

SHORT NOTES

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**PREGNANCY DECREASES SET
POINT TEMPERATURES FOR
BEHAVIOURAL
THERMOREGULATION IN THE
WALL LIZARD *PODARCIS MURALIS***

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Pregnancy in females is one of the many factors which can affect the activity temperatures of lizards (Huey, 1982). Body temperatures or selected temperatures increase during pregnancy in four species (*Hoplodactylus maculatus*, Werner & Whitaker, 1978; *Gerrhonotus coeruleus*, Steward, 1984; *Chalcides bedriagai*, Hailey, Rose & Pulford, 1987; *C. ocellatus*, Daut & Andrews, 1993). They fall in five others (*Sceloporus cyanogenys*, Garrick, 1974; *S. jarrovi*, Beuchat, 1986; *S. virgatus*, Andrews & Rose, 1994; *Lacerta vivipara*, Van Damme, Bauwens & Verheyen, 1986 and Heulin, 1987; *Podarcis muralis*, Braña, 1993).

Because body temperatures appear to respond to pregnancy in different lizard species in different ways, therefore, we were prompted to make a careful laboratory study of the effects of pregnancy on set point temperatures (defined in Tosini & Avery, 1993) in the European wall lizard, *Podarcis muralis*, as part of a long-term study of behavioural thermoregulation in this species using infra-red thermography. The results are presented here.

Podarcis muralis are small lizards (adult body mass is usually within the range 5-10 g) which are distributed over a wide area in central and southern Europe. The specimens used here were ten female lizards collected in the vicinity of Florence (Italy) in May 1991. They were transferred to the laboratory, and maintained under an illumination cycle of 8 h light: 16 h dark. Heat for thermoregulation during the light phase was provided by tungsten reflector bulbs. All of these lizards turned out to be pregnant. Their thermoregulation was studied during the period when they were heavily distended with eggs in the second half of June, and again in late July after they had laid their eggs. Comparisons were made with (a) data for other female lizards which had been captured near Florence in 1990, maintained under the conditions described above, and studied during the early spring of 1991 (these lizards had not had access to males, and were not pregnant; the three categories of female lizards de-

scribed above are referred to as 'during', 'after' and 'before' pregnancy, respectively) and (b) male lizards maintained under similar conditions and also studied during early spring of 1991.

Individual lizards were transferred singly to experimental arenas, where they were able to thermoregulate for 8 h per day, beginning at 10:00 h, using radiant heat from a 60 W tungsten reflector bulb set at such a height that it provided an irradiance of 58 mW cm⁻² at the point immediately beneath it. Under these conditions the lizards usually alternated periods of basking beneath the bulb with periods of movement around the arena (foraging). Values for four thermoregulatory variables (T_{bask} , T_{move} , mean bask duration and mean duration of the periods of foraging between basks) were determined using an infra-red vidicon camera; the use of this equipment to determine set point temperatures is described in detail in Tosini & Avery, 1993: T_{bask} is the lower set point temperature, measured at the point when a lizard begins basking; T_{move} is the upper set point temperature, measured when it ceases basking (definitions in Jones & Avery, 1989). Total sample sizes for each variable were before pregnancy $n = 80$ (eight lizards), during pregnancy $n = 100$ (10 lizards), after pregnancy $n = 110$ (the same 10 lizards). Since set point temperatures change on a diel cycle (Tosini & Avery, 1994), all measurements were made between 11:00 - 13:00 GMT. The frequency distributions of set point temperatures showed significant skewness and kurtosis, and so statistical analyses are in terms of both mean (parametric tests) and median (non-parametric tests) values.

Table 1 shows the mean overall values for the four thermoregulatory variables before, during and after pregnancy. Experimentally-determined values for the four variables considered (T_{bask} , T_{move} , bask duration and forage duration) did not differ among animals in the same group (Friedman tests, $P > 0.1$ in all cases). Both mean set point temperatures were significantly lower in all the pregnant lizards tested with respect to the values recorded before and after pregnancy (Multiple Comparison tests (Siegal & Castellan, 1988), $P < 0.05$). Variances of T_{move} were in all cases lower than variances of T_{bask} ($F = 1.66-1.99$, $P < 0.05$). In all the individuals tested, mean bask duration in pregnant lizards was longer (Multiple Comparison tests, $P < 0.05$). The separation of set point temperatures (i.e. $T_{\text{move}} - T_{\text{bask}}$) was smaller in pregnant lizards (Multiple Comparison tests, $P < 0.05$). Mean durations of forages between basks did not differ among the three conditions (Friedman test, $P > 0.1$).

The reductions in set point temperatures, and hence the mean activity temperatures, recorded here are consistent with previous studies of Lacertidae (Van Damme *et al.*, 1986; Heulin, 1987; Braña, 1993). The first two of these studies relate to *Lacerta vivipara*. The third relates to *P. muralis*, and demonstrated that pregnant females had lower body temperatures in the field, but not when measured in a thermal gradient (Braña,

TABLE 1. Mean and median values for the variables T_{bask} and T_{forage} ($^{\circ}\text{C}$), and mean values for bask duration and forage duration (min) before, during and after pregnancy.

	<i>Before</i>			<i>During</i>			<i>After</i>		
	mean	SD	median	mean	SD	median	mean	SD	median
T_{bask}	34.0	0.84	34.1	32.1	1.28	32.1	34.0	0.86	34.0
T_{move}	38.8	0.60	38.9	36.2	0.99	36.2	38.8	0.66	39.0
Bask duration	1.5	0.64	-	2.3	1.41	-	1.7	0.87	-
Forage duration	3.2	2.30	-	4.0	2.72	-	3.9	2.81	-

1993). It was suggested that the changes in recorded body temperatures were not a consequence of changes in thermal preferences, but a result of constraints imposed passively by changes in overall behaviour (see also Bauwens & Thoen, 1981). The changes in set point temperatures recorded here demonstrate that this is not the case; central thermoregulatory mechanisms (Firth & Turner, 1982) must be involved.

The set point temperatures of pregnant lizards are likely to have evolved as a result of compromises between potentially conflicting pressures such as physiological optima for embryonic development, physiological optima for the female, and ecological constraints (Beuchat, 1986, 1988; Beuchat & Ellner, 1987; Daut & Andrews, 1993). The optimum temperature for embryogenesis in *P. muralis* lies within the range 24–32 $^{\circ}\text{C}$, and is probably close to 28 $^{\circ}\text{C}$ (Van Damme, Bauwens, Braña & Verheyen, 1992). Since this lies below the normal activity temperature range of the species (Avery, 1978; Braña, 1990; Van Damme *et al.*, 1992), the shift is probably adaptive.

There is an alternative - and not mutually exclusive - explanation. Total body mass may increase by more than 30% in pregnant *P. muralis* (unpublished data). The ability to flatten the body while basking, which in non-pregnant females can increase the dorsal surface area between the pectoral and pelvic girdles by up to 40% (unpublished data), is impaired. Heating rates during basking are therefore reduced; since the value for ($T_{\text{move}} - T_{\text{bask}}$) changes only slightly, the time spent basking increases (Table 1). This may increase the vulnerability of pregnant animals to predation (Bauwens & Thoen, 1981; Braña, 1993). There will thus be a selective advantage in reducing mean body temperatures, since overall basking times will then fall.

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