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ORIGINAL PAPER

Rabbit burrows or artificial refuges are a critical habitat component for the threatened lizard, *Timon lepidus* (Sauria, Lacertidae)

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Abstract Refuges are crucial for most animal species as they offer essential protection against predators and provide buffered environmental conditions to their occupants. Our data show that northern populations of the threatened ocellated lizard (*Timon lepidus*) depend on the availability of the burrows excavated by the European rabbit (*Oryctolagus cuniculus*). In the last decade, a severe decline in rabbit populations has had a disastrous effect on lizard numbers. To compensate for the lack of refuges, artificial shelters were constructed in autumn 2005 and 2007 and were monitored the following years (2006–2009). Most of the artificial refuges were rapidly occupied by lizards, notably juveniles, suggesting that this technique was successful to improve lizard habitat. Because other factors such as food resources might be also crucial, further assessments are required to determine if artificial refuges are sufficient to stem population decline. These results nonetheless provide an encouraging option to maintain and/or to restore threatened populations, for instance through a buffering of rabbit burrow fluctuations. More generally, the

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availability of suitable refuges (e.g. natural or artificial) is likely to be a central component for the conservation of many reptile species. The combination of empirical and experimental data further demonstrates that great attention must be paid to the structure and distribution of the refuges and that simple practical actions can effectively improve habitat quality for threatened species.

Keywords Artificial burrow · *Timon lepidus* · Lizard conservation · *Oryctolagus cuniculus* · Refuge · Reptiles

Introduction

The presence of suitable refugia is essential for the survival of most animal species. Not only do refuges offer protection against predators, but they also provide buffered conditions against thermal and hydric variations that prevail in terrestrial environments (Schwarzkopf and Alford 1996; Bulova 2002; Millidine Armstrong and Metcalfe 2006). There is little doubt that in the absence of appropriate cavities, dens, or burrows, the survival of a vast array of small animals would be compromised (Anderson 1986; Sih 1997; Berryman and Hawkins 2006). A broad dichotomy can be proposed between the species that dig their own burrows (Kotler et al. 2004) *versus* those that exploit pre-existing refuges (Williams et al. 1999; Goldsbrough et al. 2004; Read et al. 2008). Within such a context, the first category of animal species is relatively less dependent on characteristics of the environment (but see Bonnet et al. 2009). By contrast, the availability of pre-existing refuges, often dug by other organisms, may strongly constrain the distribution range of species that cannot construct their own refuges (Armstrong and Griffiths 2001; Beck and Jennings 2003; Souter et al. 2004).

Most squamate reptiles living in temperate areas do not dig their own burrows and typically belong to the second category. In the absence of appropriate refuges, daily and seasonal fluctuations of ambient temperatures would be lethal for many reptile species (Bonnet et al. 2009). Additionally, lack of refuges would likely decrease survivorship due to increased exposure to predators. Squamate reptiles are generally able to find appropriate refuges (fallen trees, heaps of debris, ruins of old buildings…) in the environment that have not been “cleaned up” (Webb and Shine 2000; Shine and Bonnet 2009). Indeed, crevices, rocks, rodent burrows, logs, thick bushes or dead leaves offer abundant potential suitable refuges. Unfortunately, this is not always the case, and at least one lizard species, *Timon lepidus*, has declined due to specific habitat and refuge requirements. Firstly, this lizard is by far the largest saurian species in Western Europe (body size reaches 24 cm snout-vent length, 75 cm total length), but its size does not eliminate predatory threats. (e.g. avian; Real 1996; Mateo 2008). Large and deep refuges are therefore necessary to accommodate this species. However, oversized refuges would not be appropriate as larger refuges may provide access to feral and native predators (e.g. cats, dogs, foxes). Secondly, this species largely relies on insects that live in open areas, especially natural grasslands where cavities that match the size of the ocellated lizard are rare or absent (Castilla et al. 1991; Hódar et al. 1996; Cheylan and Grillet 2004; Thirion et al. 2009). Thirdly, large open herbaceous zones are important for this fast moving reptile: the ocellated lizards spend considerable amounts of time basking in the sun in the vicinity of their refuges. Unfortunately, the occurrence of natural suitable refuges is often in opposition with the presence of open, relatively flat and herbaceous areas. Mammals (mainly rabbits) excavate burrows that sometimes form underground networks that can be used by different reptile species

