

Conservation status of the St Paul's Island wall lizard (*Podarcis filfolensis kieselbachi*)

ARNOLD SCIBERRAS¹ and PATRICK J. SCHEMBRI^{2,3}

¹ '131 ARNEST', Arcade Street, Paola, Malta. bioislets@gmail.com

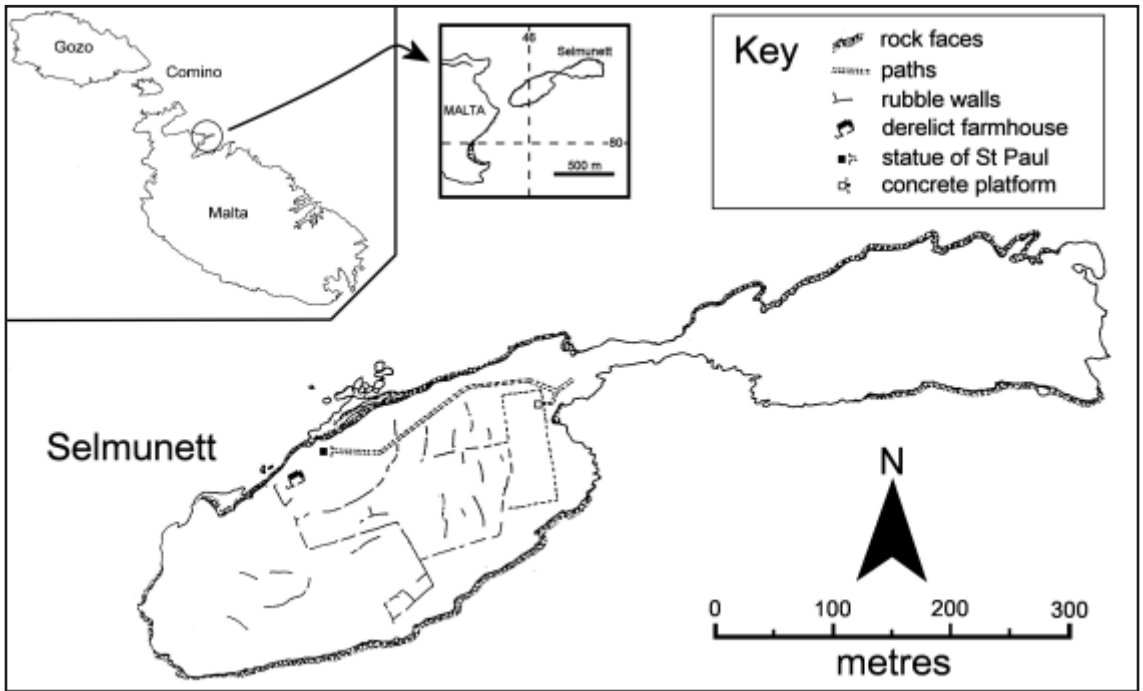
² Department of Biology, University of Malta, Msida MSD2080, Malta

³ Corresponding author: patrick.j.schembri@um.edu.mt

ABSTRACT – The population of the endemic Maltese wall lizard, *Podarcis filfolensis*, on the small island of Selmunett (10.9 ha), off the northeast coast of the island of Malta, has been described as a distinct subspecies *P. f. kieselbachi*. Selmunett is a protected site and its lizard is a protected species. Reports of a pronounced decline in the Selmunett lizard population were investigated by systematic visual estimates of lizard population density started in 1999. Since August 1999, population counts declined from a high of 18 individuals observed per hour to zero by August 2005. The rate of decline was greatest for juveniles and females. Numerous cases of predation of the lizards by rats were observed and such predation seemed to be the cause of the decline in lizard population; visual counts of daytime-active rats, also started in 1999, showed a large rat population on Selmunett. In turn, the rat population appeared to have increased as a result of organic waste left by human visitors to the islet. A rat eradication programme implemented in 2006–2007 exterminated rats from Selmunett by the summer of 2007, when a few lizards captured in 2004 and kept in captivity since were released back on the islet to augment what remained of the population there (some lizards were spotted by casual observers, even if none were recorded during the actual counts). It remains to be seen if this attempt at saving the Selmunett wall-lizard population has been successful.

