Changes in the phenology of the Adder, *Vipera berus*, over four decades: a comparison with Prestt (1971)

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ABSTRACT – In 1971 Ian Prestt published his pioneering study of the Adder, *Vipera berus*, in the Purbeck and Wareham area of southern Dorset. Most of this work was completed during 1959–1961, but further observations continued until 1965. The author met with Ian Prestt in 1970 and walked his study sites, and in 1971 two sites, Furzebrook and Wareham Forest, were adopted as potential study areas with regard to continuing research on the Adder, and also the Smooth snake, *Coronella austriaca*. Since that time many aspects of the Adder's lifestyle and behaviour have been recorded. During the latter part of the study period results have shown that there have been significant changes in activity cycles, particularly with regard to an increase in active days, and a more erratic ecdysis regime. To date, these changes do not appear to have had a negative impact, and populations have remained stable throughout the term of the study. In addition, there does not appear to be any notable change with regard to reproductive cycles of either males or females.

THERE is now a consensus that climate change is affecting a wide range of animal and plant species throughout Britain (Sparks, *et al.*, 1998; Collinson & Sparks, 2003; Collinson & Sparks, 2004; Thomas *et al.*, 2004). Changes in the timing of naturally occurring events is most obvious in the annual cycles of plant growth, and the arrival and nesting dates of migrant birds. Herpetologically, the Common frog, *Rana temporaria*, has been shown to be an excellent indicator of phenological change with regard to spawning dates and tadpole development (Beebee, 2002; Cummins, 2003; Collinson & Sparks, 2004). Information with regard to the affect on reptiles in Britain is virtually non-existent, although Phelps (2000) has shown that the Sand lizard, *Lacerta agilis*, in southern Dorset breeds earlier than in previous years, and that there has been a significant increase in fecundity in that currently around 25% of females produce two clutches each year.

Changes in the annual cycle of the Adder, *Vipera berus*, were not apparent in the current study until comparatively recently, and from 1971–1989 very much mirrored the results from 1960 (Prestt, 1971). The date of emergence from hibernation was probably the most obvious clue to any change in annual activity. However, emergence dates have always been variable, Prestt in 1959 gives emergence dates for males from March 4th–10th, and for 1960 February 27th–29th. Phelps (in prep) also recorded similar variables in emergence dates between 1971 and 1989, and although commonly observed, solitary Adders recorded as early as January were not included in the results. The aim of the study was to determine the potential influence of increased activity days on such aspects as feeding periods and female reproductive cycles.

MATERIALS AND METHODS

Study Area: The study area was situated in the Isle of Purbeck, Dorset, three miles south of Wareham and formed part of Ian Prestt's original study area. The area covered approximately 75 ha, and habitat consisted of large expanses of lowland heath mosaic, (*Calluna, Erica* spp.), with good stands of common gorse, (*Ulex europa*), and significant carpets of dwarf gorse (*Ulex minor*). Tree cover was minimal with some scattered young Corsican pine, (*Pinus* sp.) and small copses of birch (*Betula* sp.). About 35 ha to the south and west of the study area consisted of wet heath and bog. *Molinia* and *Erica* formed the dominant vegetation with the occasional small willow carr. This latter area formed the summer feeding ground for the majority of the Adder population.

Identifying Individual Adders: Until 1989 individual Adders were marked by clipping a series of ventral scales to a preconceived code (See Prestt, 1971 for details). From 1989 each Adder was also given a photographic identification with particular attention given to the head and anterior part of the body. More recently photographs have been scanned, or method replaced directly with digital photography. This allowed a snake to be examined more easily in greater detail.

Study Period: The study took place from 1972 until 1980 and then continued from 1985 until 2003. The most intensive study took place during the spring and late summer/Autumn months, i.e. emergence and ingress. During these periods the study area was visited a minimum of twice weekly.

RESULTS

A range of differences were observed in Adder phenology between Prestt's (1971) study and the current study (Figures 1–3). For spring emergence, marked differences were observed between males and females in both 1960 and 2003 (Figure 1) with females emerging 20.6 days later than males on average across the two years. There was no evidence of a change of emergence date between the two study years for either male or female (Figure 1). In contrast, the date of the last sighting (ingress) showed evidence of substantial difference between 1960 and 2003 (Figure 2). Both sexes ingressed later in 2003 than 1960 with a similar mean day of 275.7 in males and 283.3 in females (30 days later for males; 26.4 days later for females). Based on a comparison of data from 1978 and 2003, this was statistically significant (males: paired samples t test = -144.649, df 11, P = 0.000; females: t = -6.869, df 12, P = 0.000). As

