African Journal of Herpetology,
Vol. 66, No. 1, 2017, 1–11

Daily activity, biometry and diet of the North African ocellated lizard *Timon pater* in Mount Chélia, north-eastern Algeria

Messaoud Saoudi[1]*, Abdeldjabar Necer[1], Idriss Bouam[2], Farouk Khelfaoui[2] & Oussama Saadi[1]

[1]*Department of Biology, Faculty of Natural and Life Sciences, University of Chadli Bendjedid, El Tarif, 36000 Algeria;* [2]*Department of Ecology and Environment, Faculty of Natural and Life Sciences, University of Batna 2, 05110 Fesdis, Batna, Algeria*

Abstract.—Although *Timon pater* is among the largest species of lacertids found throughout North Africa, mainly in Morocco, Algeria and Tunisia, studies examining the ecology of this lizard remain rare. In this paper we describe the daily activity patterns, biometry and diet of *T. pater* in a mountain area during its period of maximum activity. We carried out the field study in the southern slope of Mount Chélia in the middle of the Aurès Massif, north-eastern Algeria. In order to analyse the daily activity patterns we performed surveys along 4 000 m long random transects. To obtain biometrical measurements we captured and measured 20 adults with a digital calliper. We obtained diet data by analysing 17 extracted stomach contents. The daily activity patterns of *T. pater* were similar during the summer periods (early and late summer), and no variation in activity was detected. Adult males were slightly larger and heavier than adult females and their heads were longer, larger and thicker than females' heads. *T. pater* primarily consumed Coleopterans, but diet composition was noticeably different between the two summer periods. There were no sexual differences in dietary preferences.

Key words.—*Timon pater*; daily activity; biometry; diet; Mount Chélia; Algeria.

Introduction

Timon is a small genus of lacertids containing six large species of ocellated lizards, distributed across the eastern and the western Mediterranean (Ahmadzadeh *et al.* 2016). *Timon lepidus* (Daudin, 1802), *Timon tangitanus* (Boulenger, 1889), *Timon pater* (Lataste, 1880) and *Timon nevadensis* (Buchholz, 1963) occupy the western part of the Mediterranean from the Iberian Peninsula to north-western Italy in Europe, and from Morocco to northern Tunisia in North Africa (Paulo *et al.* 2008; Perera & Harris, 2010; Miraldo *et al.* 2012). Alternatively, *Timon kurdistanicus* (Suchow, 1936), recently elevated to species level (Ahmadzadeh *et al.* 2012), and *Timon princeps* (Blanford, 1874) are distributed in the Mediterranean eastern region (Ahmadzadeh *et al.* 2016).

While other western Mediterranean species of *Timon* are well studied, particularly the European *T. lepidus* (Castilla *et al.* 1991; Castilla & Bauwens, 1992; Vicente *et al.* 1995;

*Corresponding author. Email: massi76100@gmail.com

ISSN 2156-4574 print/ISSN 2153-3660 online

https://doi.org/10.1080/21564574.2016.1271834
http://www.tandfonline.com

Hodar et al. 1996; Salvidio *et al.* 2006), and the Moroccan *T. tangitanus* (Busack, 1987; Perera & Harris, 2010), the North African ocellated lizard *Timon pater* is a little researched species. It is one of the largest lacertids in North Africa. Dorsal colouration is green, bronze and yellowish-brown, with dark reticulation heavy to absent. Blue centred ocelli are often present at body sides, where several rows may occur (Schleich *et al.* 1996). The known distribution is across North Africa, where it is found in North Eastern Morocco, Northern Algeria and Northern Tunisia (Arnold *et al.* 2007; Paulo *et al.* 2008; Perera & Harris, 2010).