THE only living lacertid on the Maltese Islands is the Maltese wall lizard, *Podarcis filfolensis* (Bedriaga 1876), a species endemic to the Maltese Islands and the Pelagian Islands of Linosa and Lampione (Lanza, 1972). Four races of this lizard have been named from the various islands of the Maltese group and one race from the Pelagian Islands: *filfolensis* on the island of Filfla, *maltensis* (Mertens, 1921) on Malta, Gozo and Comino, *generalensis* (Gulia in Despott, 1915) on Fungus (= General's) Rock, *kieselbachi* (Fejervary, 1924) on Selmunett (= St. Paul's) Islands, and *laurentiimuelleri* (Fejervary, 1924) on Linosa and Lampione (Lanfranco, 1955; Lanza, 1972; Baldacchino & Schembri, 2002). Savona Ventura (1983) regards the population on the island of Cominotto (= Kemmunett) as a distinct subspecies, which he did not name, while Bischoff (1986) has suggested that the lizards of Pantelleria, which most workers considered to belong to *Podarcis sicula*, might actually be *Podarcis filfolensis*. According to the immunological data of Lanza & Cei (1977) *Podarcis filfolensis* is closely related to *Podarcis*

wagleriana, a species endemic to Sicily, however, the genetic investigations of Capula *et al.* (1988), suggested a closer relationship to *Podarcis sicula*, a predominantly southern European species, and possibly to *Podarcis melisellensis*, a species of the east Adriatic coast. Recent molecular genetic work (Capula, 1994) has confirmed that the *Podarcis filfolensis* of the Maltese Islands is a well-differentiated species most closely related to *Podarcis sicula* than to any other lizard, that the lizard of Pantelleria is not *Podarcis filfolensis* but *Podarcis sicula* as originally thought, and that the lizards of Linosa and Lampione belong to *Podarcis filfolensis* and, surprisingly given the long time the Pelagian Islands have been cut off from the Maltese Islands, that they are very similar to the Maltese populations. All in all this suggests that *Podarcis filfolensis* is most probably derived from mainland populations of *Podarcis sicula* which became cut off when the various islands of the Maltese and Pelagian groups finally became separated from the Sicilian mainland. However, the great similarity between the Pelagian and Maltese population of *Podarcis filfolensis* may



mean that the Pelagian Islands were colonised much more recently by *Podarcis filfolensis* from the Maltese Islands by natural means or through human agency (Capula, 1994).

The named subspecies of *Podarcis filfolensis* differ mainly in mean body size and coloration, especially of the gular region of males and in the degree of dark markings on the back, flanks and ventral region of the neck (Ferjervary, 1924; Lanfranco, 1955; Lanza, 1972; Savona Ventura, 2001; Baldacchino & Schembri, 2002). However, there are no consistent morphological differences between the various subspecies, and the different subspecies can only be securely named on the basis of provenance, since each isolated population includes a range of forms that overlap with those of other populations. No definitive molecular studies have as yet been made to establish the taxonomic status of the various populations, although unpublished preliminary sequencing of mitochondrial 12S and 16S rDNA from the named subspecies and other isolated populations of *Podarcis filfolensis* from the Maltese Islands have demonstrated only small and almost negligible genetic differences between the populations (D James Harris, AS & PJS, unpublished data), conforming to the results

Figure 1. Map of Selmunett islet and insets showing its location off the northeast coast of the island of Malta.

obtained by Podnar & Mayer (2005) in their phylogenetic study of central Mediterranean species of *Podarcis*, including *Podarcis filfolensis*. However, even if the various named subspecies of *Podarcis filfolensis* have a very low degree of genetic differentiation between them, these populations may nonetheless be considered as 'evolutionarily significant units' (ESUs) *sensu* Waples (1986) (populations that are reproductively separate from other populations and have unique or different adaptations), certainly as far as reproductive isolation is concerned, since the named subspecies occur on isolated islets. In this respect, the different microinsular populations of *Podarcis filfolensis* are of intrinsic interest.

Podarcis filfolensis kieselbachi was described by Fejervary (1924) as *Lacerta muralis* var. *kieselbachi*. This race has a mean snout to vent length of 54.4 ± 4.9 mm (Borg, 1989) and is brownish grey with small black patches or reticulations on the back, especially in males; the ventral surface is yellowish with the gular region becoming a bright yellow or orange yellow in

males during the breeding season. This subspecies is limited to Selmunett, also known as St Paul's Islands, located off the northeastern coast of the island of Malta and separated from it by a channel that is some 100m wide at the point of closest approach (Fig. 1). Selmunett is an elongated block of limestone rock with a narrow neck of land (100m long and 20–25m wide) that defines a larger western 'island' (440m long and 184m wide) from a smaller eastern 'island' (344m long and 132m wide); this neck of rock is only about 1m above mean sea level such that it is frequently inundated in rough weather, giving the appearance that Selmunett is actually two islands (and hence the reason why this islet is sometime referred to in the plural). The western 'island' has an area of approximately 7 hectares and is just over 23m above mean sea level at its highest point; the eastern 'island' is about 3.9 hectares in area and its highest point lies 8m above mean sea level.