(Thirion and Grillet 2002; Ward 2005). The ocellated lizard is generally observed in association with the common European rabbit, suggesting that the burrows excavated by this mammal may be important refuges for the ocellated lizard (Delibes-Mateos et al. 2008; Gálvez Bravo et al. 2009). More generally, a positive correlation has been documented between the availability of shelters (such as crevices, burrows, piles of large rocks) and population densities of the ocellated lizard (Paulo 1988; Vicente 1989; Diaz et al. 2006; Delibes-Mateos et al. 2008; Mateo 2008; Gálvez Bravo et al. 2009). Overall, the presence of refuges with specific features in open herbaceous areas is likely to be a critical habitat feature for the ocellated lizard.

In the northern parts of the geographic range of the ocellated lizard, where extended cold seasons occur, the availability of deep and suitable shelters situated in sunny and grassy areas that provide both thermal/hydric refuges and an immediate access to foraging and basking habitat is likely to be limited. On average, burrows that penetrate into the soil are more buffered compared to external shelters such as flat rocks (Reichman and Smith 1990; Roper et al. 2001; Cooper and Withers 2005). In practice, ocellated lizards largely use rabbit burrows as a central location for foraging expeditions and as the main refuge during hibernation, although they occasionally shelter under large rocks during foraging trips (Cheylan and Grillet 2004, 2005). The most northern population of the ocellated lizard is situated in Oléron Island (Cheylan and Grillet 2005). Over the last decade, this population, like most others, has shown strong and continuous decline. The ocellated lizard is listed as Near Threatnened (2008, IUCN 3.1) but is considered by some to be endangered (Pleguezuelos et al. 2002; Cheylan and Grillet 2004; Mateo 2008), especially in the northern parts of its distribution range where several populations have gone extinct (Thirion et al. 2002; Cheylan and Grillet 2005).

Rabbit populations have also exhibited dramatic decline over the last decade, and this species is now absent from much of its initial geographic range (Spain, Portugal and south France; Ward 2005; Alves et al. 2008; Delibes-Mateos et al. 2008; Gálvez Bravo et al. 2009). Multifactor causes explain such sharp declines, myxomatosis and other introduced viral diseases being heavily involved along with changes in agricultural practices (Alves et al. 2008), but the exact causes for Oléron island rabbit population crash remain unclear. The parallel decline in rabbit and ocellated lizard abundance suggests that the maintenance of lizard populations may be dependant on the burrows dug by the rabbits, and possibly on the insects that develop on the open areas grazed by the rabbits (especially coprophagous beetles; Castilla et al. 1991; Hódar et al. 1996; Cheylan and Grillet 2004; Grillet et al. 2008). Although evidence suggests that such an association between a reptile and a mammal could be of prime importance for conservation management, this issue remains insufficiently explored (Souter et al. 2004; Read et al. 2008; Gálvez Bravo et al. 2009). In the current paper, we first analysed long term data of ocellated lizard densities in relation with the availability of rabbit burrows. Secondly, we analysed population fluctuations following the construction of artificial refuges in habitats where both rabbits (hence their burrows) and lizards severely declined. Overall, the aim of the study was to investigate two main questions:

(1) Is there a significant correlation between the availability of rabbit burrows and the occurrence of *Timon lepidus*?
(2) Can artificial shelters replace, at least temporarily (over several years), rabbit burrows and thus play a useful role in the conservation of this species?

