

Short communication

Social aggregation behaviour in the North African amphisbaenian *Trogonophis wiegmanni*

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Abstract.—The ecology and behaviour of Amphisbaenians is poorly known due to their fossorial habits. However, amphisbaenians are often found under rocks where they thermoregulate, and probably engage in social interactions. We describe aggregations under rocks in a North African population of the little studied amphisbaenian *Trogonophis wiegmanni*. These observations could be used to make initial inferences about the social behaviour of this amphisbaenian. Results showed that amphisbaenians were sometimes found in pairs under the same rock. However, these aggregations were not random. Adult males were only found together with adult females, but we did not find pairs of adult males or adult females. This might suggest that there is intra-sexual intolerance, and that adult individuals of the same sex do not occupy the same rock space. Pairs of adults were more frequently found in spring than in autumn, coinciding with the mating season. Also, juvenile individuals were often found together with an adult, but juveniles tended to be more often with an adult female than with an adult male. This might indicate that juveniles are allowed to remain with their parents until they are older, which might enhance offspring fitness by providing access to high-quality habitats.

Key words.—Social behaviour, rock use, Chafarinas Islands, Amphisbaenia, Trogonophidae

Amphisbaenians are a group of reptiles morphologically specialised for a fossorial life style (i.e. reduced vision, elongated body, loss of limbs and compact skull) (Gans 1978). Morphological adaptations to burrowing constrain the responses of amphisbaenians to ecological demands (e.g. Martín *et al.* 1990, 1991; López *et al.* 1998; Vega 2001; Gomes *et al.* 2009). However, there is very little information on the ecology and behaviour of most species of amphisbaenians (see review in Gans 2005), probably because their fossorial habits make observations difficult. Nevertheless, some amphisbaenian species spend long periods of time under rocks in order to forage and thermoregulate (López *et al.* 1998, 2002), and can be easily located by lifting stones. Furthermore, two or more individuals are found together under the same rock on many occasions. By analysing the composition and seasonal variation of these ‘social aggregations’ (sex, age, etc), we find indications of social behaviour in amphisbaenians.

Most of the available ecological and behavioural studies on amphisbaenians have been made on European or American members of the families Amphisbaenidae or

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Bipedidae. However, little is known on the ecology of African species (e.g. Broadley & Broadley 1997; Webb *et al.* 2000 for southern African amphisbaenians). The amphisbaenian *Trogonophis wiegmanni* is a representative of the family Trogonophidae in North Africa (Gans 2005). This species is a Maghrebian endemic with a range in the Mediterranean biome that extends from southwest Morocco to northeast Tunisia (Bons & Geniez 1996). Little research has been carried out on this species, or other members of the family Trogonophidae, but the few available studies show that they live in the soil in areas with sandy soils and abundant leaf litter (Civantos *et al.* 2003; Martín *et al.* in press). Moreover, they are usually found under rocks where they thermoregulate (Gatten & McClung 1981; López *et al.* 2002). The reproductive cycle, based on the seasonal development of the reproductive organs, has also been described (Bons & Saint Girons 1963). In this paper, we analysed incidence of aggregation under rocks in *T. wiegmanni* from a single population of the Chafarinas Islands (North Africa) as a first indication of their social behaviour.

We conducted field work at the Chafarinas Islands (Spain), a volcanic island archipelago located in the southwestern area of the Mediterranean Sea (35°11'N, 2°25'W), 2.5 nautical miles to the north of the Moroccan coast (Ras el Ma, Morocco) and 27 miles to the east of the Spanish city of Melilla (Martín *et al.* in press). The archipelago consists of three small islets that are close to each other: 'Congreso' (25.6 ha; 137 m asl), 'Isabel II' (15.1 ha; 35 m asl; the only one which is inhabited), and 'Rey Francisco' (13.9 ha; 31 m asl). The climate is dry and warm Mediterranean. Vegetation is dominated by plants adapted to salinity and drought, such as species of *Atriplex*, *Suaeda* and *Salsola*. The soils are little developed and immature, and are characterised by a thin layer rich in organic matter, where the vegetation settles, which is underlain almost directly by the original volcanic rock.