Although *T. pater* occurs across North Africa, the only available ecological data are limited to one single study carried out in a coastal area (National Park of El Kala, north-eastern Algeria) by Rouag *et al.* (2006), which examined daily activity patterns and diet. This study was designed to increase our knowledge of this species including daily activity patterns, biometry and diet in Chèlia Mountain, north-eastern Algeria. We specifically describe: (i) its daily activity patterns in relation to climatic conditions of the area, given that daily activity patterns of lacertid lizards are significantly linked to climatic conditions (Foà & Bertolucci, 2001), (ii) first data on some morphological traits of adult males and females, and the existence of sexual dimorphism in size and head dimensions, and (iii) the diet assessed from stomach contents and its variation including between sexes of the same population.

Materials and Methods

Study Area and Survey Protocol

Fieldwork was conducted at the southern slope of Mount Chélia (between 1 700 and 2 100 m of elevation), a mountain in the middle of the Aurès Massif, north-eastern Algeria (35°19′ N, 6°38′ E). It is the highest mountain in northern Algeria (2 328 m). The climate is sub-humid Mediterranean, with two distinct periods over the year: a dry and hot period, extending from mid-May to mid-September with the highest temperatures in July (22 °C), and a wet and cold period during the rest of the year with the lowest temperatures in January (2°C) (Fig. 1). Rainfall is irregular and is approximately 463–543 mm/year (with precipitation increasing with elevation). The study area is an open forest, where plant cover is dominated by *Cedrus atlantica manetti* trees and *Juniperus oxycedrus*, with minor presence of *Fraxinus dimorpha* and planted *Cupressus sempervirens* trees, while the underwood consists of mostly herbs and shrubs, e.g. *Ampelodesma mauritanica*, *Asphodelus ramosus*, *Berberis hispanica*, *Bupleurum spinosum*, *Calycotome spinosa*, *Crataegus monogyna*, *Erinacea anthyllis*, *Genista pseudopilosa* and *Cytisus balancae*.

T. pater is a diurnal lizard and we only sampled during the day when meteorological conditions were favourable. Lizards were captured by hand. We carried out the surveys in random plots for 12 months (between 25 June 2013 and 9 May 2014) with a frequency of two research days per month, thus a total of 24 research days were spent throughout this study. This lizard was only observed during summer, i.e. from June to September (see results) and hence, we divided summer into two distinctive periods: early summer (June and July) and late summer (August and September).

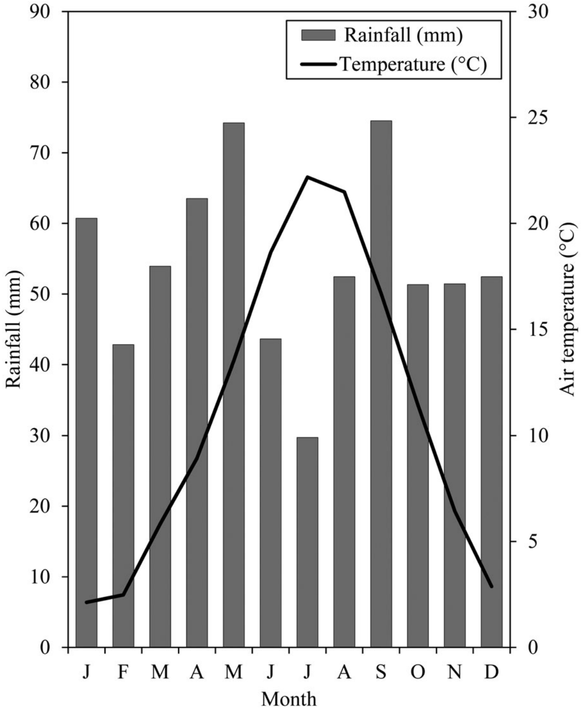

Figure 1. Mean monthly temperature (°C) and rainfall (mm) at the study area.