Material and methods

Study species

The ocellated (owing to the blue spots on the sides of the body) lizard is a Mediterranean species distributed in Spain, Portugal, southern and western France, and northwest Italy (Cheylan and Grillet 2005; Mateo 2008). Males are larger than conspecific females; total body size is usually between 40 and 60 cm (larger individuals over 75 cm have been observed). The ocellated lizard tends to be smaller in northern populations. This species is known to live for 10–11 years in the field (Cheylan 1984). In the entire geographic range, the ocellated lizard typically occurs in open and sunny habitats (such as rocky scrub, olive plantations and grasslands). Mating has been observed in late spring and early summer; females lay 5–24 eggs in June and July, hatchlings occur from early September to mid October. The ocellated lizard shows high fidelity to a specific refuge (unpublished). In many places substantial declines have been recorded due to habitat loss (Grillet et al. 2006) and human persecution (e.g. based on the wrong beliefs that the ocellated lizard feed on young rabbits and domestic bees, hunters and farmers consider them as competitors). The ocellated lizard is now classified as Near Threatened (NT) (European Red List of Reptiles, http://www.iucn.org), especially in the northern parts of the distribution area. Urgent practical conservation actions are therefore required before irreversible population decline occurs.

Study site

Oléron Island (30 km long, 175 km^2) is situated on the French Atlantic coast (45°59′35″N, 1°20′45″W–48°17′33″N, 1°13′47″W). The climate is oceanic with a Mediterranean influence (Kessler and Chambraud 1990), characterised by a substantial number of sunny days (on average the region receives > 2,250 h of sunshine a year; http://france.meteofrance.com/france/climat_france) and a summer drought (Lahondère 1980). The study site, located near the southwest shore of Oléron island, is a narrow (10–500 m wide) sandy habitat that stretches over 6.5 km and covers approximately 200 ha. The habitat is comprised of an alternating dunes (either fixed or mobile) and flat sandy depressions. A typical assortment of herbaceous plants well adapted to marine influence (e.g. *Helichrysum stoechas*, *Ephedra distachya*, *Artemisia campestris* subsp. *maritima*, and *Koeleria glauca*) dominates the vegetation. In order to take into account the spatial heterogeneity of the habitat and for analytical purposes, we considered 26 segments of 250 m each along the study site.

Lizard and natural refuge surveys

Lizard and natural refuge surveys were performed in 2000, 2001 and 2006. The surveys were systematically performed during favourable meteorological conditions for observations: the lizards often bask in the sun for prolonged periods of time when ambient temperatures are mild (15 < air temp < 25°C). We avoided cold (e.g. winter) and very hot-and-dry periods during which the lizards are concealed and thus remain invisible. The surveys covered the entire study zone in 2000 (200 ha), but they focused on a more localised area (25 ha near Grand Village) in 2001 and 2006. The spatial distribution of all observations (lizard and rabbit burrows) was analysed with a grid generated using Density Binning (BIOTAS 1.3).

The surface area of the grid cells was 2,500 m^2; this value was used as a reasonable compromise between the home range of the species and the possibility to practically take into account the characteristics of the study zone (e.g. topography). The lizards were not individually marked, and their abundance was crudely estimated with the total number of lizards observed. However, this diurnal and sedentary species exploits open habitats, and therefore intensive visual surveys are likely to account for most of the individuals.

(1) 2000 surveys: because the habitat used by the ocellated lizard is open, all the refuges available and/or effectively used by the lizards were easily accessible to observers and consequently they were entirely inventoried and positioned in 2000 (GIS system WGS84). A refuge was considered as occupied when at least one ocellated lizard was observed entering or leaving it. We also recorded tracks in the sand. To avoid possible confusion with the common green lizard (*Lacerta bilineata*), we relied on subsequent direct visual confirmation, the data were discarded otherwise. Searching effort (total 340 h) was homogenous for the whole study site. The main types of refuges identified were burrows dug by rabbits and rodents (e.g. *Apodemus sylvaticus*), scattered large rocks, woodpiles, blockhouses and concrete blocks from WWII. Overall, the 2000 inventory provided a global view of the lizard population and of the refuge availability.
(2) 2001 and 2006 surveys: using the same methodology, lizard abundance and rabbit burrow availability were monitored in the central area (Grand Village) of the study zone. The survey method (38 h of searching efforts during 8 days per year) was identical in 2001 and 2006.

