

# Pair bonding and multiple matings in the western green lizard *Lacerta bilineata*

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**ABSTRACT** – Few studies have focused on the activities of individual lizards, which have often been hampered by the problems of tracking them in natural environments. Using photographs, the behaviour of western green lizards *Lacerta bilineata* were observed during the springs of 2023 and 2024. The length of time that males paired with females varied from only a few days to over most of the reproductive season and in this time, two females, one during 2023 and one in 2024, mated with more than one male, suggesting that reproductive performance may be enhanced by polyandry. Furthermore, one of the females appears to have laid egg clutches twice within a year, a further enhancement of reproductive performance.

## INTRODUCTION

The western green lizard *Lacerta bilineata* occupies a range of habitat types including woodland edges, hedgerows and scrub areas. It is one of the larger European lizards feeding mainly on invertebrates and occasionally other lizards (Street, 1979). In the study locality the main reproduction period is April to June during which males hold territories that are defended against other males. Females are usually intolerant of each other but mate and pair with males for varying time durations. Although there are several studies on the population ecology of *L. bilineata* there are few at the level of the individual, especially during the reproductive period (Meek & Luiselli, 2024a). In part this is due to the problems of tracking and identifying the lizards in dense vegetation. In addition, matings are often brief and hence observing this behaviour relies heavily on chance (Uller & Olsson, 2008). However, the data on the duration and extent of pair formation and social interactions are important in population ecology since they impact on spacing patterns and ultimately on reproductive success (e.g. Uller & Olsson, 2008). The present observations form part of a long-term study on the behaviour and population ecology of *L. bilineata* (e.g. Meek & Luiselli, 2020; 2022; 2024a; 2024b). The information presented here is derived from observations of longer-term pair bonding and mating frequencies in individual lizards during the spring/summer periods of 2023 and 2024. Although based on small sample sizes the observations give some insight into the behaviour of *L. bilineata* during the key reproductive period.