Daily Activity Patterns

Our methodology was very similar to that applied by Rouag *et al.* (2006). We analysed the daily activity patterns with 4 000 m long random transects, and by recording the time of day and the microhabitat of each observation. The records were then subdivided into four intervals of 2 hours each (from 09:00 to 17:00 h). Additionally, we divided the records into three periods (i.e. morning, midday and afternoon), and the microhabitats into four categories: (1) Cedar trees (*Cedrus atlantica manetti*), in this category lizards were found under leaf litter or climbing tree trunks; (2) grass/shrub (i.e. isolated *Juniperus oxycedrus* with dense grassy undergrowth); (3) under rocks (i.e. medium (40–80 cm) or large (>80 cm) rocks); (4) under fallen deadwood of Cedar trees on the ground. We measured a total of 37 active lizards. We laid surveys in homogeneous habitats for all transects during sunny days. In order to avoid pseudoreplication of the data (Hurlbert 1984), we walked a different and independent transect each research day, thus only a single time data was used for each individual observed.

Biometrical Measurements

In this analysis, we captured and measured 20 adults of the 37 specimens recorded. Adults were defined by the size and colour of the ocelli, which are large with a blue colour in adult specimens, and greenish white with a dark brown boundary in juveniles, where they might be reduced or entirely absent (Schleich *et al.* 1996). We determined sex by dorsal colour patterns (Schleich *et al.* 1996)—females have a distinct ocelli, and open and plain dorsal patterns, while males have a weakly expressed ocelli, and closed and reticulate dorsal patterns. We measured body mass with a balance (to the nearest 0.001 g), as well as snout-to-vent length, head dimensions (head length, head width and head height), and the distance between the tip of the snout and the outer edge of the collar with a vernier digital calliper (to the nearest 0.1 mm).

Diet

Stomach contents were extracted from 17 adult specimens (9 males and 8 females) preserved in the scientific collection of the University of Batna, Batna, Algeria. These specimens were collected from June to September 2013, from the same study area for other research. Prey items were calculated and identified up to the lowest possible taxon level using a binocular microscope.

Diet composition was described by the relative 'prey abundance' (i.e. the percentage of a given prey type relative to the total prey number), and by the relative 'prey presence' (i.e. the percentage of stomachs containing a given prey type). Diet diversity was assessed by means of the Shannon–Weaver index ($H' = -\Sigma pi \mathrm{Ln} pi$ where pi is the proportion of each prey species in the stomach contents) for the identified taxonomic categories (Magurran 1988).

Data Analyses

All data were tested for normality and homogeneity of variances using the Shapiro–Wilk test and F_{max} test, respectively. Whenever necessary, data were $\log_{10}(x)$ or $\log_{10}(x + 1)$ transformed to improve normality. Hence, normality was achieved for all transformations and parametric analyses were used.

In order to examine intra-seasonal daily activity patterns, we used an independent samples *t*-test. We examined diel and intra-seasonal variation in microhabitat use of *T. pater* using one way ANOVA for each analysis. We compared daily means of lizards observed at each daily interval and not the total number of specimens, which minimized statistical biases (Oksanen, 2001).

We used General Linear Models (GLMs) to analyse the difference between morphological log-transformed variables between sexes.

We examined diet variation of *T. pater* using Fisher's Exact Test by comparing absolute prey abundance between early and late summer periods, and between sexes. Analyses of intersexual dietary differences between summer periods was not performed due to the relatively small sample size (i.e. 7 females and 6 males in early summer, and 1 female and 3 males in late summer), and only intersexual dietary differences were examined.

We performed statistical analyses using SPSS version 20.0 PC software, with $\alpha = 0.05$.