Artificial refuges

At the beginning of hibernation, in November 2005, 14 artificial refuges were built and buried in the study site in locations where rabbit burrows had disappeared in the course of the study (see results). The artificial refuges were positioned at both extremities (4 in the North and 10 in the South) of the most intensively monitored zone (i.e. 25 h situated in the centre of the study site) that still contained ocellated lizards. In winter 2007, 20 additional artificial refuges were constructed in one of areas where the disappearance of rabbit burrows was the most dramatic and where the ocellated lizard was virtually absent (e.g. zero observation in 2007; Doré 2008). Interestingly, this novel experimental zone was roughly situated midway between the northern and southern zones. The total number of artificial refuges established to date is 34 (14 set up in 2005 that constitute the main focus of the current study, and 20 in 2007). Natural rabbit burrows inspired the dimensions and broad characteristics of the artificial refuges. A wooden box (L = 50 cm, W = 25 cm, H = 25 cm) open in the bottom was placed at a 40–50 cm depth. The box was connected laterally to the surface via two PVC ringed pipes (diameter = 6 cm, length = 150 cm, slope = 30°). The whole installation was recovered with sand, leaving two openings at the surface. Each artificial refuge constructed in 2005 was monitored each month between March and October 2006 under favourable climatic conditions to observe the lizards; the monitoring continued in 2007, 2008 and 2009, and included the artificial refuges constructed in 2007 the two last years. The sand at the entrances of the artificial burrows was flattened in the morning, and a second observation was performed in the afternoon. Indirect evidence (such as faeces, sloughed-skin, sand tracks) indicating the presence of a lizard was recorded. Where evidence was observed, the refuge was visually monitored from distance in order to confirm the presence of at least one ocellated lizard.

Results

Natural refuges and lizard occurrence

In 2000, we observed 253 ocellated lizards, exclusively in the open herbaceous habitat. Despite investigations, the ocellated lizard was never observed in other habitats on the island, notably within the forest adjacent to the study site. Excluding rabbit burrows, the refuges found in the study site were scarce and poorly diversified: few large stones ($N = 8$, large enough to accommodate a lizard), two blockhouses, several woodpiles and small rodent burrows. By contrast, rabbit burrows were abundant ($N = 473$) and they represented 86% of the refuges used by the lizards. Large stones and woodpiles provided 9% of the refuges; other shelters were seldom utilised by the lizards (rodent burrows 3% and anthropogenic shelters 2%). Most of the rabbit burrows (53%) were effectively used by the lizards.

The distribution of the burrows was not homogeneous along the 6.5 km of the study area; the number of burrows fluctuating from 0 to 55 per 250 m segment (Fig. 1; comparison between a theoretical spatially homogenous distribution against the observed distribution: $\chi^2 = 286.2$, $P < 0.01$). The occurrence of the ocellated lizards was strongly and positively correlated with rabbit burrow availability (Spearman rank correlation: $r = 0.78$, $P < 0.05$; Figs. 1, 2). Figure 2 shows a linear relationship between the respective abundances of lizards and rabbit burrows (e.g. the correlation is not due to a particular outlier), suggesting a tight relationship between the studied variables across the range of values documented. The spatial distribution of rabbit burrows and lizard observations overlapped greatly (Fig. 3).

Rabbit burrow and lizard population decline

In the area monitored in 2001 and 2006, the rabbit population declined and the number of rabbit burrows decreased dramatically (80% decline between 2001 and 2006; Fig. 3).

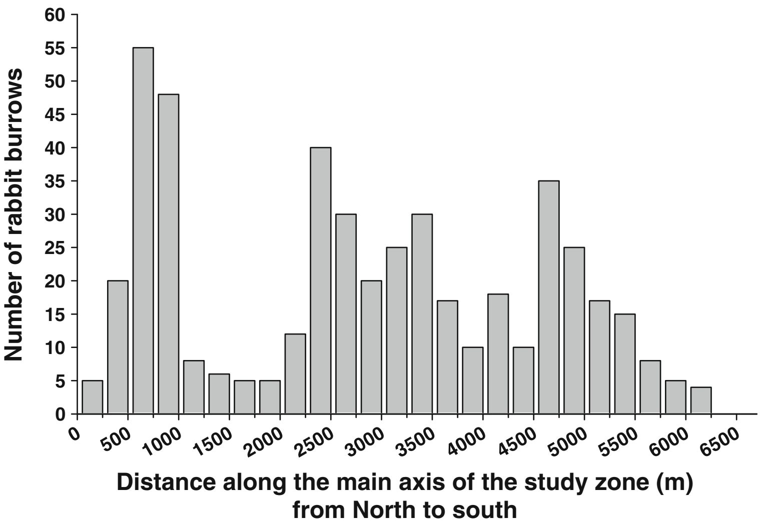

Fig. 1 Numbers of rabbit burrows observed in each of the 250 m sections along the 6.5 km long axis (N/S oriented, west shore of Oléron Island) of the study zone (see text for statistics)

