



UDC 598.112.23:712.23(65)

## MICROHABITAT PREFERENCES OF TWO SYMPATRIC LACERTID IN THE NATIONAL PARK OF EL KALA, ALGERIA

Rachid Rouag<sup>1,3,\*</sup>, Nadia Ziane<sup>2,3</sup>, Slim Benyacoub<sup>2</sup>

<sup>1</sup>Université Chadli Bendjedid, 36100 El Tarf, Algeria

<sup>2</sup>Université Badji Mokhtar, Département de Biologie, BP. 12, El Hadjar, 23000 Annaba, Algeria

<sup>3</sup>Laboratoire de Bio-surveillance environnementale, Département de Biologie,  
Université Badji Mokhtar, 23000 Annaba, Algeria

\*Corresponding author

E-mail: rachid\_rouag@yahoo.fr

### Microhabitat Preferences of two Sympatric Lacertid in the National Park of El Kala, Algeria.

**Rouag, R., Ziane, N., Benyacoub, S.** — Habitat preferences were studied in sympatric populations of two Lacertids, *Psammodromus algirus* and *Acanthodactylus erythrurus* (Lacertidae) from the National Park of El Kala (north-eastern Algeria). The relationship between habitat physical structure and population densities was studied in order to establish eventual segregation between the two lizards. A difference exists between the two species in their distributions. *Acanthodactylus erythrurus* is a strictly terrestrial species, usually found on sandy and more open grounds than *Psammodromus algirus* which can penetrate dense vegetation and look for sunny locations by climbing on shrubs; a behavior which *A. erythrurus* does not control. Our results confirm spatial segregation on a microhabitat scale, supporting the conclusions that microhabitat selection is an important factor in lizards community organization and contributing to reduce potential competition.

Key words: lizards, microhabitat, segregation, El Kala National Park, Algeria.

### Introduction

Open habitats are important for ectotherms because they provide access to the sunlight and temperature patches used for thermoregulation (Vitt et al., 1996; Greenberg, 2001). Any change in the availability of open habitats could directly influence faunal composition. Thus, the increase in forest cover has been linked to decreased abundance of open habitat specialists (Ballinger & Watts, 1995). Saurians, as other animals are not evenly distributed in space, but associated with combinations of external factors. Space has been considered as the principal dimension in the segregation of many lizard communities (Pianka, 1966, 1973; Barbault & Maury, 1981; Toff 1985). Sympatric lizards are well known to usually partition the spatial resource in a wide variety of habitats and climatic conditions (Barbault & Maury, 1981; Huey & Pianka, 1977; Pianka, 1966, 1973, 1986).

The objective of this work is to study the modes of the occupation of space by two sympatric species of lizards (*Psammodromus algirus* and *Acanthodactylus erythrurus belli*) in the dune scrub of the National Park of El Kala in the north-eastern part of Algeria. For reptiles, this type of open environment is ideal as it offers open spaces necessary for thermoregulation and prey hunting, as well as scrubby vegetation that allow predators to escape. The two species are similar at several points (morphology, physiology, behavior) and should, therefore, have very similar requirements (Gatz, 1979; Connell, 1980). Food habits and daily activity patterns were studied

in those sympatric populations. Both species were insectivorous, and the interspecific diet overlap was very high (Rouag, 2007). Daily activity patterns differed interspecifically during both spring and summer. In this study, we evaluate the influence of vegetation structure on the coexistence of the two species.

## Materials and methods

### Study area

This study was carried out in the National Park of El Kala, in north-eastern Algeria, situated between 36.816922° Latitude and 8.413000° Longitude. Overall, the national park has a surface of 78 400 ha, and is characterized by a varied terrain with lakes, marshes and hilly territories, covered with relatively dense vegetation (De Belair, 1990). The climate was Mediterranean (Seltzer, 1946); rainfall was moderate, and strongly concentrated during the winter months: total annual rainfall was about 630 mm, and the mean monthly rainfall was about 52 mm. The study site was characterized by altered 'maquis-type' vegetation, with the main plant species being *Cistus monspelliensis*, *Cistus salvifolius*, *Ampelodesma mauritanicus*, *Chamaerops humilis*, *Erica arborea*, *Lavandula stoechas*, *Pistacia lentiscus*, *Calycotome villosa*, *Genista ferox*, and *Quercus coccifera* (Rouag, 2007).