Results

Daily Activity Patterns

The patterns of the daily activity of *T. pater* were similar during the early and late summer periods (independent samples *t*-test, $t = 0.777$, $P = 0.467$), with activity greater around

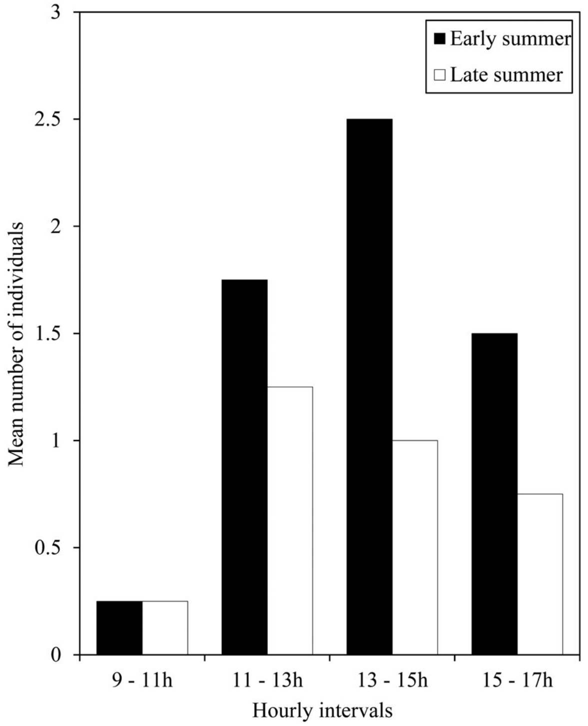

Figure 2. Daily activity patterns of *Timon pater* at the study area, expressed as the mean number of individuals seen at each daytime interval along several independent 4000 m long transects.

midday (from 11:00 to 15:00 h) with a second lower peak of activity during the afternoon hours (from 15:00 to 17:00 h) (Fig. 2).

There was no significant diel variation detected in the microhabitat use for *T. pater* ($F_{2,11}$ = 0.400, P = 0.682). However, we encountered more individuals under rocks and on Cedar trees during morning. While at midday we found more individuals on Cedar trees. In the afternoon the number of individuals did not differ, except on shrubs where the number was low at all periods (Fig. 3). It is somewhat noteworthy to mention that there is no intra-seasonal variation in microhabitat use (F = 3.395, P = 1.000).

Biometrical Measurements

Adult males were slightly larger than adult females (mean ± SE = 116.60 ± 3.91 for males vs 102.92 ± 4.9 for females; $F_{1,18}$ = 4.880, P = 0.04) and heavier (mean ± SE = 49.11 ± 4.30 for males vs 31.63 ± 3.3 for females; $F_{1,18}$ = 8.408, P = 0.01). Males and females significantly differ in their absolute head size, male heads were longer, larger and thicker than female heads (head length: mean ± SE = 30.77 ± 1.21 for males vs 24.54 ± 0.85 for females; $F_{1,18}$ = 14.321, P = 0.001; head width: mean ± SE = 16.54 ± 0.75 vs 13.46 ± 0.47; $F_{1,18}$ = 9.138, P = 0.007; head depth: mean ± SE = 17.76 ± 0.78 vs 14.34 ± 0.70; $F_{1,18}$ = 8.751, P = 0.008). However, the distance between the snout and the collar did not differ between adults ($F_{1,18}$ = 4.113, P = 0.058) or in relative distance between the snout and the collar (GLM with SVL as a covariant, $F_{1,18}$ = 0.152, P = 0.70) (Table 1).

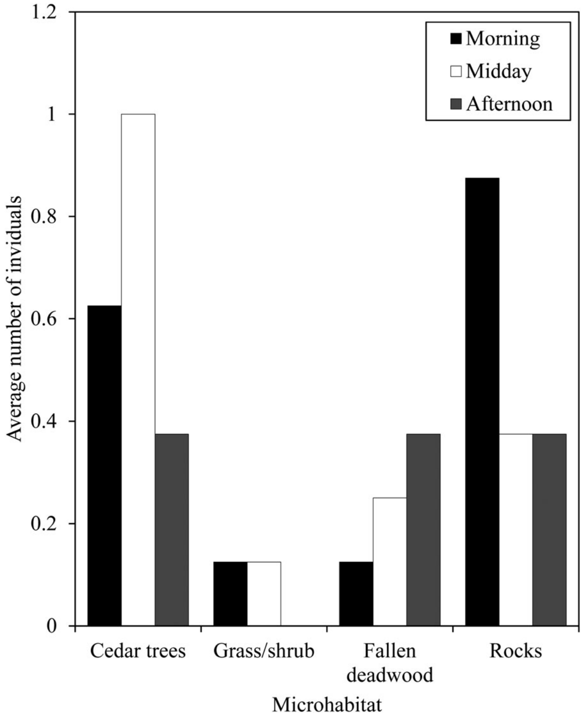

Figure 3. Diel variation in microhabitat use for all *Timon pater* encounters averaged over all sampling dates.