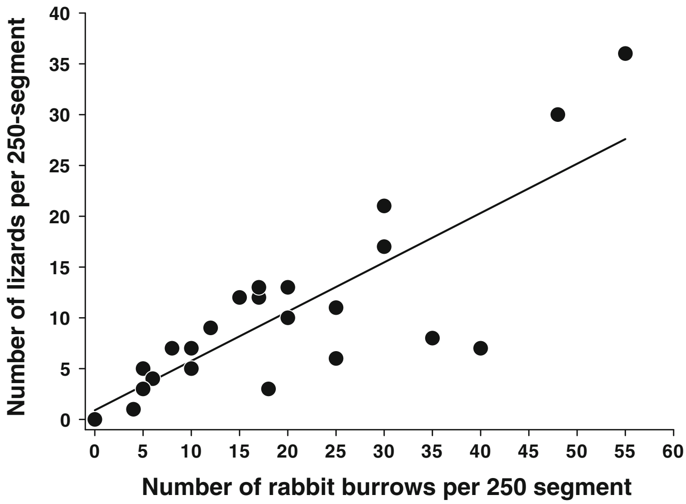

Fig. 2 Relationship between the number of rabbit burrows and the number of ocellated lizards. Each *dot* corresponds to the data gathered in a 250 m section of the study site: sand dune in the southwest Oleron island (see text for statistics)

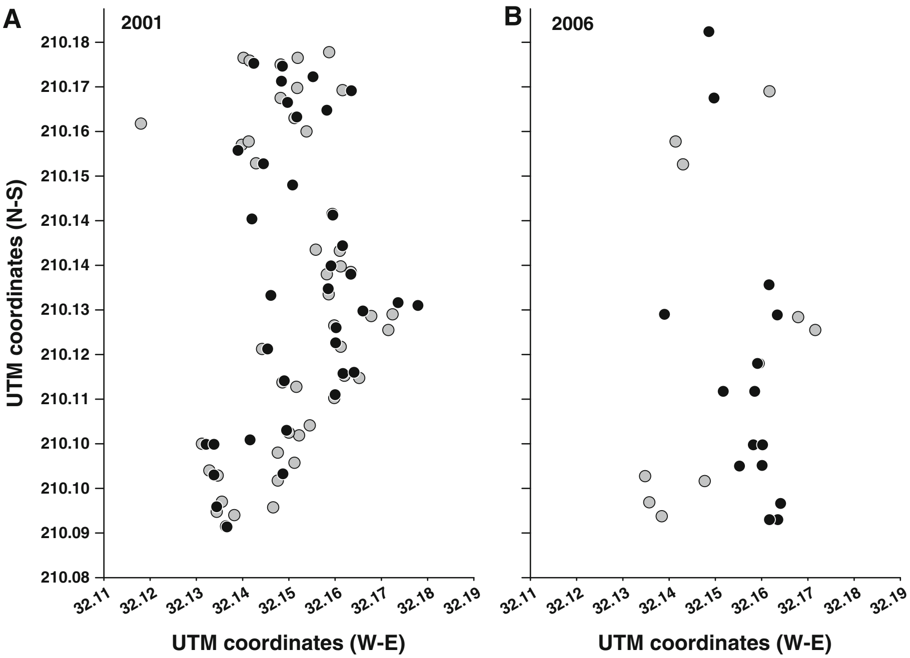

Fig. 3 Distribution of the rabbit burrows (*grey circles*) and of the ocellated lizards (*black dots*) observed in 2001 (**a**) and 2006 (**b**) in the study zone (coordinates are indicated as Universal Transverse Mercator, UTM). For clarity the study zone and the different habitats are not displayed

Depending upon the 250 m segment considered, the decrease in burrow density varied from 40 to 90%. The mean (±SD) burrow density calculated per cell of the grid generated for analyses (BIOTAS) dropped from 0.442 ± 0.886 to 0.087 ± 0.313 over the five years ($N = 104$ cells; t test $P < 0.01$). In the same area, the total number of lizards observed decreased markedly (56%; Fig. 3). The mean density of lizard observations decreased from 0.346 ± 0.647 to 0.154 ± 0.515 (t test $P < 0.02$).