In the past, the land in the central and eastern parts of the west 'island' was cultivated by a farmer who also kept a number of domestic animals and who lived in a small farmhouse on the central-northwestern coast of the larger 'island'; farming activity was abandoned in the 1940s (Farrugia Randon, 2006) and today only the ruined farmhouse and the remnants of the dry-stone walls that formed the field boundaries remain, together with a statute of the Apostle Paul close to the ruins of the farmhouse (Fig. 1). The vegetation of the larger 'island' consists of an impoverished maritime garigue on the low-lying coasts, rupestral assemblages on the cliff coasts, and a low garigue dominated by Pine spurge (*Euphorbia pinea*), Seaside squill (*Urginea pancration*), and Golden samphire (*Inula crithmoides*) on the inland parts with the addition of Common ferule (*Ferula communis*), Cardoon (*Cynara cardunculus*) and Prickly pear (*Opuntia ficus-indica*) on the previously cultivated higher ground at the top of the island (Lanfranco, 1983). Due to its exposure to sea spray, the east 'island' is only vegetated by the same maritime assemblage that is found in the lower lying coastal regions of the west island, consisting of Shrubby glasswort (*Arthrocnemum glaucum*), Crystal-plant (*Mesembryanthemum nodiflorum*), Zerapha's sea-lavender (*Limonium zeraphae*, endemic to the Maltese Islands) and

Maltese sea-chamomile (*Anthemis urvilleana*, also endemic to the Maltese Islands) (Lanfranco, 1983).

Selmunett was originally declared a 'nature reserve' in 1993 under the Environment Protection Act 1991. This designation fully protected all species of flora and fauna on the Island and also restricted access to Selmunett to between sunrise and sunset, and visitors to designated footpaths only. Selmunett was subsequently declared a 'Special Area of Conservation - Candidate Site of International Importance', which is the designation given to sites proposed by the Government of Malta for inclusion in the Natura 2000 network of the European Union's 'Habitat Directive'.

Podarcis filfolensis kieselbachi was first declared a protected species in 1992 with the enactment of the Reptiles (Protection) Regulations, 1992. These regulations prohibit the pursuing, capture, killing, possession, sale, import, export or exchange of all Maltese reptiles. It is presently listed as a 'species of national interest whose conservation requires the designation of Special Areas of Conservation' under the Flora, Fauna and Natural Habitats Protection Regulations, 2006. The Maltese wall lizard (and therefore including the population on Selmunett) is protected internationally by the Habitats Directive (listed in Annex IV 'species of Community interest in need of strict protection') and by the Bern Convention (listed in Appendix II 'strictly protected species of fauna').

One of us (AS) had been observing the reptiles of Selmunett since 1999 and in the summer of 2003 noted a remarkable decline in the population of *Podarcis filfolensis kieselbachi* on the islet, compared to the situation in previous years. This confirmed anecdotal reports that the other of us (PJS) had received in 2002–2003 from persons who visited Selmunett for the specific purpose of photographing the lizards and who either did not see a single specimen or else saw very few. In order to assess whether the apparent decline in the Selmunett lizard population was a real phenomenon and if so, to quantify it, we developed the observations initiated in 1999 into a census of the lizards on Selmunett that is still ongoing. Here we report on our results for the period 1999–2007.

METHODS

At the time we were alerted that the *Podarcis* populations on Selmunett may be declining, we already had five years worth of data collected as part of a general study on the reptiles of Selmunett. Since this was the only quantitative data on the lizard populations of the island that existed, we were constrained to use this as our baseline and to use the same sampling protocol that had been used since 1999, even if this was not specifically designed to census the *Podarcis filfolensis kieselbachi* population.

Selmunett was visited during spring or summer (when lizards are most active) at least once every year since 1999, and in most years, the island was visited more than once in spring-summer and sometimes also in autumn and winter during sunny periods (when lizards are also active). When the island was visited multiple times in the same month of a particular year, the data for the different visits during that month were combined. For surveying, Selmunett was divided into six sections and during each visit, an observer visited each section in turn and took a fixed position at the boundary of the section, then used binoculars to scan the area within the section. Any lizards or other reptiles or mammals that were spotted within the section were identified and recorded, and note was taken of their behaviour. In general, each section was scanned for one hour, however, when this was not possible due to logistic difficulties, each section was scanned for a shorter period, that was however never less than 30 minutes. On some occasions, each sector was scanned for 1.5 h and sometimes for longer. Because of the variable time of each survey, the abundance data were standardised to 'individuals per hour'. Because the lizards are territorial and they could be identified individually due to their markings, no lizards were counted twice during the same survey.