Table 1. Biometrical measurements (mean ± SE; range below) of adult male, female *Timon pater* at Mount Chélia (Algeria).

	Males (n = 12)	Females (n = 8)
Snout-to-vent length (mm)	116.60 ± 3.91	102.92 ± 4.91
	(92.37–134.85)	(86.89–129.43)
Body weight (g)	49.11 ± 4.30	31.63 ± 3.38
	(24.3–74.65)	(21.1–47.54)
Head length (mm)	30.77 ± 1.21	24.54 ± 0.85
	(22.03–36.99)	(21.69–28.68)
Head width (mm)	16.54 ± 0.75	13.46 ± 0.47
	(12.01–20.67)	(11.57–15.35)
Head depth (mm)	17.76 ± 0.78	14.34 ± 0.70
	(11.61–21.01)	(11.76–18.13)
Nose-collar length (mm)	37.02 ± 1.33	32.77 ± 1.68
	(28.87–42.96)	(27.2–42.38)

Diet

The examination of the 17 stomach contents revealed a total of 128 animal prey items, all of which were arthropods belonging to 32 different taxa identified at different systematic levels and classified into two classes, five orders and 21 families. Additionally a few plant remains were also identified. The number of individual prey items per stomach contents ranged between one and 28 (mean ± SE = 7.52 ± 1.61; n = 17). Insects were the most consumed and frequent animal prey in the stomach contents (n = 17) throughout summer (i.e. from June to September) with a percentage of 98.44% (126/128) of all prey, the remaining 1.56% were spiders.

Coleoptera were very abundant and the most important prey group, followed by Hemiptera (these two categories accounted for 69.53% and 21.10% of all prey, respectively), representing altogether 90.63% of the total number of prey items. All the other prey taxa were scarce (i.e. Hymenoptera with 7.03%, Areanae with 1.56% and Orthoptera with 0.78%). Within the Coleoptera, *Coccinella septumpunctata* of the family Coccinellidae were numerically the most important (33.71% of total number of Coleoptera), followed by Scarabeidae (25.48%), Geotropidae, Curculionidae. Representatives of 9 other beetle families were encountered in low numbers (<5% of total Coleoptera numbers for each group taxa). Most Hemiptera eaten were members of the family Pyrrhocoridae, specifically *Pyrrhocoris apterus* species; Lygaeidae and Pentatomidae families were only detected occasionally.

Over the entire study period, Coleoptera especially Scarabaeidae and Coccinellidae (94.12% of all stomachs) and Hemiptera (64.71%) contributed the largest proportions to the insect diet of the lizards and were a constant prey for this lizard. Other insects, represented by Hymenoptera (17.65%) and Orthoptera (5.88%) occurred in much lower numbers of stomach contents and were rather less conspicuous in the diet. Arachnids (11.76%) were poorly present in the stomach contents. The stomachs also contained very small amounts of plant materials (mostly Cedar needles; 17.65%).

Shannon's Index (H') indicates that the diet of this lizard was narrow throughout summer (H' = 2.03), composed essentially of Coleopterans.

Fisher's test revealed a significant dependence between absolute 'prey abundance' and summer periods (F = 12.375, P = 0.031), with higher abundances in early summer of Coccinellidae, Scarabaeidae, Pyrrhocoridae, and in late summer of Curculionidae and Scarabaeidae (Table 2). Alternatively, there was no significant dependence between 'prey abundance' and sexes (F = 9.136, P = 0.939).