Monitoring of the artificial refuges

In spring 2006, after the emergence from hibernation, and thus shortly after the setting up of the 14 artificial rabbit burrows in 2005, we observed ocellated lizards in the novel refuges. The first lizard occupying an artificial refuge was recorded the 20 April 2006, broadly 1 month after winter emergence. Over the following months, the occupation of artificial refuges increased constantly to reach a value of 86% occupancy at the end of the 2006 activity season (Fig. 4a). In October 2006, only 2 artificial refuges among 14 remained unoccupied. Interestingly, most of the lizards that decided to utilise the artificial

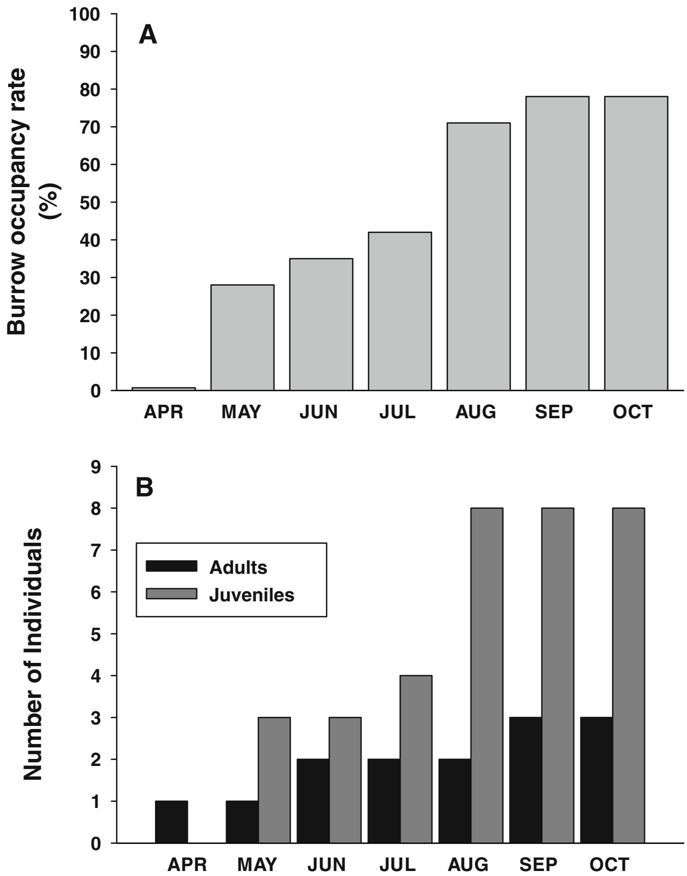

Fig. 4 Changes during the 2006 active season of the occupancy rate (%) by ocellated lizards of the 14 artificial refuges set up in late 2005 (**a**). The numbers of adult versus juvenile lizards observed in the artificial refuges are indicated (**b**)

refuges were juveniles. These young lizards were likely born in late summer 2005 (juveniles retain a typical coloration and small body size over the first year). In the monitored population, the proportion of juveniles observed in the study site increased over time compared to the number of adults that remained stable (Fig. 4b).

The first lizard using one of the 20 additional (2007) artificial refuges was observed 19 April 2008. In early August, 50% of these novel refuges were occupied despite an almost total absence of records of lizard (e.g. not seen when observations were made) in the selected areas during the previous two years. The surveys performed in 2009 indicated that the colonization process was progressing with an occupancy rate of 80% in summer. These results clearly indicate a fast re-colonisation process.