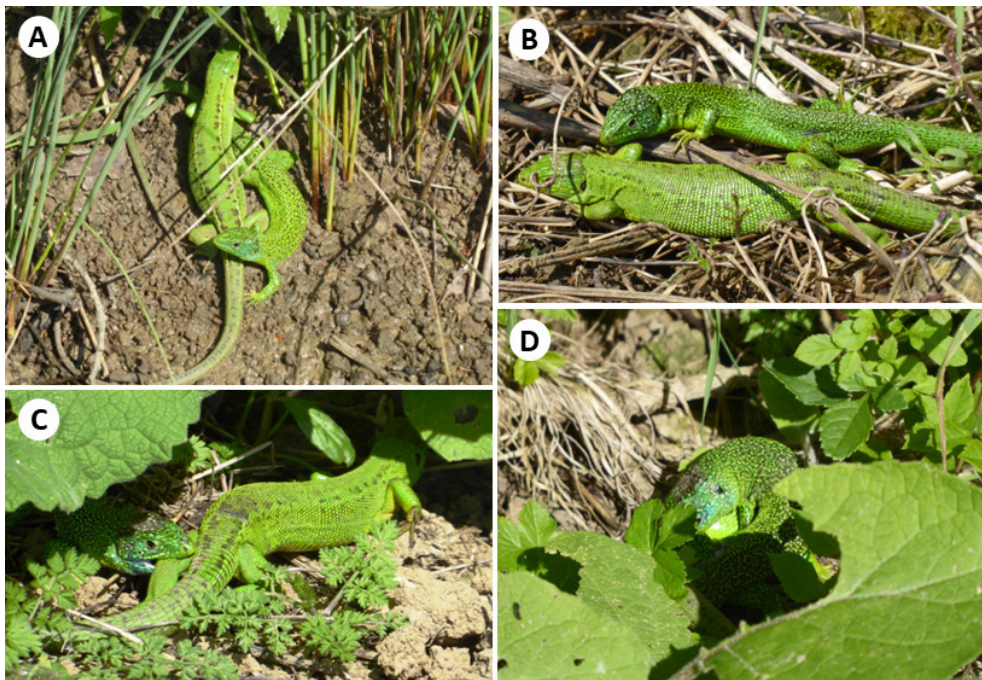
## HABITAT & METHOD

The study locality was a hedgerow (Fig. 1) situated in western France (46° 27' N, 1° 53' E). It consisted of mostly low growing bushes (*Rubus fruticosus* and *Hedera helix*), ash trees (*Fraxinus excelsior*) and oaks (*Quercus robur*) bordered by a drainage ditch that was usually dry by June due to



**Figure 1.** Examples of hedgerow habitat showing where most basking and mating activities were observed - **A.** Where female B and male C were photographed, **B.** Where female A and males A and B were photographed

desiccation from high temperatures (Fig. 1B). A prominent plant was *Actium lappa*, where much of the basking and mating activities of female B and male C took place (Fig. 1A). The total length of the surveyed section was about 260 m. The area is an open system with no barriers to prevent lizards from entering or moving outside the study area.



**Figure 3.** Reproductive behaviours of individually recognised western green lizards - **A.** Mating guarding of female A by male A during 2023, **B.** Mating guarding of female B by male C during 2024, **C.** & **D.** Parts of the mating sequence of female B and male C during late morning (beginning 11:50 h) on 3 June 2024, this pair remained together from April to June, copulation scars can be seen on female B from previous matings. This pair were observed mating twice and on both occasion the lizards were under the broad-leafed *Actium lappa* shown at the edge of the hedgerow in Fig 1A.

Except during inclement weather, daily sampling was approximately even across seasons and carried out 5–6 days each week for around 45–60 minutes daily and, depending on the weather conditions, undertaken between 08:30 h and 13:00 h by a single observer. The hedgerow was surveyed over a total of 1,560 m each day. Data collection was by surveying the entire study hedgerow an equal number of times daily and photographing all sighted lizards using a Lumix DMC-TZ70 camera. This was set to Intelligent-Auto mode for rapid use. When possible, several photographs of each lizard were

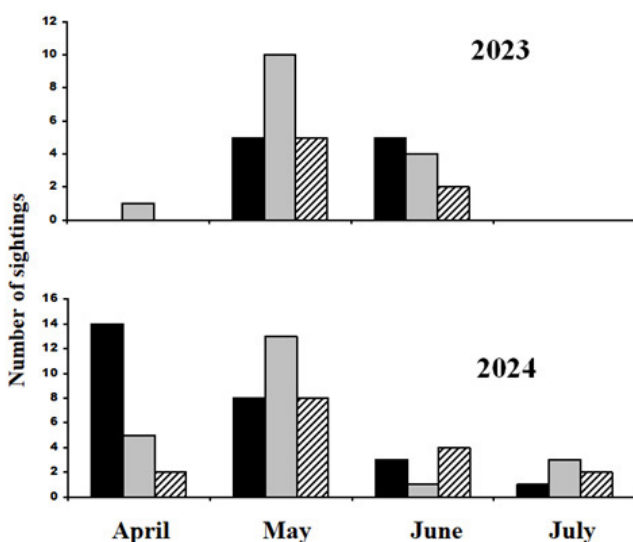
taken and then individuals recognised by colour pattern differences including variation in the shades of green, dorsal spots and lines. This was aided by making use of the computer enlargement facility. Given the relatively low numbers of lizards present recognition error was likely small.

### RESULTS

In total, 32 lizard sightings were made during 2023 of which 25 were of solitary basking lizards with 7 sightings of males paired with females (= 21% of total). During 2024, there were a total of 64 sightings of which 16 were males paired with females (= 25% of total). Annual counts of lizards in pairs during the two years as proportions of total sightings were in good statistical agreement, two tailed z-score = 0.083,  $P = 0.4$ . A summary of monthly sighting frequencies, including sightings of pairs, is shown in Fig. 2.