Discussion

In this study, we report the activity patterns, biometry and diet of *T. pater* in Mount Chélia. The daily activity patterns and diet of this population of *T. pater* were compared with the only existing data reported on food habits and activity patterns exhibited by this lizard in coastal localities, north-eastern Algeria (Rouag *et al.* 2006). Whereas for the biometrical measurements data of *T. pater*, this study presents the only existing data, thus comparisons were only made with datasets available for the closely related species of the same genera, the large European ocellated lizard *Timon lepidus* and the large Moroccan ocellated lizard *Timon tangitanus* (e.g. Busack, 1987; Castilla *et al.* 1991; Castilla & Bauwens, 1992; Salvidio *et al.* 2006).

This study conducted over a period of 12 successive months indicated that *T. pater* is mainly active during the summer. The exact period of activity could not be determined, but this may be related to the number of research days per month (n = 2), which was not sufficient to estimate the exact period of activity. Daily activity patterns differ from those found

Table 2. Abundance and frequency of presence (i.e. percentage of stomachs containing the item) of the main prey items, evenness (i.e. H'/H_{max} where $H_{max} = \log_2$ (number of items)) and prey taxon diversity (H') for *Timon pater* in summer periods (early and late summer periods) and in sexes (males and females).

	Early summer		Late summer		Males		Females	
Prey item	Abundance (%)	Presence (%)	Abundance (%)	Presence (%)	Abundance (%)	Presence (%)	Abundance (%)	Presence (%)
Areanae	0.85	7.69	10	25	1.96	11.11	1.30	12.50
Gryllidae	0.85	7.69	0	0	0	0	1.30	12.50
Pyrrhocoridae	14.41	61.54	0	0	21.57	55.56	7.79	37.50
Other Hemiptera	5.93	15.38	20	50	1.96	11.11	10.39	37.50
Scarabaeidae	17.80	61.54	20	50	19.61	55.56	16.88	62.50
Coccinellidae	25.42	61.54	0	0	15.69	55.56	28.57	50
Curculionidae	1.69	15.38	40	25	1.96	11.11	6.49	25
Geotropidae	7.63	23.08	0	0	5.88	11.11	7.79	25
Other Coleoptera	18.64	84.62	0	0	13.73	44.44	19.48	87.50
Hymenoptera	6.78	15.38	10	25	17.65	33.33	0	0
H'	1.94		1.47		1.92		1.90	
Evenness	0.70		0.91		0.87		0.86	

by Rouag *et al*. (2006) in *T. pater* that was more active during the early morning hours to early afternoon. We casually observed frost in the early morning hours of surveys, thus we suggest that *T. pater* was more active in late morning hours because basking periods may be required during higher temperatures, in order to obtain preferred activity temperatures. Consequently, the activity is delayed to late afternoon hours. In terms of seasonal differences of daily activity, our data are consistent with the data available for *T. pater* (e.g. see Rouag *et al.* 2006), although our results indicate that there is no difference between the early and late summer of daily activity patterns (i.e. no intra-seasonal differences). This may be related to the absence of important changes in air temperature (Fig. 2), which might explain the constant pattern of daily activity throughout the summer. While no significant diel changes in *T. pater* microhabitat use were found, more individuals were encountered under rocks and on Cedar trees during morning and on Cedar trees at midday (Fig. 3). Additionally, no significant differences were found in intra-seasonal microhabitat use. These results may be due to the fact that the period of activity was limited to only one season. Our results agree with the results available in Castilla & Bauwens (1992): although they concluded that *T. lepidus* can be considered a habitat generalist both on a local and regional scale, *T. pater* can also be considered a habitat generalist but only on a local scale since the lizards were found throughout the microhabitats available in the study area.