### Research protocol

The variation in vegetation structure was used to study habitat partition between the two species. 04 stations were selected based on the grade of opening and height of the vegetation, by sampling open habitat (semi-open areas), semi-open habitat (low maquis and medium maquis) and closed habitat (high maquis). The four study stations are presented as a succession of vegetation where the degree of opening of the vegetation (covering rate) as well as the height grow positively and regularly from one station to another (table 1).

Station 1 presents itself as an open ecosystem that has largely support human interference. It is an herbaceous formation on sandy soil. The vegetation cover is mainly composed of grasses and a few plants of *Halimium halimifolium* and *Chamaerops humilis* scattered in the landscape. These are former agricultural areas in which are preserved some elements of the original vegetation.

Stations 2 and 3 are characterized respectively by formations of the low and medium "maquis type" on sandy soil. They are therefore semi-open habitat. They form homogeneous covert dominated mainly by *Quercus coccifera*, *Calycotome villosa*, *Pistacia lentiscus*, *Cistus monspelliensis*, *Erica arborea*, *Phillyrea angustifolia*, *Juniperus oxycedrus*,... etc. The herbaceous strata is practically absent except for a few scattered species.

The station 4 is characterized by dense vegetation cover. This type of habitat constitutes a stage of degradation of the oak forest. The humidity conditions maintained by the proximity of the groundwater allow the development of luxuriant shrub vegetation. The Maquis consists of *Quercus coccifera*, *Pistacia lentiscus*, *Phillyrea angustifolia*, *Juniperus oxycedrus*, *Juniperus phoenicea*. The shrub cover is composed mainly of *Quercus coccifera*. The herbaceous cover is absent.

A density index was used to compare the variation in abundance of the two species in the different sampled habitats. The density of the two species was calculated by applying the primary index of density (Id) described by Livet (1981). This index can be calculated only on the number of animals observed along a 1000-m-long line transect laying along each station. Six (06) transects were made in each habitat.

To verify possible segregation in the microhabitats and to better understand the impact of the cover and the height of the vegetation on the distribution of the two species of lizards, the average cover and the height of grass and shrub vegetation were evaluated in the Contact point of every lizard in the entire site. The shrub cover was classified for all contacts at all stations on a 20 % range and the height on a range of 20 cm. The number of contacts for each species in vegetation classes was presented as a percentage to moderate the impact of the high density of *Psammotromus algirus* about that of *Acanthodactylus erythrurus*. We also record the nature of the soil, the number of holes near each lizard, and the rate of litter cover. These parameters were used to describe the microhabitat in the vicinity of each lizard contacted.

### Statistical analysis

Analysis of variance (ANOVA) was used to check the densities of the two species through different stations. The relationships between the two species and the microhabitat were assessed by Spearman rank correlation coefficient. To test the differences between the two species in the occupation of microhabitats, we use different coverings and heights of vegetation. All variables were checked for normality before applying parametric tests. In all statistical tests, a *p*-value of <0.05 was considered to be significant. All statistical analyzes were done by an SPSS (version 11.0.1).

**Table 1.** Vegetation variables of the sampled stations

Vegetation	Station 1	Station 2	Station 3	Station 4
Shrub mean height, cm	30.50	32.44	64.4	125.8
Shrub cover, %	10.38	19.00	28.1	51.80
Herbaceous mean height, cm	02.32	4.62	4.60	00.00
Herbaceous cover, %	70.62	2.67	2.70	00.00

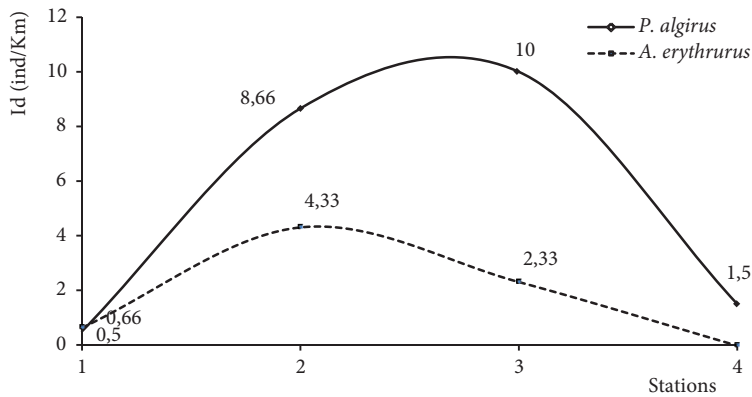


Fig. 1. Variation of the density index of the two species in the sampled stations.