We visited the study area on two occasions during one week in September 2009 (autumn) and during another week in March 2010 (spring). We followed different random routes during the day between 07:00 and 18:00 (GMT), covering all the available habitats on the islands, searching for amphisbaenians by lifting all the stones found. Amphisbaenians were typically found under stones with optimal body temperatures and activity levels during the day (López *et al.* 2002). We captured individuals by hand for taking measurements in situ and then released them at their exact capture points in less than 1 min. We used a metallic ruler to measure (to the nearest 1 mm) snout-to-vent length (SVL; from the tip of the snout to the extreme posterior point of the cloacal flap). We determined sexes of adult amphisbaenians by examining cloacas and everting the hemipenes of males. Juveniles (SVL < 110 mm; see Bons & Saint Girons 1963) could not be reliably sexed. We ensured that the same individuals were not measured twice by avoiding sampling the same areas twice. For each rock we measured (with a metric tape to the nearest cm) its maximum length, width and height.

We found amphisbaenians under a total of 344 rocks (representing approximately one out of every 50 rocks examined). Two hundred and ninety-three of these rocks were used by a single individual, but 45 rocks were used by two individuals, four by three individuals (one adult and two juveniles), and two large rocks were used by four individuals separated in two groups. Nevertheless, it is possible that some amphisbaenians escaped detection into preformed burrows below or beside the rocks, and therefore, the actual number of aggregations might have been higher. Aggregation of individuals under the same rock was more common in spring (rocks

sheltering two or more amphisbaenians: 36 out of 163; 22.1%) than in autumn (15 out of 181; 8.3%) ($\chi^2 = 12.93$, 1 df, $P = 0.0003$) (Fig 1). Rocks used by a single male, female or juvenile did not differ significantly in size (MANOVA for the three rock size dimensions, Wilks' $\lambda = 0.97$, $F_{6,576} = 1.28$, $P = 0.26$) (Table 1). However, rocks used by a single individual were significantly smaller than those used by two or more individuals (MANOVA for the three rock size dimensions, Wilks' $\lambda = 0.94$, $F_{3,333} = 6.83$, $P < 0.0002$; univariate ANOVAs: length, $F_{1,336} = 17.80$, $P < 0.0001$; width: $F_{1,336} = 15.32$, $P = 0.00011$; height: $F_{1,336} = 6.24$, $P = 0.013$) (Table 1).

When two adult individuals were found together under a rock, these were always a male and a female, we never found two adult males or two adult females together (Chi-square test comparing observed sex composition of a pair in comparison with expected frequencies considering the adult sex ratio 1:1.1 in the population, $\chi^2 = 6.67$, 2 df, $P = 0.036$) (Fig 1). Adult males and females were significantly more often found together in spring than in autumn (7.8% vs. 2.3% of rocks sheltering a pair of adult amphisbaenians from the total of rocks used by adults; $\chi^2 = 3.93$, 1 df, $P = 0.047$) (Fig 1).

Juveniles were found with an adult significantly more times than with another juvenile (77.5% vs. 22.5% respectively, $\chi^2 = 5.16$, 1 df, $P = 0.023$) (Fig 1). Juveniles tended, although not significantly so, to be found more often with an adult female than with an adult male (71.0% vs. 29.0% respectively, $\chi^2 = 3.28$, 1 df, $P = 0.07$) (Fig 1). Juveniles found with an adult and those found alone did not significantly differ in body size (SVL, 89 ± 3 mm vs. 89 ± 2 mm; ANOVA, $F_{1,97} = 0.01$, $P = 0.82$). However, rocks used by a single juvenile individual found alone were significantly smaller than those used by a juvenile found together with an adult (MANOVA for the three rock size dimensions, Wilks' $\lambda = 0.83$, $F_{3,99} = 6.66$, $P < 0.0004$; univariate ANOVAs: length, $F_{1,101} = 14.62$, $P = 0.0002$; width: $F_{1,101} = 14.07$, $P < 0.0003$; height: $F_{1,101} = 7.60$, $P = 0.007$) (Table 1).