RESULTS

During the period 1999–2007, Selmunett was visited on 39 separate occasions, grouped in 26 months: 20 months in spring-summer and seven months in autumn-winter. The relative abundance of *Podarcis filfolensis kieselbachi* estimated as described above is plotted in Fig. 2. It is clear that

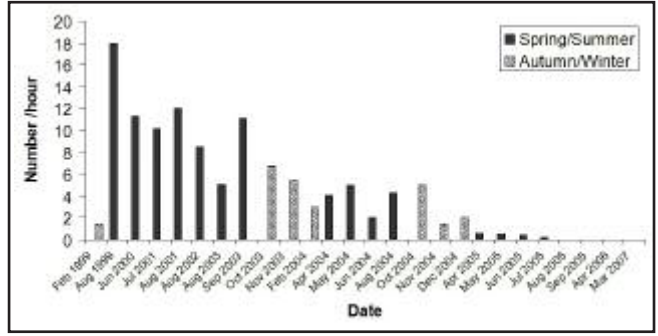
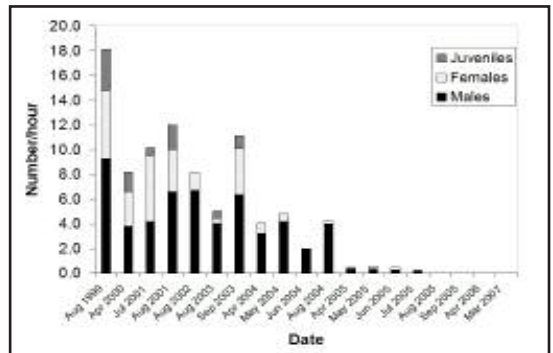


Figure 2. Variation in population density of *Podarcis filfolensis kieselbachi* on Selmunett, estimated as number of individuals counted per hour of observation, for the period 1999-2007.

starting from August 1999 (the first of our summer population counts; 18 ind. h⁻¹), the population has suffered an exponential decline such that by August 2005 we did not count any individuals, a situation that persisted in 2006 and 2007. The plot of the spring-summer abundances of males, females and juveniles (juveniles are most active in spring-summer) (Fig. 3) shows that by April 2004, no more juveniles were spotted during the surveys while the sex ratio became heavily skewed towards males, suggesting a differential disappearance of the small-sized individuals (juveniles and females, which are smaller than males: mean snout to vent length of males = 56.7 ± 2.9mm, females 48.3 ± 2.3mm; Borg, 1989).

In the July 2001 survey we recorded two carcasses of *Podarcis* and one of the gecko

Figure 3. Variation in population density of male, female and juvenile *Podarcis filfolensis kieselbachi* on Selmunett, estimated as number of individuals counted per hour of observation, for summer counts in the period 1999-2007.



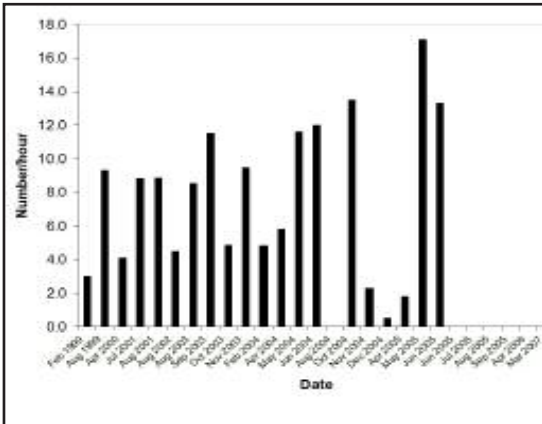


Figure 4. Variation in population density of daytime-active rats on Selmunett, estimated as number of individuals counted per hour of observation, in the period 1999-2007.

Hemidactylus turcicus in the central part of the eastern Selmunett ‘island’ while during the course of four separate visits in August of the same year we recorded four *Hemidactylus* carcasses, 1 carcass of the gecko *Tarentola mauritanica*, and two carcasses of the Leopard Snake *Elaphe situla*, one of which was missing the head, and another injured *Elaphe*; on five occasions we recorded dead *Podarcis* being eaten by rats (*Rattus* sp.) and we witnessed three chases of *Podarcis* by rats, which were unsuccessful. These observations suggested that a possible cause of the decline in the lizard population was predation by rats. Since we had already been recording the density of rats spotted during the surveys, we continued to record rat abundance and these results are given in Fig.4. Note that since rats are mostly active by night while our surveys were made during the day, rat abundance is probably grossly underestimated; however, the results are nonetheless indicative of a large and thriving rat population on Selmunett. Predation of *Podarcis* was confirmed by direct observation on at least four occasions: in August 2003 we observed a rat with a live juvenile *Podarcis* in its mouth; in February 2004 we witnessed a successful chase and capture of a *Podarcis* by a rat, and in April of the same year, the capture of the female of a courting pair; and in November 2004 another successful chase and capture of a female *Podarcis* by a rat. Apart from the observations reported above, we came across

half-eaten carcasses of *Podarcis* in August 2002 (2 carcasses), August 2003 (1 carcass) and October 2003 (3 carcasses), and May 2004 (1 carcass). We also noted carcasses of *Hemidactylus turcicus* and *Tarentola mauritanica* on numerous occasions as well as the capture by a rat of one individual of each species (in October 2003 and April 2004, respectively). On one occasion only (August 2002), we witnessed the successful predation of a juvenile *Podarcis* by a Spanish sparrow (*Passer hispaniolensis*).

