. Mean daily temperatures ranged from 11 °C (June) to 18 °C (April) (Table 1). Data for the study period (April to June) and for the mid-summer months based on a 1 arc min grid were taken and modified from Schulze (1997).

In order to assess the composition of the reptile fauna, visual encounter surveys were conducted throughout the sample plots following a randomized-walk design consisting of 60 random compass directions which were each followed for 40 m (Crump & Scott Jr 1994). Each sample plot was surveyed in turn over two complete, consecutive, warm days during daytime. Days with unsuitable weather conditions like rain were skipped but replaced by the next sunny day. The procedure was conducted four times until all sample plots were surveyed for eight days each. When a lizard or snake was identified, time, air temperature, locality/microhabitat structure, age class (immature, adult) and weather conditions (sunny, partly cloudy, overcast) were noted. Air temperature was measured in degrees centigrade about 5-10 cm above the ground in the nearest shaded place to the specimen (max. 1.0 m) with a standard thermometer.

Available data for *A. rupicola* was compared to those obtained for ecologically similar, syntopic taxa based on hourly intervals between the very first and very last recording (= ten hourly intervals from 8:00 h to 17:59 h)

Table 1. Daily mean (mean) and means of daily maximum (max.) temperatures in the study area for April (Apr), May and June (study period) and for the mid-summer months (December (Dec), January (Jan) and February (Feb)) for comparison. Source: Schulze (1997).

	Temperature [°C]					
	SP 1		SP 2		SP 3	
	mean	max.	mean	max.	mean	max.
Apr	16	22	18	25	17	23
May	14	20	15	23	14	21
June	11	18	12	20	12	18
Dec	19	24	22	27	20	25
Jan	20	25	22	27	20	25
Feb	19	24	21	27	19	24

for all SP together as well as separately. Times and temperatures of minimum, mean and maximum activity of all species were computed and compared. Niche overlap was calculated using the Pianka-Index (Pianka 1974)

$$O_{jk} = \frac{\sum_i^n P_{ij} P_{ik}}{\sqrt{\sum_i^n P_{ij}^2 \sum_i^n P_{ik}^2}}$$

where O_{jk} $\{0 \leq O_{jk} \leq 1\}$ is niche overlap and P_{ij} and P_{ik} represent the proportions of the *i*th resource used by the *j*th and *k*th species.

Results

Within the sample plots, 16 species including *A. rupicola* were recorded, whereby the reptile fauna comprised 11 other lizard species and four snakes (Appendix 1). At least five of the other lizard taxa (*Lygodactylus capensis capensis*, *Lygodactylus nigropunctatus incognitus*, *Lygodactylus ocellatus soutpansbergensis*, *Platysaurus relictus* and *Trachylepis varia*) used similar rocks for basking (all of them), cracks for shelter (*L. nigropunctatus incognitus*, *L. ocellatus soutpansbergensis, P. relictus*) or hunting substrate (*L. capensis capensis*, *T. varia*) as *A. rupicola*. Whereas the dwarf geckos (*Lygodactylus* spp.) are clearly ecologically and morphologically different to *A. rupicola*, the endemic cordylid *P. relictus* (SVL 58-65 mm; Branch 1998) and the skink *T. varia* (SVL 50-60 mm; Branch 1998) are considered to be most similar to *A. rupicola* in terms of body size (SVL 40-50 mm; Branch 1998). *Trachylepis varia* (Fig. 1C, D) is stockier than *A. rupicola* (Fig. 1A, B) and always has two white lateral stripes. The species forages on broken ground, climbing on rocks and trees (Branch 1998). *Platysaurus relictus* is the largest of the three and is extremely flattened (Fig. 1E, G). In contradiction to the brownish females with their three cream stripes the males have a green back and a bright orange tail. This quick flat lizard lives on sandstone outcrops (Branch 1998). In total, the daily activity patterns of 83 *A. rupicola*, 26 *T. varia* and 40 *P. relictus* specimens were compared. It needs to be noted that *P. relictus* was absent from SP 2 and 3.

