Activity patterns in a viviparous snake, *Vipera aspis* (L.), from Mediterranean central Italy

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Activity in snakes is a conceptual aspect of life history traits frequently debated among herpetologists (see Saint Girons, 1996; Bonnet and Naulleau, 1996; Luiselli et al., 1996; Luiselli and Zimmermann, 1997). The neural basis of activity in reptiles has recently been reviewed by Underwood (1992), but very little is known about this aspect in snakes (Whiting et al., 1996), even though many field observations on various aspects of snake behaviour are available (Shine, 1979; Sexton et al., 1992). In addition, ecological constraints (e.g. different structures and exposures of habitats) on activity may produce variations in observed patterns and hinder capture. The use of different habitats by the same taxon can sometimes lead to bias in the comparative estimation of the activity patterns of the species (Reinert, 1993). A different physiological status, for example reproduction (Reinert, 1993; Luiselli et al., 1996; Luiselli and Zimmermann, 1997), moulting, feeding and digestion can also greatly influence frequency of catchability.

A number of aspects of the biology of *Vipera aspis*, e.g. the frequency of activity in the open (Naulleau, 1975), space usage (Moser et al., 1984), diet and feeding ecology (Monney, 1990), thermal ecology (Saint Girons, 1978; Naulleau, 1979), and reproductive biology (Bonnet et al., 1994) may vary considerably, depending on climate, season, altitude and habitat structure of the site considered. The characteristics of activity patterns in *V. aspis*, and their dependence on local ecological constraints, have been only briefly reported for Italy by Luiselli and Rugiero (1990). Even if many aspects of *V. aspis* activity have been reported sparsely in most of the previously cited works, no available contribution has
specifically dealt with the activity frequency in the field. This short contribution is aimed at showing the following points: i) the visibility of asp viper sedentary adult females could be used as a good predictive variable in assessing their reproductive status; ii) the visibility of adult vipers could be dependent on local climatic conditions.

The study area is at Amino, 10 km South West of Pisa and 2 km East of the Ligurian Sea coast, in the "Parco Naturale di Migliarino, S. Rossore, Massaciuccoli", western Tuscany, central Italy (43°43'N, 10°23'E, 0-9 m asl). Its surface area is about 3.9 ha. Average maximum and minimum air temperatures (July and January, 1978-1987) were (mean±sy) 19.27 ± 0.38°C and 9.81 ± 0.35°C respectively (Rivano, 1985-1988, modified). Animals were searched for from sunrise to sunset during randomly selected days (n = 258), on sunny as well as cloudy and rainy days, from February to November 1990-1992. Each transect route was performed from at least two up to four times during the day, following a given direction at the first attempt and the opposite direction on the successive sampling route. On the following day, the first route direction was the opposite of that selected on the previous day.

Nocturnal activity patterns were studied during two consecutive seasons, with externally attached radiotransmitters, but no snake was found active in the open. Nocturnal activity is a relatively common pattern in snakes, described in many temperate species during the summer (Naulleau, 1975; Cheylan, 1986). However, in this area summer nights (i.e. July and August) are generally characterized by a strong thermal inversion, very often with fog and a high relative humidity. Visual sampling periods were limited only to the daylight hours.

Only captured adult animals were sexed, measured (total length, snout to vent length), weighed and marked with ventral scale clipping and dorsal colour markings for visual recognition. Vipers were divided a priori into two main biologically relevant groups: i) animals basking in the open or under vegetation if in the sun, moving, mating or sloughing, that is snakes which were actually active; and ii) immobile and/or hidden animals in the shade, as well as those sheltered or under cover, that is snakes that did not display any evident pattern of activity, here considered as virtually inactive snakes. Snakes under cover were found looking for them under roots, leaves and branches. The vipers disturbed by the researcher and in movement at the moment of the encounter were not considered for analysis. To maintain the independence of observations (Lutterschmidt and Reinert, 1990) we plotted all data relative to males and, separately, those relative to females. Each observation was recorded in an hour class (from 6.00 to 19.59 hours of solar time). Frequencies of data were graphically tested to achieve normality and approximation to the $\chi^2$ distribution. Averaged hourly observation frequencies and frequencies of monthly observations in males and females were compared using the median test (Mann-Whitney U test, for pairs). All tests and analyses were plotted with the Statgraphics package (4.0 PC version).

A total of 343 data entries for adult snakes (males, n = 105; females, n = 238; from 11 adult males and 12 adult females) were recorded. Minimum adult size was assumed at snout to vent length $\geq$ 41.5 cm, as indicated by Bonnet and Naulleau (1996). Basking in the open was the commonest pattern observed (>94% of the overall sample); the pattern of activity had a unimodal distribution. The activity periods differed between sexes: males were frequently seen in the open from early February to late May, but much more rarely in the following months. Females were seen in the open in the period February-April, but the highest activity was recorded in May-June and the lowest activity in July-September. The month-by-month frequency of distribution of observations of males and females was not-normal (males, $\chi^2 = 14.16$, 3 df, $P < 0.005$; females, $\chi^2 = 46.74$, 6 df, $P < 0.005$), and was significantly different between sexes ($U = 7.23$, $P < 0.005$). The hourly activity was unimodal, but a tendency towards bimodality was recorded in June-July only in females (fig. 1). A different pattern was observed between sexes: males showed a normal distribution of observations ($\chi^2 = 3.29$, 5 df, $P > 0.6$), whilst females