**Results**

The density estimation for the two species in the four habitats shows that *P. algirus* is more abundant than *A. erythrurus*. Both species showed their highest densities in stations 2 and 3 with values of 8.66 ind/km and 10 ind/km respectively for *P. algirus* and 4.33 ind/km and 2.33 ind/km For *A. erythrurus*. The Stations 1 and 4 Show a remarkable decrease in the density index for the two species (fig. 1).

The figure shows bell curves for both species, meaning that both species of lizards avoid both highly exposed habitat as the herbaceous formation (station 1) and very closed habitat like the high maquis (station 4). The analysis of the variance (One-Way ANOVA:  $F_{1,6} = 1.63, p = 0.249 > 0.05$ ) shows no significant difference in the distribution of the two species across the four different studied stations. To describe the microhabitats of each species, we estimate the rates of the use of each vegetation cover class in the different used habitats (table 2).

Fig. 2 shows that both species occupy the same classes of cover but do not exploit them in the same way. Indeed, *A. erythrurus* shows a high affinity for the most exposed habitat with attendance ranging from 28.41 % to 42.06 % between 0 % and 40 % of vegetation cover. When cover reaches 60–80 %; the lizard presence rate decreases to 10.22 %. At 100 % cover *A. erythrurus* is completely absent. There is a negative correlation between the observation frequency of *A. erythrurus* and the rate of shrub cover:  $r_{\text{acan tho}} = -0.9 (p = 0.037)$ . *P. algirus* does not frequent the open habitats; it expresses its strong presence between 20 and 60 % of cover with an overall attendance rate of 69.38 %. When the habitat closes, the presence of *P. algirus* also decreases and becomes null when the cover is more than 80 %. No relationship exists between the frequency of observation of *P. algirus* and the cover of shrub vegetation:  $r_{\text{psamo}} = -0.35 (p = 0.517)$ . The application of the chi-square test ( $\chi^2$ ) revealed a significant difference ( $\chi^2 = 39,679; P = 0.000 < 0.05$ ) in the occupation of the different cover classes between the two species of lizards

**Table 2. Lizard frequencies by class of cover and height of shrub**

Variable	<i>P. algirus</i> , %	N	<i>A. erythrurus</i> , %	N
Shrub cover, %				
< 20	6.12	15	28.41	25
20–40	34.69	86	42.06	37
40–60	34.69	86	19.31	17
60–80	24.49	61	10.22	9
> 80	0	0	0	0
Shrub height, cm				
< 20	0	0	2.27	2
20–40	3.92	10	12.50	11
40–60	21.57	53	26.13	23
60–80	9.80	24	31.81	28
80–100	19.61	49	12.52	11
100–150	15.69	39	9.09	8
> 200	29.41	73	5.68	5

In the description of the microhabitats of each species, the variation in

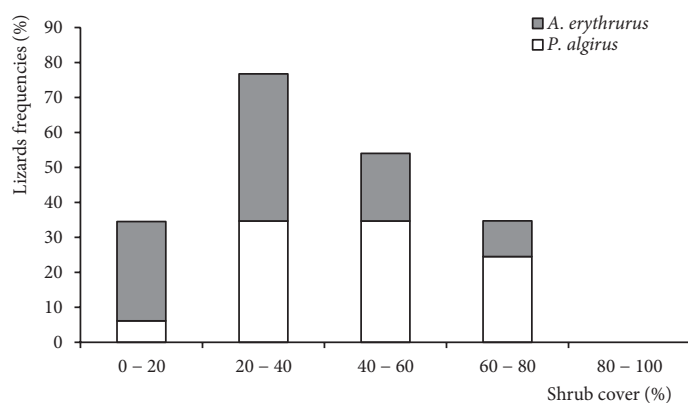


Fig. 2. Distribution of the two species according to shrub cover.