Our data indicated that this population of *T. pater* is composed of relatively small average adult body size (mean SVL = 111.13 ± 3.35 mm, range = 86.89–134.85 mm) compared to Spanish populations of *T. lepidus* (i.e. mean SVL = 138.10 ± 6.8 mm, range = 47–229, n = 88), previously described by Busack (1987), and Moroccan populations of *T. tangitanus* (average SVL = 117.70 ± 6.05 mm, range = 46–170, n = 66). This could be explained by sampling bias. Moreover, it might be related to age of the adults, the lizards measured might be of a young age and they might attain larger body sizes. According to Schleich *et al.* (1996), this species can reach a maximum SVL of 170 mm. Although our sample size is limited, biometrical data also indicate the existence of sexual dimorphism in body size, with males being larger and heavier, and in head dimensions, with males having longer, larger and thicker heads than females. Sexual size dimorphism might be linked to sexual selection on male size, for male-male competition over females during the breeding season (Stamps, 1983). Whereas sexual dimorphism in head dimensions might be explained by males with bigger heads having greater success in male-male combat and territorial competitions with other males (Gvozdik & van Damme, 2003). In addition, during mating attempts, males with larger heads can hold the females faster and stronger during copulation (Braña, 1996).

T. pater showed low diversity in diet selection with an exclusive arthropod prey. This is not as expected for the large sized lizards, which can have very diversified diets, with the possibility of consumption of small vertebrates (Corti & Lo Cascio 2002). Nevertheless, our results mirror the data available for other populations of *T. pater* and European populations of *T. lepidus*. Vertebrate items are indeed extremely rare in diets of both species populations previously studied (see Castilla *et al.* 1991; Rouag *et al.* 2006; Salvidio *et al.* 2006). Moreover, they were also nearly entirely arthropod consumers. Although plant materials were also found in the diet of the population of *T. pater* studied beforehand in the National Park of El Kala, Algeria (Rouag *et al.* 2006), further studies are required to confirm that plant material was not ingested accidentally with arthropods. The finding for this population of *T. pater* to feed mainly upon Coleopterans is in agreement with other studies on populations of *T. pater* and *T. lepidus* including Rouag *et al.* (2006) (52.1%

of the prey items), Castilla *et al.* (1991) (74%) and Salvidio *et al.* (2006) (34.9%). This preference for Coleopterans might be explained by the robust mouth vigour and chewing strength of this large sized lizard that enables it to crush relatively large beetle species that provide a lot of biomass (Rouag *et al.* 2006). Additionally, hard preys (i.e. Coleopterans) are more common in adults than in juveniles (Carretero *et al.* 2006). This may explain the dominance of hard prey in our results, since we included only adults in this study. Temporal variation in prey abundance between early and late summer is likely related to the climate and vegetation structure that differs from time to time, thus influencing the availability and abundance of invertebrates (Wolda 1988). This may provide a proximate explanation for the prey abundance temporal variation. Few differences between lizard sex groups in dietary composition were found. The virtually identical composition of the diet in males and females suggests that the sexes have similar foraging habits and prey choices, despite differences in morphometric characters (body size, relative head dimensions) that may influence feeding ecology. Further investigation should examine prey size, in order to determine if males prey on larger prey than females.

The limitations for our study were determined by the low population size of *T. pater*, which rendered greater sample sizes difficult to obtain. Future studies with increased sample sizes could determine whether there are seasonal variations in activity, and variations in morphological traits between age classes as well as the potential changes in diet preferences and prey availability.

ACKNOWLEDGEMENTS

We would like to express our most sincere thanks to the many individuals who helped with the fieldwork, especially Benbouta Chemseddine, Bouteghriout Abbes, Taher-Chaouch Laarbi, and Zeghina Med Saïd. We gratefully acknowledge two anonymous referees for reviewing an earlier manuscript. We also thank Roger Meek for his help in language editing. Our thanks to Professor Si Bachir Abdelkrim for his help with prey identification.

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Received: 3 January 2016; Final acceptance: 9 December 2016