Daily activity cycles of the three species are visualized in Figures 2A-D (dependent on time of day [h]) and 2E-H (dependent on temperature [°C]). Analysing diurnal activity data of all sample plots together, the three species did not show a clear modality in their activity patterns (Fig. 2A). *Australolacerta rupicola* showed high activity from 8:20 h onwards with a decline between 9:00 h and 10:00 h and between 13:00h

Appendix 1. Species recorded in the sample plots.

Suborder: Serpentes

- *Afrotyphlops bibronii* (A. Smith, 1846)
- *Aparallactus capensis* A. Smith, 1849
- *Prosymna stuhlmannii* (Pfeffer, 1893)
- *Psammophis crucifer* (Daudin, 1803)

Suborder: Sauria

- *Scelotes limpopoensis limpopoensis* FitzSimons, 1930
- *Trachylepis margaritifer* (Peters, 1854)
- *Trachylepis varia* (Peters, 1867)
- *Australolacerta rupicola* (FitzSimons, 1933)
- *Nucras intertexta* A. Smith, 1838
- *Gerrhosaurus flavigularis* Wiegmann, 1828
- *Cordylus warreni depressus* (FitzSimons, 1930)
- *Platysaurus relictus* Broadley, 1976
- *Lygodactylus capensis capensis* (A. Smith, 1849)
- *Lygodactylus nigropunctatus incognitus* Jacobsen, 1992
- *Lygodactylus ocellatus soutpansbergensis* Jacobsen, 1994
- *Pachydactylus vansoni* FitzSimons, 1933

Figure 1A-G. The three analysed reptile species: *Australolacerta rupicola* feeding on a spider (A) and in natural habitat (B), *Trachylepis varia* basking (C, D), *Platysaurus relictus* feeding on a flower (E) of *Thorncrofita succulenta* (F) and swallowing a bee (G). Photos: S. Kirchhof.

and 14:00 h. Most individuals were active between 15:00 h and 16.00 h (Table 2), followed by a strong decrease until 16:20 h. *Trachylepis varia* was less abundant than *A. rupicola* in each sample plot (n = 6, 11 and 9 respectively). It was, similar to *A. rupicola*, active between 8:40 h and 16:00 h; however, activity patterns showed a noticeable peak between 9:00 h and 10:00 h and a slightly higher peak between 13:00 h and 15:00 h. *Platysaurus relictus* was only recorded in the highest SP 1 where it was the most abundant of the three species. Its activity period started a little later than those of the other species with the earliest, yet frequent, observations around 9:30 h. A second, much higher peak in the activity of *P. relictus* was detected between 13:00 h and 14:00 h, but specimens were not active after 16:35 h. Values for the Pianka-Index were generally high ($O_{Au\_ru/Tr\_va(Time)} = 0.88$, $O_{Au\_ru/Pl\_re(Time)} = 0.81$, $O_{Tr\_va/Pl\_re(Time)} = 0.96$) indicating considerable overlap of the temporal niche in all three species (Table 3). Nevertheless, the maximum activity periods of *T. varia* and *P. relictus* fell into the periods of lowest activity of *A. rupicola* and vice versa. Temperature dependent activity is demonstrated in Figure 2E and Table 2 and was near equal in all three species but with the narrowest activity range determined for *A. rupicola* (15-24 °C) and the widest for *T. varia* (14-25 °C). Most observations of *A. rupicola* were made at 18 °C (median = 19 °C), for *T. varia* at 19 °C (median = 20 °C) and for *P. relictus* at 21 °C (median = 20 °C). The Pianka-Index indicates very high niche overlap ($O_{Au\_ru/Tr\_va(Temp)} = 0.81$, $O_{Au\_ru/Pl\_re\ (Temp)} = 0.87$ and $O_{Tr\_va/Pl\_re\ Temp)} = 0.82$) (Table 3).