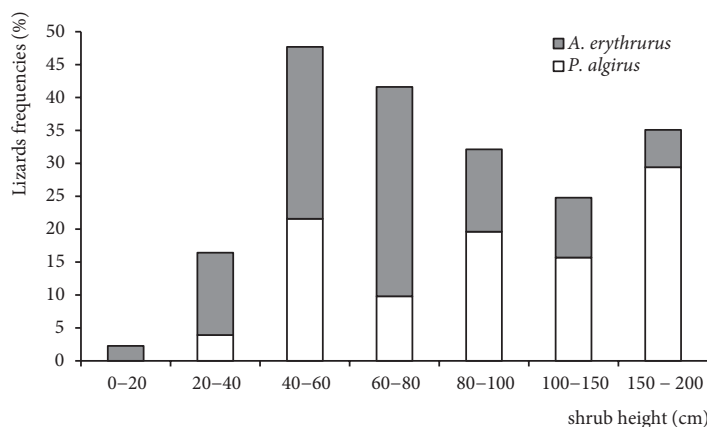


Fig. 3. Distribution of the two species according to shrub height.

the height of the vegetation was also taken into account, an estimation of the utilization rates of each height class at the different habitats fused (table 2). The frequency of observation of *A. erythrurus* decreases considerably beyond 80 cm in height (fig. 3). Conversely, the rate of *P. algirus* is very low (3.92 %) between 0–40 cm. Overhead, it increases and especially from 80 cm, like that of *A. erythrurus* decreases. Indeed, more than 60 % of contacts were made between 80 and 200 cm.

The abundance of *Psammodromus algirus* is not correlated with the height of the shrub;  $r_{\text{psamo}} = 0.75$  ( $p = 0.066$ ). There is no correlation between the observation frequency of *A. erythrurus* and the height of the shrub:  $r_{\text{acantho}} = 0.00$  ( $p = 1$ ). The application of the chi-square test ( $\chi^2$ ) revealed a significant difference ( $\chi^2 = 48.92$ ;  $p = 0.000 < 0.05$ ) in the occupation of the different height classes between the two species.

## Discussion

The choice of studying Reptile species in a dune maquis of the El Kala National Park characterized by formations of varying degrees of openness is the result of a reflection on the understanding of the modes of organization of these communities and the influence exerted by the structure of these habitats. Thus, habitat quality assessment is central to contemporary ecological studies (Huey, 1991). Space can be a key element in the segregation between ecological niches of sympatric lizards (Gonzalez-Romero et al., 1989; Perez-Mellado, 1992). Temperature is also a physical parameter of the environment that can be considered as a resource (Magnuson et al., 1979). Of course, the temperature itself is not limiting for ectotherms. However, access to the preferred temperatures for each can be limited in space and

time by the presence of competitors. Studies have shown that the quality of thermoregulation may be related to the presence of intraspecific competitors (Beitinger, Magnuson 1975; Medvick et al., 1981) and interspecific (Melville, 2002; Downes, Bauwens, 2002).

Our two species of lizards do not show a difference in the exploitation of the different stations sampled (One-Way Anova :  $F_{1,6} = 1,63$  ;  $p = 0,249 > 0,05$  ). Thus no partition of space takes place at this level. Both lizards use the same habitats. To examine if there is a selection of microhabitat, habitats have been divided into different classes of covers and vegetation heights. Indeed, the use of microhabitat can have a direct effect on the survival of lizards (Tracy, 1982) and home range quality (Fox, 1978). A significant difference then appears in the microhabitats where the height and the cover of the shrub vegetation are factors of separation.

A difference then exists between the two lizards in their distributions on the microhabitat. This difference manifests itself mainly in the first and last classes of recovery. Indeed, *Acanthodactylus erythrurus* is a strictly terrestrial species, usually found on sandy and more open grounds than *Psammodromus algirus*. It does not penetrate dense vegetation like *P. algirus* (Busack, 1976; Busack, Jaksic 1982; Arnold, 1987). This is probably related to the biogeographical origin of these two species, Euro-Saharan with high temperatures for *Acanthodactylus erythrurus* and Mediterranean with low temperatures for *Psammodromus algirus* (Belluire, Carrascal; 1996). Also, the scarcity of vegetation cover in xeric environments, which is essential for the protection of lizards and the high risk of predation in these structures, would favor the presence of fast species; such is the case of *A. erythrurus* which is, according to Bauwens et al. (1995), the fastest lizard of the 13 species of Mediterranean Lacertidae. Usually this species frequents open sandy areas but does not penetrate dense shrubs and often takes refuge in burrows (Arnold, 1983). Also, the pale coloring with dark spots of *Acanthodactylus erythrurus* allowed it to be easily confused with the sand of the dune maquis. This character makes it difficult to locate it thus facilitating the capture of prey and escape to predators.