Discussion

Our empirical and experimental results offer strong evidence that rabbit burrows play a key role in the maintenance of ocellated lizard populations, at least at the northern limit of the distribution range. In the studied area, rabbit burrows provide the almost uniquely suitable refuges against climatic fluctuations and predators, notably mammals and birds (Diaz et al. 2006). Indeed, in open herbaceous zones, alternative shelters such as large stones or woodpiles are scattered and likely do not sufficiently buffer daily and seasonal thermal variations. By contrast, deep underground refuges, characterised by stable environmental conditions, are suitable during hibernation and they also protect individuals from hot summer temperatures and from desiccation during drought (Beck and Jennings 2003; Cosepac 2004; Bonnet and Brischoux 2008). Consequently, the spatial distribution of rabbit burrows and areas where lizards have been observed overlapped considerably (Fig. 4).

The tight association between the rabbit burrows and the ocellated lizards is expected in the relatively cold oceanic environmental context of Oléron Island. Accordingly, the ocellated lizard has been systematically observed in association with the common rabbit in all other locations investigated at their northern distribution front: Paussac, la Rochebeaucourt (Dordogne), and Bussac (Charente-Maritime) (Grillet, unpublished). However, this association is also documented in southern populations both in continental zones (Gálvez Bravo et al. 2009) and on islands (Paulo 1988). Notably, on Berlanga Island (offshore of Peniche) in Portugal where high rabbit density favoured the lizards with estimates reaching the impressive densities of 16 individuals per 1,200 m^2 (Paulo 1988). Unfortunately, these Portuguese populations became extinct after dramatic rabbit population decline before 2000. Overall, the link between the two vertebrate species supports the notion that rabbit burrows play a key-role for the ocellated lizard, especially in relatively cool climates.

The rabbits also facilitate food acquisition for the lizards. Firstly, the grazing activity of the rabbits influences the structure of the vegetation by maintaining short herbaceous stratum where the lizards can effectively catch their prey. Secondly, the rabbit faeces are essential for the development of the coleopterans that represent an important part of the diet of the ocellated lizard (Hódar et al. 1996; Cheylan and Grillet 2004; Mateo 2008; Thirion et al. 2009). Overall, ocellated lizard populations benefit from the presence of the rabbits for two major resources: shelter and food.

An examination of historical records provides further evidence for the dependence of the lizards on rabbits. The ocellated lizard and the common rabbit originate from the same bio-geographic region (Iberian Peninsula), they exhibit similar initial distribution ranges and since the Pliocene they share parallel colonisation/regression phases (Callou 1995, 2003; Letty et al. 2005; Mateo 2008; Paulo et al. 2008). The first fossil records of the common rabbit were found in southern Spain in mid-Pliocene layers (2.5 million years); from this region the rabbits progressed to the north, and at the end of the Pliocene colonised the whole Iberian Peninsula and the south of France (Lopez-Martinez 2008). Following a major shrinking episode of the distribution range during the last ice age cycle, the species reached again its current northern limits in the course of the progressive climatic warming (Charente Maritime, France). Although less comprehensive, the information available for the ocellated lizard provides an identical picture (Mateo 2008; Paulo et al. 2008) and fossils records show that this species reached south France at least in the late Pliocene. We hypothesise that in the course of colonisation and re-colonisation process toward northern Europe, the rabbit opened the route to the lizard; further studies are required to test this idea. Currently, fluctuations in the distribution range of the common rabbit probably determine the distribution of the ocellated lizard.

Unfortunately, in Europe, major concerns have been raised about the status of the common rabbit over its natural geographic range (Alves et al. 2008). Successful introductions of the common rabbit (generally in the absence of natural predators, entailing environmental damages) do not benefit the ocellated lizard (because the lizards are not present in these areas); and the introduction of other lagomorph species in southwestern Europe disrupts the ecology of the native species (Alves et al. 2008). The worrying decline of natural populations of the rabbit in many places follows a broad long-term negative trend suggesting that most lagomorphs are vulnerable to environmental changes. This strong decline over time is currently worsening due to anthropogenic pressures such as artificially spread diseases and changes in agricultural practices (Villafuerte et al. 1995; Cabral et al. 2005; Ward 2005; Delibes-Mateos et al. 2008). Multiple threatened predators that feed heavily on rabbits now face difficulties (e.g. IUCN listed: *Lynx pardinus* [Critically Endangered], *Aquila adalberti* [Endangered = EN], *Hieraaetus fasciatus* [EN], *Neophron percnopterus* [EN]). Our study adds a reptile species to this list of species that depend on common rabbits (Ward 2005; Delibes-Mateos et al. 2008; Gálvez Bravo et al. 2009).