On the basis of coloration and general morphology, the majority of the rats observed on Selmunett appeared to belong to *Rattus rattus*; however, on at least one occasion, a rat conforming to the description of *Rattus norvegicus* was spotted, so both species may occasionally co-occur on Selmunett, at least temporarily.

Concerned about the rapidly declining population of *Podarcis filfolensis kieselbachi* on Selmunett, in November 2003 a report on the situation was lodged with the Environment Protection Directorate (EPD) of the Malta Environment and Planning Authority, the agency concerned with the management of protected species and protected areas in Malta, in which a number of recommendations were made, including that the rat population needs to be controlled or eradicated. Such an eradication programme was initiated in April 2006 and by the end of summer 2006, Selmunett was declared rat-free. In the meantime, one of us (AS) keep six individuals of *Podarcis filfolensis kieselbachi* in captivity with the intention of returning the species to the wild after rats are exterminated from Selmunett; four males and two females were collected in 2004, and five (one senescent male died in captivity) were handed over to the EPD in May 2006 for eventual release. Members of the EPD reported glimpsing some lizards on Selmunett during visits in connection with the rat eradication programme, and in June 2007 the EPD decided to release the remaining lizards back on Selmunett in a last attempt to augment any surviving population of lizards and possibly enable the population to recover in the absence of predation by rats. Our last survey on Selmunett was in March 2007, before the release of the captive lizards and we did not spot any lizards on that occasion.

DISCUSSION

There is no doubt that a large population of *Podarcis filfolensis kieselbachi* originally existed on Selmunett; while no quantitative population estimates had been made before the present study, Moravec (1993) reports that in August 1986 the population on Selmunett was "very dense", while one of us (PJS), who has visited the islet regularly since the late 1970s, estimates an 'order of magnitude' population density of at least one individual per 100m² up to the early 1990s. Such a density would give a total population of some 1000 individuals for the whole of Selmunett. The highest number of lizards observed in the present study was 127 in 11 hours of observation on 17 August 2001, which even on an order of magnitude basis, is much lower than the estimated pre-2000 population density. Whatever the population density was before the present study, it declined during the period 1999–2007, reaching zero values in 2006 and 2007. This is not to say that the population is extinct, since some individuals were spotted in 2006 and the individuals kept in captivity were released back on the island in 2007, however, whether the population will recover depends on many factors, especially if any of the individuals that remained on the island were female and were still of reproductive age and thus capable of breeding with any resident males or those released. The fate of *Podarcis filfolensis kieselbachi* is presently unknown, however, if not already extinct, the population will be severely endangered for the foreseeable future.

Predation by rats seems to be the most likely cause of the decline in the *Podarcis filfolensis kieselbachi* population on Selmunett. Direct predation of lizards by rats was observed on numerous occasions (and of geckoes as well), and carcasses of lizards, geckoes and snakes were frequently encountered. The successful attacks by rats on lizards were predominantly on smaller individuals (juveniles and females) which may explain why as the population declined males started outnumbering females and juveniles, and when six lizards were captured in 2004, these were all large individuals. The differential targeting of small lizards by rats leads to the concern that even if some lizards have survived on Selmunett following eradication of the rats, these are males

and post-reproductive females. Juvenile lizards may also be targeted by Spanish sparrows as observed on one occasion. Fornasari & Zava (2000) seem to have observed regular predation of *Podarcis filfolensis laurentiimuelleri* by Spanish sparrows on Linosa; however, while such predation may contribute to the decline of *Podarcis filfolensis kieselbachi* on Selmunett, all evidence points to predation by rats as being far more significant.

Since rats have been present on Selmunett for decades, the question arises as to why predation by rats should suddenly cause a decline in the *Podarcis* population. We hypothesise that the reason for this is a change in the levels of human presence and in the nature of human activities on Selmunett. When Selmunett was still being farmed, the only human presence on the island was the farmer and his family who occupied the upper room of the (now derelict) three-roomed farmhouse (Farrugia Randon, 2006); from this it can be deduced that the farmer's family could not have been too numerous and in any case, the farmer did not live permanently on Selmunett but resided on Malta (Farrugia Randon, 2006). In 1958, Selmunett was given on a 30 year emphyteusis and the tenants bred rabbits on the island to hunt, and used the farmhouse for weekend stays on the island (Farrugia Randon, 2006) (we never noted any rabbits or their droppings during any of our visits to Selmunett in connection with our surveys). During this period, only fishers and a few visitors frequented the island so human presence was low key. In 1988, Selmunett reverted to the Government of Malta and in 1993 it was declared a 'nature reserve'; visitors were allowed on the island during the daylight hours for swimming and walking on the designated paths, but all other activities were prohibited. However, as noted by Farrugia Randon (2006), these regulations were seldom respected and they were not enforced by the authorities; in particular, the islands became popular with boat owners as a bathing and barbeque spot, and as more people started owning boats during the 1990s so did human presence on the island increase. A direct consequence of this was that a great deal of organic material, including food waste, started to accumulate on the island and it is our opinion that the rat population bludgeoned as a result, and when food became scarce for any reason, predation on the herpetofauna, including the lizard population, increased.

