Activity, tail loss, growth and survivorship of male *Psammodromus algirus*

Alfredo Salvador[1], José P. Veiga[1]

Male lizards may increase activity and mobility during the breeding season to patrol their home range more effectively and increase access to females (Ruby, 1981). However, male reproductive effort might compromise survival (Marler and Moore, 1991; Salvador et al., 1996). More active males may suffer higher predation pressure. While autotomy may provide an immediate benefit to survival (Arnold, 1988), associated costs during tail regeneration, such as reduced growth and survival might have a negative impact on future reproductive output (Vitt et al., 1977; Schwarzkopf, 1994).

Here we present the results of a field study on *Psammodromus algirus* lizards which investigates male activity during the reproductive season, and their effects on tail loss; we also examine the consequences of tail loss to survival and growth in the next reproductive season.

Field work was carried out in a deciduous oak-forest (*Quercus pyrenaica*) near Navacerrada, Madrid province, Spain, during the 1997 breeding season (i.e., March-May). From February 1-15, we established a 100×60 m grid with markers every 10 m. We visited the plot every day after 20 February to search for lizards. Lizards were captured by noosing and transported to El Ventorrillo Field Station (5 km distant by air) where they were weighed to the nearest 0.01 g with an electronic balance, and their snout-vent (SVL) length measured to the nearest 0.5 mm. Individuals were marked with four colour-coded paint dots on the dorsum for individual recognition and released at site of capture within 4 h to minimize influence on social conditions.

To analyze activity, we walked several transects per day between 0800 and 1200 h (five days per week during March, April, and May) and recorded the identification of every individual encountered. To estimate mobility, we observed males from a distance of 5-10 m using binoculars and noted the distances moved (m) during 15 min periods of continuous recording. The mean number of observation periods per male was three (range = 1-6). To prevent bias introduced by overrepresenting a single individual, we used only one observation period per week for males with two or more periods. To consider temporal variation of male movements during the mating season, we computed a regression of distances moved per min on date, and used the residuals of this regression in analyses of spatial behavior. We did not analyse the number of movements because we have previously shown that this variable had no effect on pairing success (Salvador and Veiga, 2001). When males were recaptured at the end of the reproductive season, we measured their SVL to the nearest 0.5 mm and noted whether they had lost the tail (TA) or not (CT). The number of days elapsed between the first capture and final recapture of CT males (mean =

1 - Departamento de Ecología Evolutiva, Museo Nacional de Ciencias Naturales, CSIC, José Gutiérrez Abascal 2, 28006 Madrid, Spain
e-mail: mcnas500@mncn.csic.es

Table 1. Activity and movements of males according to tail condition at final recapture.

	TA (Tail loss) N = 7		CT (No tail loss) N = 29		ANOVA	
	Mean ± SE		Mean ± SE		F	P
No. of sightings	26.3	6.2	15.7	2.0	7.21	0.01
Residuals of m/min on date	0.22	0.2	−0.30	0.1	4.0	0.05

44.7 ± 1.3 days, $n = 29$) and males with TA (mean $= 42.8 \pm 5.7$ days, $n = 7$) did not differ significantly (Mann-Whitney U-Test, $Z = -0.26$, $P = 0.79$). We continued field work during the subsequent year in the same plot to examine male survival and measure their SVL at first capture.

There were no significant differences in SVL at first capture between TA males (76.1 ± 1.3 mm) and CT males (75.7 ± 0.7 mm) (ANOVA, $F = 0.08$, $P = 0.78$). TA males were sighted more often and moved longer distances (table 1). The SVL at final recapture of TA males (77.9 ± 0.5 mm) and CT males (77.5 ± 0.7 mm) did not differ significantly (ANOVA, $F = 0.13$, $P = 0.72$). We recaptured 3 of 7 TA males and 7 of 29 CT males at emergence the following year, and there were no significant differences in survival between the two groups ($\chi^2 = 0.98$, $P = 0.32$). The SVL at emergence the following year of TA males (mean $= 79.3 \pm 0.3$ mm) and CT males (mean $= 83.5 \pm 1.5$ mm) was significantly larger than their SVL at final recapture the previous year (Repeated measures ANOVA, $F = 19.2$, $P = 0.002$). However, the increase of SVL was significantly lower for TA males than for CT males (Repeated measures ANOVA, interaction between SVL and tail condition, $F = 7.06$, $P = 0.029$).