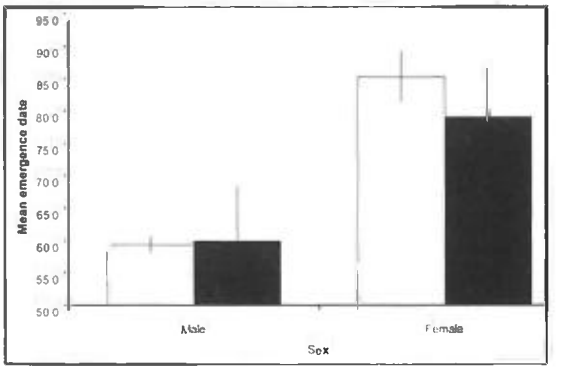


Figure 1. The mean emergence date (± standard deviation) for male and female Adders in the years 1960 (open bars) and 2003 (filled bars). Females emerged significantly later than males, with no evidence of differences between years for either sex (two–way ANOVA: Sex $F_{1, 34}$= 48.88, P < 0.001; Year $F_{1, 34}$= 0.49, P = 0.49; Sex x Year $F_{1, 34}$= 0.75, P = 0.39).

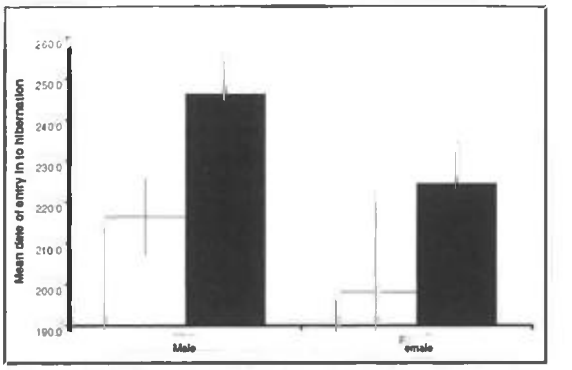
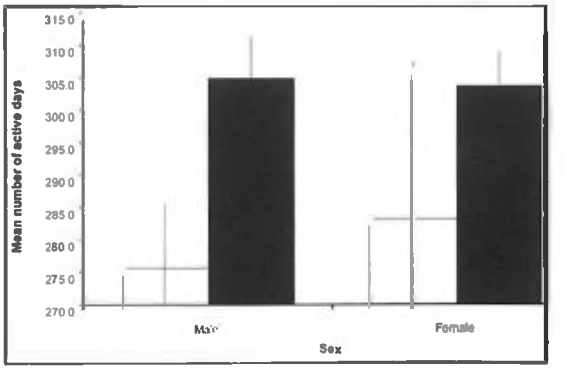


Figure 2. The mean date of last sighting (± standard deviation) for male and female Adders in the years 1960 (open bars) and 2003 (filled bars). There was no significant difference between the sexes, but ingress was significantly different later in 2003 than 1960. Interaction between year and sex was not significant (two–way ANOVA: Sex $F_{1, 24}$= 1.23, P = 0.28; Year $F_{1, 24}$=11.89, P = 0.002; Sex x Year $F_{1, 24}$= 1.65, P = 0.21).

Figure 3. The mean number of active days (± standard deviation) for male and female Adders in the years 1960 (open bars) and 2003 (filled bars). Males were active for a significantly longer period during the year than females, with both sexes being active for significantly longer in 2003 than 1960 (two –way ANOVA: Sex $F_{1, 24}$= 15.56, P = 0.001; Year $F_{1, 24}$= 22.92, P < 0.001; Sex x Year $F_{1, 24}$= 0.01, P = 0.94).



a consequence of the last sighting dates, the combined number of active days was greater in 2003 than in 1960 (Figure 3), and the earlier emergence of males in both years was reflected in a greater number of active days than females (Figure 3). Both males and females showed the same pattern of change in activity in 1960 to 2003 (Figure 3).

Prestt's mean figure for active days for 1960 was males = 219 (range 210–237, n=3) and females = 197.75 (range 170–228, n=4). Data for intervening years did not differ too significantly from Prestt's 1960 results. The most recent data for 2003, number of active days, males, mean = 248.08 (range 230–265, n=12); for females, mean = 228.33 (range 207–244, n=9).

The very significant increase in the number of active days influenced behaviour in other important ways. Firstly, this has presented the opportunity for a higher feeding regime, and one positive indication was that around 50% of both adults within a population moulting more frequently (pers. obs).

It was thought that an increased feeding regime would affect the average size of adults within a population. Data for the general adult population for 1978 showed a mean total length of 470.41mm (range 340–610mm, n=60), and for 2003, a mean total length of 478.42mm (range 345–650mm, n=54). Although this appears insignificant, more meaningful results were obtained by comparing a sample of males of the same age, in the sixth season of growth for the same two periods: 1978 – mean (mm) = 438 (range 410–480, n=5); 2003 – mean (mm) = 485 (range 470–510, n=5); a mean increase of 47mm for this male age group (t = -4.799, df = 5, P = 0.005).

Although respective emergence dates for both males and females were similar, there appear to have been notable changes to the phasing of the male spring moult, and the timing of the mating period. Prestt (1971) shows a peak of the first male moult in mid-April across the adult male population (n=56).