In *A. rupicola*, activity patterns suggested that availability of sunlight is the most restrictive factor during the winter. As soon as the habitat was exposed to full solar radiation in the morning and air temperature rose above 15 °C, lizard activity increased, with foraging and sun-shade shuttling for thermoregulation being the most commonly observed activities. When the sun became obscured by clouds, the lizards immediately retreated into rock cracks or underneath loose rocks. Earlier studies showed that on overcast days specimens of *A. rupicola* did not emerge from shelter at all (Kirchhof & Richter 2009). Beside weather conditions, the period of direct sun exposure varied from locality to locality dependent on exposition, habitat structure and altitude. Accordingly, lizard activity might differ from the activity cycle shown in Figures 2A and 2E during any given day and over different study sites. Therefore, each SP was also analysed separately.

At SP 1, 35 individuals of *A. rupicola*, nine *T. varia* and 40 *P. relictus* were recorded. The locality had the longest period of direct sun exposure on cloudless days over the study period (from around 7:55 h to 17:10 h). However, due to the altitude temperature amplitude was wider with colder night and morning temperatures and mean daily temperatures were lower (Table 1). Consequently, individuals of all three species emerged quite late from their retreats. The earliest individuals of each species observed were *P. relictus* (9:30 h) followed by *T. varia* (9:44 h) and *A. rupicola* (10:20 h) (Table 2). Activity of *A. rupicola* showed a distinct peak between 15:00 h and 16:00 h, most individuals of *T. varia* were observed between 12:00 h and 13:00 h. *Platysaurus relictus* ranged in between with most observations between 13:00 h and 14:00 h (Fig. 2B). Niche overlap was lower than when pooling all plots together ($O_{Au\_ru/Tr\_va(Time)} = 0.64$, $O_{Au\_ru/Pl\_re(Time)} = 0.67$, $O_{Tr\_va/Pl\_re(Time)} = 0.88$, $O_{Au\_ru/Tr\_va(Temp)} = 0.71$, $O_{Au\_ru/Pl\_re\ (Temp)} = 0.58$, $O_{Tr\_va/Pl\_re\ (temp)} = 0.51$) (Table 3).

Sample Plot 2 has the lowest altitude of the three sample plots and generally experiences the warmest daily mean and maximum temperatures (Table 1). During the study period the habitat of *A. rupicola* was exposed to direct sunlight from around 7:00 h in the morning until around 16:45 h in the afternoon. In total,