The height of the vegetation also plays an important role in the availability of places for sunlight. Thus, the abundance of both species should decrease with the height of the shrub. This is the case with *A. erythrurus* where the frequency of observation decreases considerably beyond 80 cm in height whereas that of *P. algirus* increases. This shows a certain vertical separation between the two species. The behavior and requirements of each species may explain this. Indeed, *P. algirus* can climb on shrubs and jump from one branch to another to look for sunny locations, which *A. erythrurus* does not control. This behavior is reported by several authors in all the Mediterranean ecosystems of the Iberian Peninsula (Mellado et al., 1975; Mellado, 1980; Perez-Mellado, 1982; Carrascal et al., 1989; Diaz, Carrascal, 1991; Pollo, Perez-Mellado, 1988; Perez-Mellado et al., 1991; Perez-Quintero, 1995). Our observations are supported by the complete absence of *Acanthodactylus erythrurus* in forest ecosystem where the cover of the trees is important, especially in highland forests where it is completely absent (Rouag, Benyacoub, 2006).

We thank anonymous referees helpfully commented on the submitted draft and the Director of the 'Parc National d'El Kala' to released permits to make the study on this protected area.

## References

- Arnold, E. N. 1983. Osteology, genitalia and relationships of *Acanthodactylus* (Reptilia: Lacertidae). *Bull. Brit. Mus. Nat. Hist. (Zool.)*, **44**, 291–339.
- Arnold, E. N. 1987. Resource partition among lacertid lizards in southern Europe. *Journal of Zoology, London (B)*, **1**, 739–782.
- Ballinger, R. E., Watts, K. S. 1995. Path to extinction: impact of vegetation change on lizard populations on Arapaho Prairie in the Nebraska sandhills. *American Midland Naturalist*, **134**, 413–417.
- Barbault, R., Maury, M. E. 1981. Ecological organization of a Chihuahuan desert lizard community. *Oecologia*, **51**, 335–342.
- Bauwens, D., Garland, T. Jr., Castill, A. M., Van Damme, R. 1995. Evolution of sprint speed in lacertid lizards: morphological, physiological, and behavioral covariation. *Evolution*, **49**, 848–863.