The current study showed a similar peak between the years 1971–1989, and also that the male spring moult was fairly synchronised, with all males within a population moulting over a period of two to five days. Since 1989 there are indications that the male spring moult is becoming more erratic, and phased over several weeks rather than days. However, results so far are inconclusive, in so far as how this may affect mating strategies. Phelps (2008) states that the highest number of mating pairs in 2002 occurred during the first week in April, which is earlier than as stated in Prestt (1971).

DISCUSSION

The number of active days for females slightly exceeding that of males was unexpected, as traditionally the active season of females was around 20 days shorter. It may be that a larger sample will be required to confirm this phenomenon, but currently it is of interest to note that in recent years the latest sightings of Adders at ingress have always been females (pers obs).

It is well known that the male spring moult is the trigger for the mating season (Prestt, 1971; Andren *et al.*, 1997; Phelps, 2004a). The combined phenomena of a less synchronised male spring moult, and that of earlier mating, had the potential of impacting on behaviour. One possible effect was the influence on the male hierarchic structure, an important component of male strategy during the mating period (in press). However, observations in recent years have shown that male behaviour appears so far to be unaffected.

The mean increase in total length of a specific male age group for 1978 and 2003 was significant, and a subtle indication of change. Unless a detailed history of a particular population was known, then such data would remain hidden.

Since 1995 there has been a definite increase in the feeding rate for both males and females, and also the Smooth snake, which occurs in the same area (in prep). It was thought that a higher feeding rate for post-parturition females would influence breeding cycles; but so far this has not been the case. However, since 1995 there are significantly more females with a total length in excess of 650 mm, with the potential of increased fecundity expressed by larger litters (>14). It is appreciated that with an extended foraging opportunity there was a trade-off with increased exposure to

predators, although results to date show that this has been minimal.

There is also a trade-off between the number of potential active days and inactive days because of extended periods of extreme warm weather. Adders reacted in several ways to hot weather, firstly, it was known that some engage in crepuscular and nocturnal activity (Wareham, 1998; Phelps, 2003). A more recent phenomenon was that at Furzebrook, during the summer of 2003, when a number of Adders underwent a period of aestivation for periods of up to 28 days (Phelps, 2003). Adult males actually returned from the summer grounds to the hibernation bank during this period, and the longest period of aestivation was for two non-breeding females that remained in the area throughout the season.

It is almost impossible to forecast how further climate change will affect Adder, and other reptile populations in southern Britain. Results from this study strongly indicate that Adders within specific age groups are larger than their counterparts of 30 years ago. Lourdais *et al.* (2004) in a recent study of *Vipera aspis,* have shown that thermal conditions during pregnancy influence gestation length, embryo viability and offspring phenotypes. It was stated that extended periods of hot weather hastened gestation and reduced the incidence of stillborn. Hot weather early in gestation produced offspring with increased ventral scale counts. This last result is most interesting with regard to the Adder. Lindell *et al.* (1993), in a study of ventral scale counts and body size in the Adder, have shown that there is a probable link between high number of ventral scales, increased growth, body size and survival.

Although the Adder has the widest known range of any snake (Mallow *et al.*, 2003) it is found largely in areas within a moist temperate climate, and in the southern parts of it's range occupies montane habitat (Luiselli, 1995). No part of the Adder's range is characterized by a Mediterranean climate (Capula *et al.*, 1992) and such typical dryer habitats are occupied by other members of the genus, *Vipera aspis, Vipera ammodytes*, and *Vipera latastei* (Arnold, 2002). In some areas the range of the Adder appears to overlap with at least two of the above mentioned species, however they are almost always locally allopatric. Monney (1996) has shown that the Adder and *Vipera aspis*, which appear to have an overlapping range in Switzerland, are actually largely separated by altitude, and also exhibit significant differences in habitat choice.

Results clearly show that so far, the changes in activity cycles have not produced any negative effect, and that population numbers have remained remarkably stable for more than three decades (Phelps, 2004b). However, the present study shows that populations in Britain, and elsewhere in Europe, need careful and consistent monitoring, because the causes, and consequent effects will probably be slow and subtle, and may easily go unnoticed.

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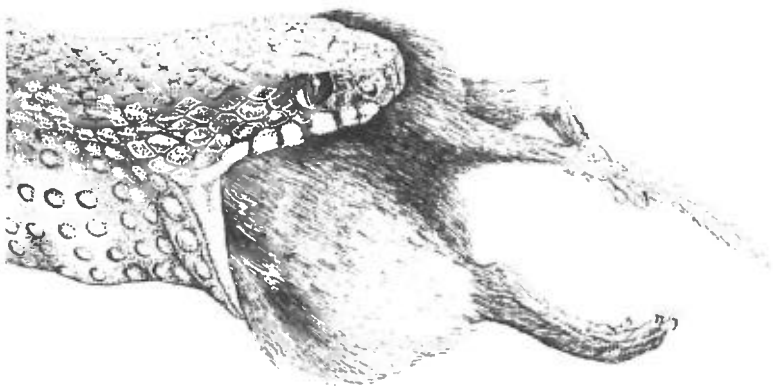

Vipera berus. P. Stafford.