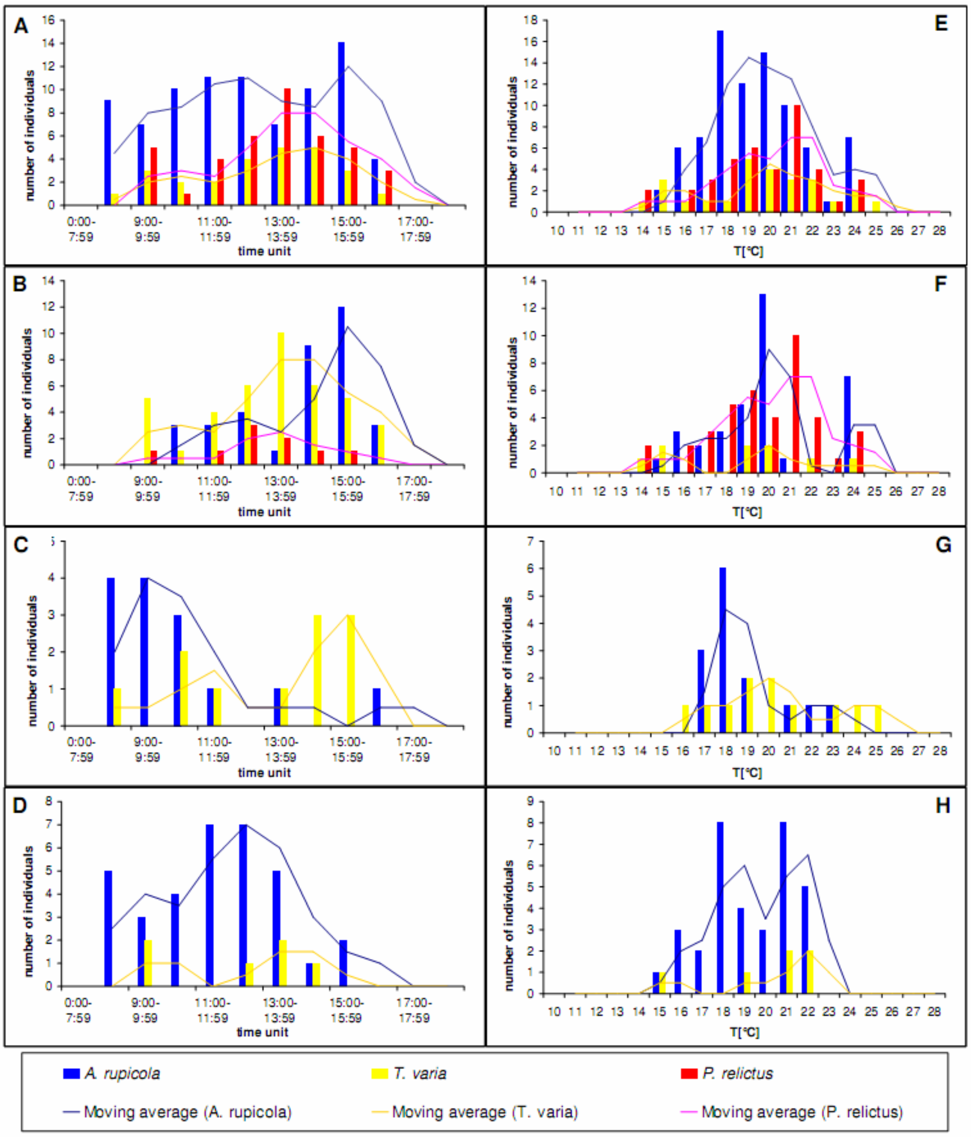

Figure 2A-H: Activity of *A. rupicola* (blue), *P. relictus* (red) and *T. varia* (yellow) dependent on time of day (A-D) and temperature [°C] (E-H). Figures A and E show data of all sample plots together, figures B and F show data collected at SP 1, figures C and G show data collected at SP 2 and figures D and H show data collected at SP 3.

14 specimens of *A. rupicola* and 11 *T. varia* were observed and data recorded. This was the only sample plot where *A. rupicola* was completely absent between 12:00 h and 13:00 h when the sun stands in zenith. The species exhibited highest activity levels during the first half of

the day from 8:00 h (first record at 8:20 h) to 11:00 h (Fig. 2C). Only three individuals were recorded after 11:00 h, the latest at 16:00 h. *Trachylepis varia* had its peak of maximum activity between 14:00 h and 16:00 h. Preferred temperatures of *A. rupicola* ranged from 17-23 °C (median = 18 °C) with most sightings at 18 °C (Fig. 2G). Activity temperature of *T. varia* showed broader amplitude from 16-25 °C with a higher median (20 °C) and most sightings at 19-20 °C. As a consequence, niche overlap was quite low with $O_{Au\_ru/Tr\_va(Time)} = 0.36$ and $O_{Au\_ru/Tr\_va(Temp)} = 0.54$.

Sample Plot 3 was exposed to direct sunlight from around 7:55 h until 15:45 h. Due to its south-eastern exposition the sun was screened by the mountain from 15:45 h onwards and the area lay in shade. *Australolacerta rupicola* was very abundant (34 observations), but only six individuals of *T. varia* were recorded. Activity of *A. rupicola* was concentrated between 8:30 h and 13:15 h with a peak between 11:00 h and 13:00 h which was later than at SP 2 (Fig. 2D). The last observation was made at 15:30 h just before the area lost the sun. *Trachylepis varia* showed a bimodal activity pattern

Table 2. Range of activity time t[h] and temperature T[°C] with median and maximum (Max.) activity including sample sizes (n) of the analysed species at the different sample plots SP 1, SP 2, SP 3 and in total.