Although there do not seem to be any genetic differences that justify separation of the Selmunett population of *Podarcis filfolensis* as a distinct subspecies, nonetheless, all indications are that this population is reproductively isolated from any other populations in the Maltese archipelago, while it also shows some phenotypic differences. Therefore, the Selmunett population qualifies as a 'management unit' *sensu* Moritz (1994) (a population that is currently demographically independent from other populations), and possibly also as an ESU. The Selmunett population of *Podarcis filfolensis* is therefore of conservation as well as of cultural value (Baldacchino & Schembri, 2002) and all efforts should be made to conserve it. Only future monitoring will tell if the efforts made in this respect have been in time and sufficient to achieve this.

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REFERENCES

Baldacchino, A. E. & Schembri, P. J. (2002). *Amfibji, rettili, u mammiferi fil-Gzejjer Maltin*. Il-Pjeta, Malta: Publikazzjonijiet Indipendenza. xii + 256 pp. [in Maltese]

Bischoff, W. (1986). *Podarcis filfolensis* – Maltaeidechse. In: *Handbuch der Reptilien und Amphibien Europas, Band 2/II., Echsen III (Podarcis)*. pp. 50–64. Böhme, W. (Ed.). Wiesbaden: Aula-Verlag.

Borg, M. J. (1989). Aspects of the biology of *Podarcis filfolensis*. Unpublished B.Ed. dissertation, Faculty of Education, University of Malta, Malta; viii + 130 pp.

Capula, M. (1994). Evolutionary relationships of *Podarcis* lizards from Sicily and the Maltese Islands. *Z. Zool. Syst. EvolForsch.* **32**, 180–192.

Capula, M., Nascetti, G. & Bullini, L. (1988). Genetic

differentiation among species of the genus *Podarcis* (Reptila: Lacertidae). *Abstracts of the LII Congresso Nazionale dell'Unione Zoologica Italiana, Camerino 12–16 Settembre 1988*: p. 59.

Farrugia Randon, S. (2006). *Comino, Filfla and St. Paul's Island*. Malta: [The author]; 48 pp.

Fejervary, G. J. (1924). Preliminary notes to a monograph of the lacertian fauna of the Maltese Islands. *Acta Biol. Hung.* [Budapest], 1–14.

Fornasari, L. & Zava, B. (2000). Predazione di *Podarcis filfolensis laurentimuelleri* da parte di *Passer hispaniolensis maltae* sull'Isola di Linosa. In: *Societas Herpetologica Italica, 3° Congresso Nazionale. Riassunti*. p. 42. Barbieri F, Bernini F, Fasola M (Eds.). Pavia, Italy: Centro Stampa del Comune di Pavia. 54 pp.

Lanfranco, E. (1983). The flora of St. Paul's Island. *Potamon* [Malta] No. **11**, 23–31.

Lanfranco, G. G. (1955). Reptiles, amphibians of the Maltese Islands. *Malta Year Book* **1955**, 198–203.

Lanza, B. (1973). Gli anfibi e i rettili delle isole circumsiciliane. *Lav. Soc. Ital. Biogeogr. (Nuova Serie)* **3**, 755–804.

Lanza, B. & Cei, J.M. (1977). Immunological data on the taxonomy of some Italian lizards (Reptilia Lacertidae). *Monitore Zool. Ital. (Nuova Serie)* **11**, 231–236.

Moravec J. (1993). Captive breeding of *Podarcis filfolensis*. In: *Lacertids of the Mediterranean region*. pp. 243–248. E.G. Valakos, Bohme, W., Perez-Mellado, V. & Maragou, P. (Eds.). Athens: Hellenic Zoological Society.

Moritz, C. (1994). Defining 'Evolutionarily Significant Units' for conservation. *Trends Ecol. Evol.* **9**, 373–375.

Podnar, M. & Mayer, W. (2005). Can mitochondrial DNA draw the phylogenetic picture of central Mediterranean island *Podarcis*? *Herpetozoa* **18**, 73–77.

Savona Ventura, C. (1983) The herpetofauna of Comino and satellite islets with a note on the colouration of *Podarcis filfolensis*. *Animalia* [Catania, Sicily] **10**, 87–93.

Savona Ventura, C. (2001). Taxonomical status of the Maltese wall lizard (*Podarcis filfolensis* Bedriaga 1876). *Central Mediterranean Naturalist* [Malta] **3**, 89–95.

Waples, R. S. (1991). Pacific salmon, *Oncorhynchus* spp., and the definition of 'species' under the Endangered Species Act. *Mar. Fish. Rev.* **53**, 11–22.