The parallel declines we observed in rabbit and lizard population since 2000, although mirroring broader trends, remain correlative. But alternative explanations, other than the reliance of the lizards on the rabbits as primary agents that provide refuges and food resources, remain unconvincing. Indeed, during the parallel declines we did not note the arrival of any new potential predator (or any increase of the already present ones), no competitor appeared, and the main habitats did not change (except an elevation of the herbaceous stratums owing to the reduced grazing). Such conclusions are clearly supported by the success of the artificial refuge experiment: we solely manipulated the availability of shelters.

Given the difficulty of restoring vanishing rabbit populations (Alves et al. 2008), our artificial refuge experiment offers an efficient and cost/effective management tool for the protection of the ocellated lizard. Indeed, the artificial refuges allowed ocellated lizards to rapidly re-colonize areas previously occupied before population decline. Interestingly, juveniles represented the majority of the individuals occupying the artificial burrows, suggesting that dispersal is largely dependent on this age class as documented in other species (Clobert et al. 2001, 2009). This also indicates that reproduction and recruitment were effective in the studied populations. After the population crash, the remaining adult lizards were capable to produce a substantial number of dispersing juveniles that benefited from the artificial increase of refuge availability. Because ocellated lizards are highly territorial, this pattern was expected. Our results also suggest that the technique employed may be useful in maintaining connectivity between not too distant populations.

Our data clearly show that lizards used the artificial refuges, but they do not show increased lizard abundance after burrows were added. Consequently, the main limitation of our experiment is the impossibility to evaluate the capacity of the artificial refuges to compensate for the decline of the rabbits on the long-term (e.g. decades). Indeed, refuges alone do not maintain open herbaceous habitat or favours the coprophagous insects that constitute an important part of the diet of the lizards. Further studies, are therefore necessary to determine whether constructing artificial refuges actually enabled to stem population decline, and to favour population recovery in the future. An anecdotal case provides encouraging perspective: in a military site (Forêt Domaniale de Biscarrosse-33) open herbaceous habitats have been artificially maintained with mechanical grinding since 1968, concrete slabs offer shelters, hunting, tourism and agriculture are prohibited. In these well-protected areas rabbits are abundant and prosperous isolated populations of ocellated lizard have been observed (T. Thomas, ONF; PG). This suggests that simple management techniques, may favour the ocellated lizard. For instance, it would be interesting to combine the construction of refuges with mechanical grinding in experimental areas.

Maintaining open habitats and providing suitable artificial refuges, might well be insufficient to reverse declines in the ocellated lizard. The dramatic crash (80%) of the ocellated lizard recorded in the Crau area (Bouches du Rhône) despite excellent shelter availability, was likely caused by the disappearance of coprophagous insects following chemical treatments (unpublished). Overall, we consider that artificial refuges constitute a cost effective tool to maintain ocellated lizard populations in order to buffer important fluctuations in rabbit numbers on a short term basis (several years). Artificial refuges have been successfully employed to restore populations of two lizard species in Australia belonging to different lineages (*Tiliqua adelaidensis*, Souter et al. 2004; *Oedura lesueurii*, Webb and Shine 2000), suggesting that this technique should be more widely employed. But we also strongly advocate that rabbits are essential to lizard populations for several reasons: (1) to maintain open areas, (2) for the survival of coprophagous insects (the main prey of the lizards), and (3) to dig warrens avoiding construction of artificial burrows. In certain cases, the combination of mechanical grinding, burrows and supplementation with fecal pellets from herbivorous animals. (e.g. from rabbit, sheep, goat, although not yet tested) can be envisaged to help population maintenance and reintroduction programs. Such techniques should not divert managers and scientists from the main target: stopping the decline of the common rabbit and of the assortment of species that depend on these ecosystem engineers (Delibes-Mateos et al. 2008; Read et al. 2008; Gálvez Bravo et al. 2009).

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