	Species	n	Range (median)	Max.
			Total	
t[h]	*A. rupicola*	83	8:20-16:20 (12:00)	15:00-15:59
	T. varia	26	8:40-16:00 (13:05)	13:00-13:59
	P. relictus	40	9:30-16:35 (12:30)	13:00-13:59
T[°C]	*A. rupicola*	83	15-24 (19)	18
	T. varia	26	14-25 (20)	19
	P. relictus	40	14-24 (20)	21
			SP 1	
t[h]	*A. rupicola*	35	10:20-16:20 (14:17)	15:00-15:59
	T. varia	9	9:44-15:50 (13:00)	12:00-12:59
	P. relictus	40	9:30-16:35 (12:30)	13:00-13:59
T[°C]	*A. rupicola*	35	15-24 (20)	20
	T. varia	9	14-24 (19)	21
	P. relictus	40	14-24 (20)	15, 19, 20
			SP 2	
t[h]	*A. rupicola*	14	8:20-16:00 (9:30)	8:00-9:59
	T. varia	11	8:40-16:00 (14:10)	14:00-14:59
T[°C]	*A. rupicola*	14	17-23 (18)	18
	T. varia	11	16-25 (20)	19, 20
			SP 3	
t[h]	*A. rupicola*	34	8:30-15:30 (11:30)	11:00-12:59
	T. varia	6	9:35-14:45 (12:57)	9:00-9:59;13:00-13:59
T[°C]	*A. rupicola*	34	15-22 (19)	18, 21
	T. varia	6	15-22 (21)	21, 22

Table 3. Pianka-Indices for the resources time (Time) and temperature (Temp). Niche overlap was calculated for *Australolacerta rupicola* (*Au_ru*), *Trachylepis varia* (*Tr_va*) and *Platysaurus relictus* (*Pl_re*) in total and for the three sample plots SP 1, 2 and 3.

	Au_ru/Tr_va		***Au_ru/Pl_re***		***Tr_va/Pl_re***	
	Time	Temp	Time	Temp	Time	Temp
Total	0.88	0.81	0.81	0.87	0.96	0.82
SP 1	0.64	0.71	0.67	0.58	0.88	0.50
SP 2	0.36	0.54				
SP 3	0.46	0.71				

with a small peak between 9:00 h and 10:00 h and one between 13:00 h and 14:00 h. The species was not recorded between 9:50 h and 12:55 h which coincided with the maximum activity of *A. rupicola*. Activity temperature ranged from 15-22 °C in both species with a higher median for *T. varia* (21°C compared to 19°C for *A. rupicola*) (Fig. 2H). The corresponding Pianka-Indices were $O_{Au\_ru/Tr\_va(Time)}$ = 0.46 and $O_{Au\_ru/Tr\_va(Temp)}$ = 0.71.

Discussion

Although *A. rupicola*, *P. relictus* and *T. varia* are all diurnally active, only subtle differences in their daily activity pattern were apparent and niche overlap was high when data of all sample sites were pooled. Nonetheless, in periods of high activity by *A. rupicola*, *P. relictus* and *T. varia* exhibited lower activity and vice versa. An even clearer picture emerges on a local level when activity was analysed for each sample plot separately. Here, Pianka-Indices were rather low, demonstrating segregation of the temporal niche consisting of the 'resources' time and temperature (Table 3). In the case of *A. rupicola* and *T. varia*, a possible explanation for this phenomenon may be avoidance of competition for food (Huey & Pianka 1983, Rouag et al. 2007). The two species are both active foragers (Howard & Hailey 1999, Kirchhof et al. in press) and the different activity peaks observed would reduce the frequency of direct encounters and might therefore facilitate coexistence as proposed by Huey & Pianka (1983). Also, *T. varia* is terrestrial rather than strictly saxicolous like *A. rupicola* and thus different food sources can also be exploited. This is supported by the low values for $O_{Au\_ru/Tr\_va(Time)}$ when the sample plots are analysed separately (Table 3). On the contrary, the strictly saxicolous *P. relictus* is a sit-and-wait hunter, akin to other *Platysaurus* spp. (e.g. Cooper et al. 1997, Greef & Whiting 2000). The different hunting strategy likely results in a different prey utilisation pattern (see Figs 1A, E, F, G), minimizing overlap in the trophic niches between *P. relictus* and the other two species. This in turn allows for a relatively high overlap of the 'resource' time (Table 3).