We have previously shown that levels of activity and mobility were higher for males of *Psammodromus algirus* with higher pairing success (Salvador and Veiga, 2001). Males that autotomized their tail survived to the next breeding year in similar proportion to males with intact tails. Tailless lizards may shift microhabitat use, avoiding more exposed habitats and reducing distance to shelters (Martín and Salvador, 1992), and decrease their activity (Salvador et al., 1995; Martin and Avery, 1998). Diverting energy from growth into tail regeneration (Vitt et al., 1977; Smith, 1996), may be responsible for the fact that TA individuals grew more slowly than individuals with whole tails. The survival reward of tail autotomy may be counter-balanced by smaller size, which may result in lower pairing success in subsequent seasons (Salvador and Veiga, 2001).

References

Arnold, E.N. (1988): Caudal autotomy as a defense. In: Biology of the Reptilia. Vol. 16, p. 235-273. Gans, C., Huey, R.B., Eds, New York, Alan R. Liss.

Downes, S., Shine, R. (2001): Why does tail loss increase a lizard's later vulnerability to snake predators? Ecology **82**: 1293-1303.

Fox, S.F., Conder, J.M., Smith, A.E. (1998): Sexual dimorphism in the ease of tail autotomy: *Uta stansburiana* with and without previous tail loss. Copeia **1998**: 376-382.

Marler, C.A., Moore, M.C. (1988): Evolutionary costs of aggression revealed by testosterone manipulations in free-living male lizards. Behavioral Ecology and Sociobiology **23**: 21-26.

Martín, J., Avery, R.A. (1998): Effects of tail loss on the movement patterns of the lizard, *Psammodromus algirus*. Functional Ecology **12**: 794-802.

Martín, J., Salvador, A. (1992): Tail loss consequences on habitat use by the Iberian rock lizard, *Lacerta monticola*. Oikos **65**: 328-333.

Ruby, D.E. (1981): Phenotypic correlates of male reproductive success in the lizard, *Sceloporus jarrovi*. In: Natural selection and social behavior: recent research and new theory, p. 96-107. Alexander, R.D., Tinkle, D.W., Eds, New York; Chiron Press.

Salvador, A., Martín, J., López, P. (1995): Tail loss reduces home range size and access to females in male lizards, *Psammodromus algirus*. Behavioral Ecology **6**: 382-387.

Salvador, A., Veiga, J.P. (2001): Male traits and pairing success in the lizard *Psammodromus algirus*. Herpetologica **57**: 77-86.

Salvador, A., Veiga, J.P., Martín, J., López, P., Abelenda, M., Puerta, M. (1996): The cost of producing a sexual signal: testosterone increases the susceptibility of male lizards to ectoparasite infestation. Behavioral Ecology **7**: 145-150.

Schwarzkopf, L. (1994): Measuring trade-offs: a review of studies of costs of reproduction in lizards. In: Lizard Ecology. Historical and Experimental Perspectives, p. 7-29. Vitt, L.J., Pianka, E.R., Eds, Princeton; Princeton University Press.

Smith, G.R. (1996): Tail loss in the striped plateau lizard, *Sceloporus virgatus*. Journal of Herpetology **30**: 552-555.

Vitt, L.J., Congdon, J.D., Dickson, N.A. (1977): Adaptive strategies and energetics of tail autotomy in lizards. Ecology **58**: 326-337.