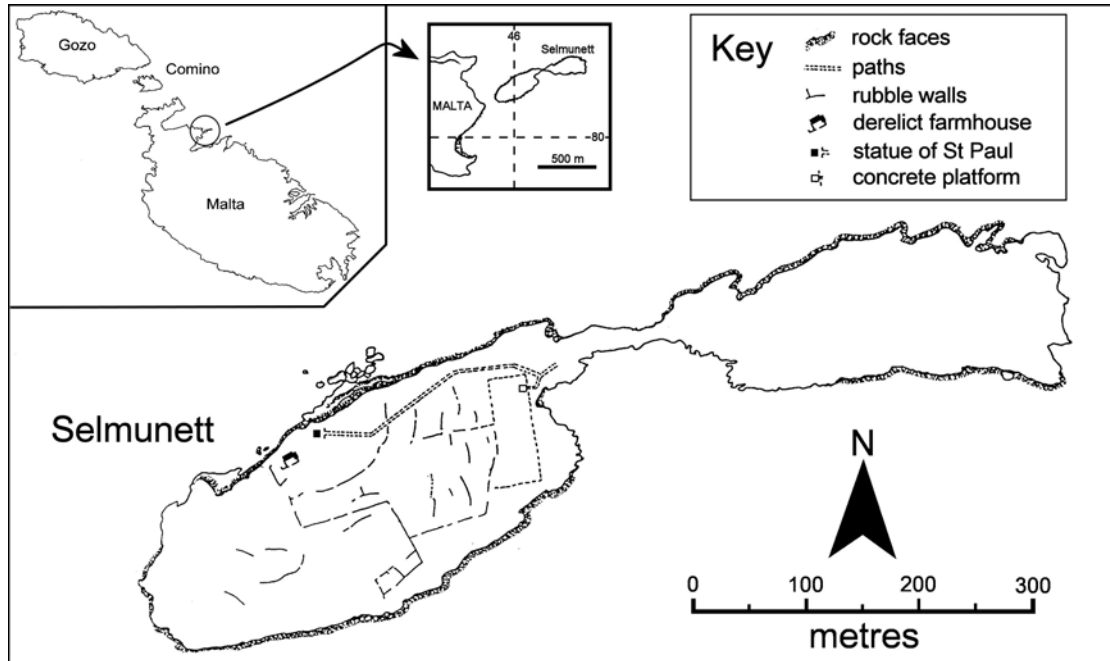


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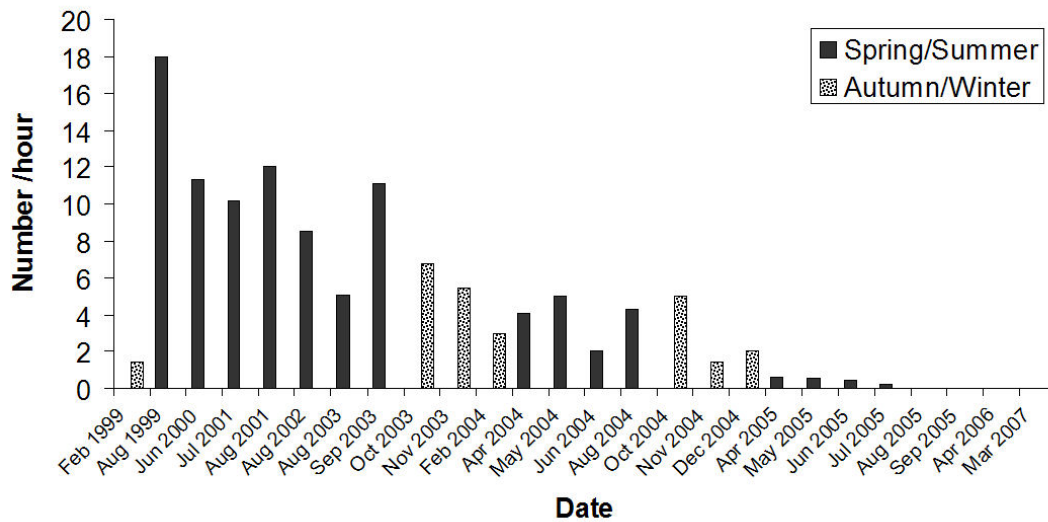