2023. Male A was observed from 1 May to 27 May (27 days between first and last sighting) when it was seen a total of 16 times, 5 of these were with female A (Fig. 2A) with mating between the two on 12 May. First sighting of female A was on 28 April, which was observed 18 times from 16 May to 6 June giving a time span of 52 days. A second male, male B, was seen only twice, initially during solitary basking on 5 June and then mating with female A on 6 June.

2024. Male C was first observed on 8 April and subsequently 47 times until 14 July giving 98 days between first and last sighting. Female B was sighted from 18 April until 13 July, giving 87 days between the first and last sighting. Of these 22 were solitary basking and 16 occasions with male C (both shown in Fig. 3B). These two individuals were thus recorded



**Figure 2.** Sighting frequencies of adult western green lizards along a hedgerow, solitary males (black), females (grey) and lizards pairings (cross-hatched), in the main reproductive period for this species

together over a time span of 84 days. Female B was observed mating with male C on 9 May and 3 June (example in Fig. 3C & D). There were indications that she deposited two clutches of eggs, the first around 28 May and a second on July 7. This was based on noticeable loss of body mass and folds along the flanks on both occasions. A third male D, was seen only 4 times with female B but mated with her on 11 July. This indicates the female mated three times, with two different males, one being with the long time pairing partner male C twice and with the second male, which she paired with for only a limited time period.

## DISCUSSION

The observations reported here present interesting new aspects of *L. bilineata* behaviour in a field context. For example the second egg clutch in female B was unexpected. Previously, double egg clutches had not been observed in any female during the 5-year study (Meek & Luiselli, 2024a). Literature searches showed no reports of second matings in *L. bilineata* in a field environment. A cooler and much wetter spring climate potentially increased invertebrate prey that could have provided sufficient nutrition to support a second egg clutch. This suggests that short-term changes in climate can impact the resources driving lizard behaviour at a finer level. The long duration of pairing behaviour, although in theory conferring benefits of shared vigilance both for detecting prey and predators, may actually increase risks. For example, pairings also increase probability of detection especially if one sex is paired with a much more visually noticeable individual (Fig. 3). May was a key month for reproductive activity (Fig. 2) with most sighting of individuals and lizard pairings, mating and egg laying but also the beginning of foraging activity of the saurophagous whip snake *Hierophis viridiflavus*. During 2024 three sightings of this species were on 19 May, 2 June and 3 June, possibly the same individual. Male C was photographed on June 5 showing tail loss of 4–5 cm that may have involved the foraging whip snake.

The observed multiple matings by both female *L. bilineata* are well known to occur in other lizards including lacertids where it leads to polyandry, for instance in *Psammodromus algirus* (Salvador & Veiga, 2001), *Lacerta agilis* (Gullberg & Tegelstrom, 1994; Olsson et al., 1996; 2011) and *Zootoca vivipara* (Fitze et al., 2005). In *L. agilis* polyandry involves sperm competition that produces egg clutches with high hatching success and juveniles with 'good genes' resulting in offspring with high survivorship (Olsson et al., 2011). Male *L. agilis* also guard females as do male *L. bilineata* but the high frequencies of solitary female *L. bilineata* sightings compared to paired sightings suggests mate-guarding is more limited compared to other species of lizard (e.g. Cooper, 2003). Absent males would likely facilitate polyandry and support for this was seen in the second mating of female B during 2023 when she moved outside her normal territory, suggesting she may have been searching for a different mate. However, the present observations are based on a limited number of lizards living in a man-made ecotonal environment where the individual component of populations changed both within years and over multiple years (Meek & Luiselli,

2024a). Nevertheless, the observations here suggest that female *L. bilineata* increase reproductive effort by producing double egg clutches and potentially enhance hatchling quality by polyandry. Future research with more comprehensive data sets may give better insights in assessing the frequency of longer-term pairings and polyandry in female *L. bilineata* given that these are apparently key adaptive traits (Uller & Olsson, 2008).

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