Our study shows that the amphisbaenian *T. wiegmanni* is sometimes found in pairs under the same rock, and, more importantly, that these social aggregations

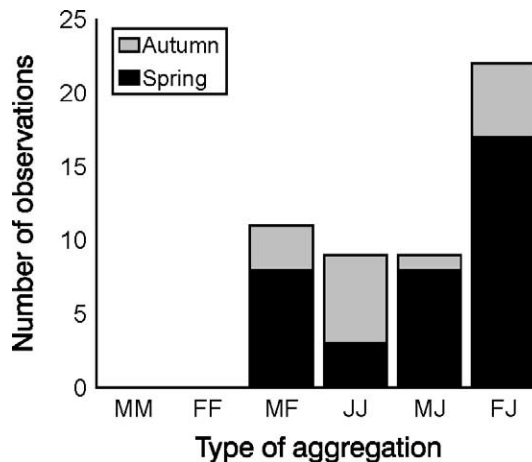


Figure 1. Characteristics (sex and age composition, M: adult male; F: adult female; J: juvenile) of the social aggregations of individual amphisbaenians *T. wiegmanni* found together under the same rock during the spring (March) and autumn (September) seasons.

Table 1. Size (mean \pm SE; range) of rocks used by adult males and females and juvenile amphisbaenians *Trogonophis wiegmanni* found alone or in aggregations.

	Male alone <i>n</i> = 113	Female alone <i>n</i> = 109	Juvenile alone <i>n</i> = 71	Pair of adults <i>n</i> = 11	Juvenile with adult <i>n</i> = 31
Length (cm)	25 \pm 1 (9–48)	25 \pm 1 (10–60)	22 \pm 2 (10–65)	34 \pm 4 (15–52)	30 \pm 2 (12–60)
Width (cm)	19 \pm 1 (8–40)	18 \pm 1 (7–40)	16 \pm 1 (4–34)	22 \pm 2 (12–30)	22 \pm 1 (9–42)
Height (cm)	10 \pm 1 (1–27)	9 \pm 1 (2–35)	8 \pm 1 (2–20)	11 \pm 1 (7–18)	12 \pm 1 (3–27)

are not random. These observations could be used to make initial inferences about some aspects of the social behaviour of this amphisbaenian. First, associations between adult males and females were observed more often in spring, coinciding with the beginning of the mating season, as previously indicated by more developed reproductive organs in that season (Bons & Saint Girons 1963). The lack of observations of two adult males or two adult females together might suggest that there is intra-sexual intolerance, and that adult individuals of the same sex do not occupy the same stone. Similarly, in the amphisbaenian *Blanus cinereus*, males are more likely to bite in response to chemical stimuli from conspecific males than to chemicals from females (Cooper *et al.* 1994). Also, in the amphisbaenians *Leposternon microcephalum* and *L. wuchereri*, bite marks related to intraspecific aggression suggest that agonistic aggressions occur in males and females (Filogonio *et al.* 2009). Therefore, a similar aggressive behaviour might likely explain why individuals of the same sex are not found together in the amphisbaenian *T. wiegmanni*. In lizards, pair-living in absence of biparental care is explained because males have problems in accessing multiple females (e.g. because of their distribution) and securing access to a single female through territoriality or mate guarding, or because females benefit from male presence through enhanced vigilance or reduced harassment by other males (Stow & Sunnucks 2004)

The amphisbaenian *T. wiegmanni* bears live young at the end of summer (Bons & Saint Girons 1963). Our observations of juveniles found together, very often in close proximity to an adult individual both in spring and in autumn might suggest that juveniles may remain with their parents until they are older. Reptiles rarely show prolonged parental care and stable social aggregations, although cohesive groups occur in Australian skinks of the Genus *Tiliqua* and *Egernia* (Bull & Baghurst 1998; Duffield & Bull 2002). These skinks are viviparous lizards with prolonged parent-offspring association; adult pairs vigorously defend their home range and their offspring against conspecifics (O'Connor & Shine 2004; Langkilde *et al.* 2007). Our field observations suggest that some parent-offspring association might also occur in *T. wiegmanni* amphisbaenians. This may enhance offspring fitness by providing access to high-quality habitats (e.g. rocks used by 'orphan' juveniles found alone are smaller), but more studies and experiments are clearly needed to test these hypotheses and understand the social behaviour of this and other amphisbaenians.

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