Asynchronous activity cycles can also be the result of different thermal requirements driven by physiological constraints (Busack 1976, Carrascal & Diaz 1989, Bauwens et al. 1990). Here, the partial sympatry of *P. relictus* and *A. rupicola* on the summit of the Soutpansberg is of particular interest: *Platysaurus relictus* is largely restricted to the drier, northern slopes of the Soutpansberg (Branch 1998), whereas the distribution of *A. rupicola* appears to be limited to the more vegetated and mist influenced southern slopes (Jacobsen 1989, Kirchhof & Richter 2009). Still, $O_{Au\_ru/Pl\_re\ (Temp)}$ and also $O_{Au\_ru/Pl\_re\ (Tme)}$ for the higher altitude SP 1 indicate a relatively high degree of niche overlap on the temporal scale.

However, within this study plot *Platysaurus relictus* showed a preference for the east orientated slope, characterised by earlier insolation, where *A. rupicola* was much less abundant. The lifestyle and morphology of *P. relictus* is probably advantageous in this regard and individuals of *P. relictus* were active earliest in SP 1. As an extremely flattened lizard it is able to maintain maximum body contact with the warm rock surface and more rapidly gain both heat radiated from the rock as well that from direct solar radiation. And as a sit-and-wait hunter *P. relictus* is likely able to combine basking with the search for prey more easily than can an active forager. Poikilothermic prey is still sluggish in the morning (Van Damme et al. 1991) and may seek rocky substrate to heat up, where it can easily be caught by a sit-and-wait hunter that relies strongly on visible cues (Mouton et al. 2000).

However, it is difficult to base statements as to the thermal preferences of the three species using the results of this study and data on activity body temperatures may be required (Busack 1976, Carrascal & Diaz 1989, Bauwens et al. 1990). *Australolacerta rupicola* did have the narrowest activity range of the three species in terms of air temperature. Most observations of *A. rupicola* were made at slightly cooler air temperatures than those preferred by *T. varia* and *P. relictus*. *Australolacerta rupicola* was active even with the sun in zenith. As its preferred air temperature seems to be rather low, one can assume that *A. rupicola* is able to avoid overheating by living in generally more humid microhabitats and by using the vegetated and more shaded structures within its habitat for foraging (Kirchhof et al. in press). Random observations made in summer in 2006 and 2007 showed, that *A. rupicola* displayed high activity around midday just like in winter, but with even more densely vegetated habitats being occupied. In winter these habitats are never exposed to direct sunlight due to the acute angle of the sun from the local horizon. Consequently, *A. rupicola* was never recorded there between April and August.

Despite the syntopic occurrence of *A. rupicola*, *T. varia* and *P. relictus* within the study sites, spatial niche separation of microhabitats by the three species was existent, most likely driven by the avoidance of competition. The ubiquitous *Trachylepis varia* was abundant in all sample plots and *P. relictus* was abundant in SP 1. However, in *A. rupicola* microhabitats, individual numbers of the two species were lower. Since *A. rupicola* is the smallest and least robust species of the three, it assumedly chooses microhabitats unfavoured by *T. varia* and *P. relictus*.

The results of this study show that during the cool dry season *A. rupicola* was strongly dependent on direct solar radiation, identifying it as a heliothermic species. Given this, its preference for shaded southern slopes (Kirchhof & Richter 2009) appears problematic, especially in winter when the sun is screened by the mountains over an extensive period of the day due to the acute angle of the sun from the local horizon. As long as data on the activity body temperature of these species is deficient, one can only assume that *A. rupicola* occupies climatically less favourable habitats to avoid competition with other rock-living lizard species. Hence, it occurs in high numbers on the southern slopes of the Soutpansberg (Kirchhof & Richter 2009) where specific adaptations in terms of habitat utilization and thermoregulation, behaviourally as well as physiologically and morphologically, are required and where other rock-dwelling lizards are less abundant.

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