- Beitinger, T. L., Magnuson, J. J. 1975. Influence of social rank and size on thermoselection behavior of bluegill (*Lepomis macrochirus*). *J. Fish. Res. Board Can.*, **32** (11), 2133–2136.
- Belliure, J., Carrascal, L. M., Diaz, A. J. 1996. Covariation of thermal biology and foraging mode in two Mediterranean lacertid lizard. *Ecology*, **7**, 1163–1173.
- Busack, S. D. 1976. Activity cycles and body temperatures of *Acanthodactylus erythrurus*. *Copeia*, 826–830.
- Busack, S. D., Jaksic, F. M. 1982. Autoecological observations on *Acanthodactylus erythrurus* (Sauria: Lacertidae) in southern Spain. *Amphibia-Reptilia*, **3** (2/3), 237–256.
- Carrascal, L. M.; Diaz, J. A.; Cano, C. 1989. Habitat selection in Iberian *Psammmodromus* species along a Mediterranean successional gradient. *Amphibia-Reptilia*, **10**, 231–242.
- Connell, J. H. 1980. Diversity and the coevolution of competitors, or the ghosts of competition past. *Oikos*, **35**, 131–138.
- De Belair, G. 1990. *Structure, fonctionnement et perspectives de gestion de quatre complexes lacustres et marécageux (El Kala, Est algérien)*. Thèse de Doctorat, Université du Languedoc, 1–193.
- Díaz, J. A., Carrascal, L. M. 1991. Regional distribution of a Mediterranean lizard: influence of habitat cues and prey abundance. *J. Biogeog.*, **18**, 291–297.
- Downes, S. J., Bauwens, D. 2002. An experimental demonstration of direct behavioural interference in two Mediterranean lacertid lizard species. *Anim. Behav.*, **63**, 1037–1046.
- Fox, S. F. 1978. Natural selection on behavioral phenotypes of the lizard *Utastansburiana*. *Ecology*, **59**, 834–847.
- Gatz, A. Jr. 1979. Ecological morphology of freshwater stream fishes. *Tulane Studies in Zoology and Botany*, **21** (2), 91–124.
- Gonzalez-Romero, A., Ortega, A., Barbault, R. 1989. Habitat partitioning and spatial organization in a lizard community of the Sonoran desert, Mexico. *Amphibia-Reptilia*, **10**, 1–11.
- Greenberg, C. H. 2001. Response of reptile and amphibian communities to canopy gaps created by wind disturbance in the southern Appalachians. *Forest Ecology and Management*, **148**, 135–144.
- Huey, R. B., Pianka, E. R. 1977. Patterns of niche overlap among broadly sympatric versus narrowly sympatric Kalahari lizards (Scincidae: *Mabuya*). *Ecology*, **58**, 119–128.
- Huey, R. B. 1991. Physiological consequences of habitat selection. *American Naturalist*, **137**, 91–115.
- Magnuson, J. J., Crowder, L. B., Medvick, P. A. 1979. Temperature as an ecological resource. *American Zoologist*, **19**, 331–343.
- Medvick, P.A., Magnuson, J. J., Sharr, S. 1981. Behavioral thermoregulation and social interactions of bluegills, *Lepomis macrochirus*. *Copeia*, **1**, 9–13.
- Mellado, J., Amores, F., Parreño, F., Hiraldo, F. 1975. The structure of a Mediterranean lizard community. *Doñana Acta Vert.*, **2**, 145–160.
- Mellado, J. 1980. Utilización del espacio en una comunidad de lacértidos del matorral mediterráneo en la Reserva Biológica de Doñana. *Doñana Act. Vert.*, **7**, 41–59.
- Melville, J. 2002. Competition and character displacement in two species of scincid lizards. *Ecol. Lett.*, **5**, 386–393.
- Pérez-Mellado, V. 1982. Estructura de una taxocenosis de Lacertidae (Sauria, Reptilia) del Sistema Central. *Mediterranea. Ser. Biol.* **6**, 39–64.
- Pérez-Mellado, V., Bauwens, D., Gil, M., Guerrero, F., Lizana, M., Ciudad, M. J. 1991. Diet composition and prey selection in the lizard *Lacerta monticola*. *Can. Jour. Zool.*, **69** (7), 1728–1735.
- Pérez-Mellado, V. 1992. Ecology of lacertid lizards in a desert area of Eastern Morocco. *J. Zool.* **226**, 369–386.
- Pérez-Quintero, J. C. 1995. Ecología de tres especies mediterráneas de Lacertidae (*Acanthodactylus erythrurus* (SCHINZ), *Psammmodromus algirus* (L) y *Psammmodromus hispanicus* Fitzinger) en el litoral de la provincia de Huelva. PhD dissertation. Universidad de Sevilla, 1–400.
- Pianka, E. R. 1966. Convexity, desert lizards, and spatial heterogeneity. *Ecology*, **47**, 1055–1059.
- Pianka, E. R. 1973. The structure of lizard communities. *Annual Review of Ecology and Systematics*, **4**, 53–74.
- Pianka, E. R. 1986. *Ecology and Natural History of Desert Lizards. Analyses of the Ecological Niche and Community Structure*. Princeton University Press, Princeton, New Jersey, 1–208.
- Pollo C. J., Pérez Mellado V., 1988. Trophic ecology of a taxocenosis of Mediterranean Lacertidae. *Ecologia Mediterranea*, **14**, 131–147.
- Rouag, R., Benyacoub, S. 2006. Inventaire et écologie des reptiles du Parc national d'El Kala (Algérie). *Bull. Soc. Herp. Fr.*, **117**, 25–40.
- Rouag, R., Djilali, H., Guerriache, H., Luiselli, L. 2007. Resource partitioning patterns between two sympatric lizard species from Algeria. *Journal of Arid Environments*, **69**, 158–168.
- Seltzer, P. 1946. *Le climat de l'Algérie*. Inst. Météo. Et de Phys. Du globe. Univ. Alger, 1–219.
- Toft, C. A. 1985. Resource partitioning in amphibians and reptiles. *Copeia*, 1–21.
- Tracy, C. R. 1982. Biophysical modelling in reptilian thermal physiology and ecology. *In: Gans, C., Pough, F. H., eds. Biology of the Reptilia Vol. 12*. Academic Press, London, 275–321.
- Vitt, L. J., Zani, P. A., Lima, A. C. M. 1996. Heliotherms in tropical rain forest: the ecology of *Kentropyx calcarata* (Teiidae) and *Mabuya nigropunctata* (Scincidae) in the Curua-Una of Brazil. *Journal of Tropical Ecology*, **13**, 199–220.

Received 18 October 2017

Accepted 9 February 2018