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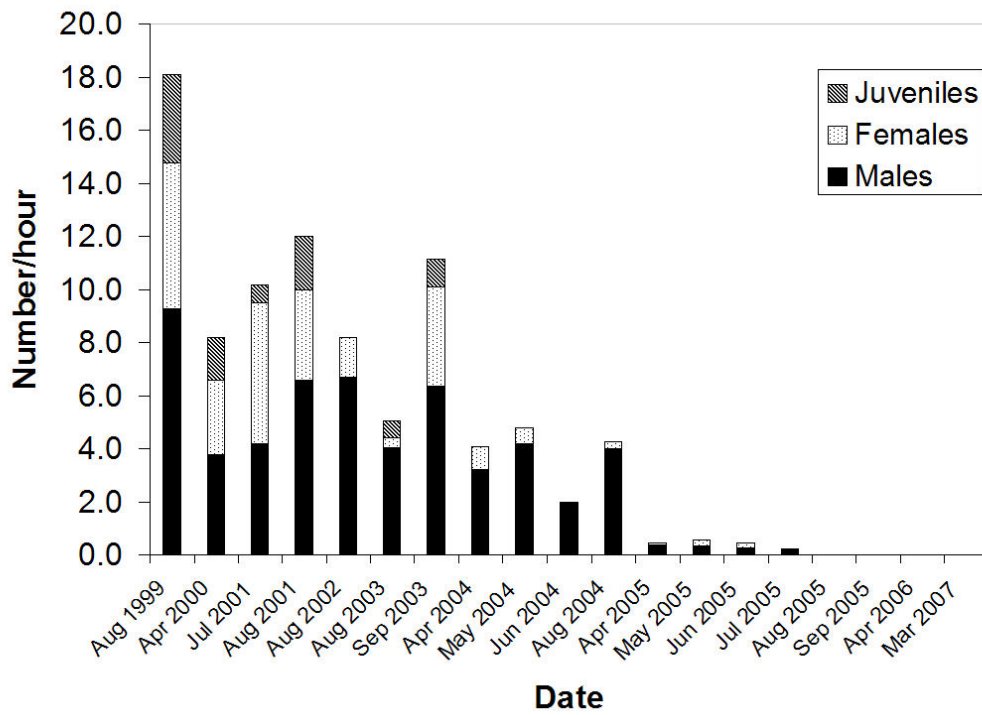


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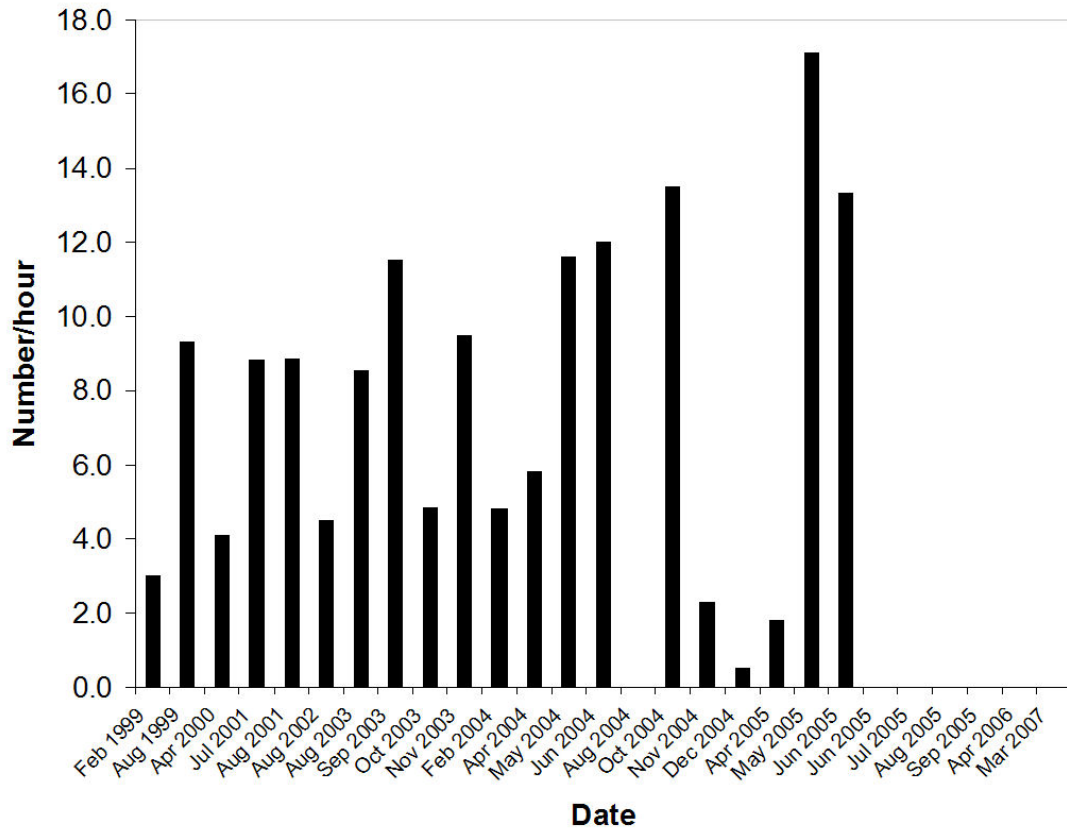


Fig. 4. Variation in population density of daytime-active rats on Selmunett, estimated as number of individuals counted per hour of observation, in the period 1999-2007.