

## Lizards and Eleonora's Falcon (*Falco eleonora* Gené, 1839), a Mediterranean micro-insular commensalism

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### ABSTRACT

Lizards and Eleonora's falcon occur on many Mediterranean islets. Data given in literature and new observations concerning their asymmetrical interactions, which have been reviewed and illustrated, allow to regard those as a commensal relationship typical on these micro-insular ecosystems. Some considerations on the ecological, ecomorphological and phenological traits involved on this commensalism are also briefly discussed.

### KEY WORDS

Commensalism; lizards; *Falco eleonora*; island ecology; Mediterranean.

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### INTRODUCTION

The Mediterranean micro-insular environments constitute an apparent paradigm of simplicity. Islets, usually hosting a low number of vertebrate species, are generally regarded as ecosystems characterized by chronic poorness in terms of trophic resources (Blondel et al., 2010).

This condition can impose severe ecological constraints to the species inhabiting the islets and, on the other hand, it stimulates a certain degree of flexibility and adaptability in their evolutionary responses.

For instance, the exposition to less potential competitors and predators, as well as the high population densities, which often occur on islets, may open new possibilities for enlarging trophic niche and/or for establishing peculiar ecological relationships among the island species.

Within the Mediterranean area, the lizards belonging to the suborder Sauria and the Eleonora's Falcon, *Falco eleonora* Gené, 1839, are generally the unique representatives of Vertebrates in the faunal assemblages of islets, that also include rats and few seabirds species.

The present paper aims to review and update the knowledge concerning an apparently unusual relationship that occurs between these two emblematic inhabitants of the Mediterranean small island ecosystems (Fig. 1).

### MATERIALS AND METHODS

#### *Data from literature*

#### **Dionysades Archipelago (Crete, Greece)**

The Dionysades (or Yianisadhes) Archipelago is situated 20 km north of the eastern end of Crete, and includes some uninhabited islets and rocks.

Among those, Paximada (314000 m<sup>2</sup>, 136 m a.s.l.) harbours about 350 pairs of *Falco eleonora* and represents one of the most important nesting site for the species at global level (Walter, 1979; Dimalexis et al., 2007); also, there is a large population of the endemic Cretan Wall Lizard, *Podarcis cretensis* Lymberakis et al., 2008 (see Lymberakis et al., 2008).

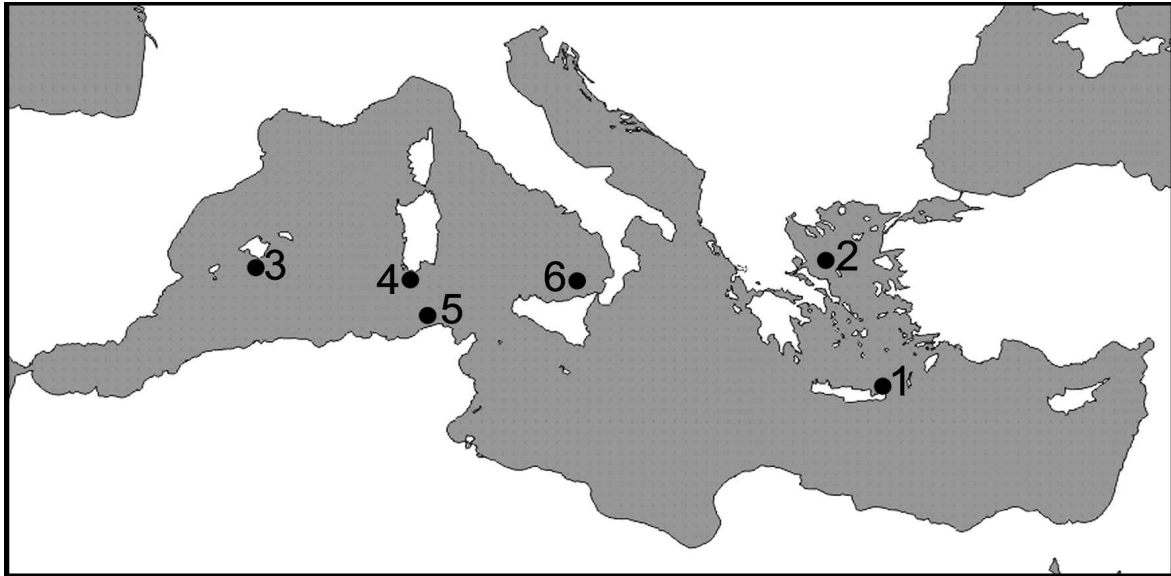


Figure 1. Geographical distribution of the sites where interactions between Eleonora's falcon and lizards have been observed. 1) Paximada; 2) Skantzoura islets; 3) Cabrera islets; 4) Il Toro; 5) Galita islets; 6) Scoglio Faraglione.

This islet has been intensely studied and monitored since the Sixties by ornithologists. Walter (1967) has observed in summer a high concentration of lizards around the falcons' colony, which daily were looking for scraps of preys, fearless in entering on the nests even in the presence of adults.

According to this author, during the summer months on this islet, lizards feed largely with the help of falcons. In particular, he reports the case of an adult female of *Falco eleonora* that plucked a prey in front a nest occupied by chicks, around which four lizards were eating the flesh remains attached to the carcass.

Another case concerns a lizard in the early morning that approached less than 20 cm to 15 days-aged falcons, that observed with interest but leaving it undisturbed, although the chicks usually eat everything that moves around the nest. However, he also found in a nest some dead lizards that showed visible signs of predation, but that have not been eaten by falcons.

As possible explanation given for this finding, the lizards may have approached too closely to the chicks (or adults) during meals and, hence, have been taken together with the prey and then thrown away. Walter (1967) concludes that these interactions can result partially unfavourable for the falcons, having observed how the preys placed few meters

away from the nests are often quickly discovered and almost emptied by lizards.

### Sporades Islands (Greece)

To Schultze-Westrum (1961) are due the first records regarding the interactions between lizards and Eleonora's falcon. This author has reported observations carried out in late September 1957 at Kyriagos, a tiny islet belonging to the uninhabited micro-archipelago of Skantzoura.

The local population of Erhard's Wall Lizard, *Podarcis erhardii* (Bedriaga, 1876), was almost exclusively concentrated around the colony, attracted by the remains of small birds preyed and deposited close to the nests, as well as by the insects occurring on the carcasses, while on the rest of the islet he did not see any lizard.

Schultze-Westrum (1961) emphasizes that the lizards were not scared by nestlings as well as by adult falcons that usually do not hunt near their nests, and considers such behaviour advantageous also for the Eleonora's Falcon, as indirect consequence of a continue cleaning from insects and food remains that would otherwise have rotted near the nests. Curiously, in a more recent paper Schultze-Westrum (2010) reminds similar behaviours for the

lizards of another satellite of Skantzoura, namely Strongylò, while doesn't mention his previous observations on Kyriagos. Both islets, occupied by medium-sized colonies of *Falco eleonora* (Dimalexis et al., 2007), have a surface lesser than 1 ha and a maximum altitude of about 50 m a.s.l.

Finally, Valakos et al. (2008) have referred that on some islets of Sporades Archipelago also the endemic Skyros Wall Lizard, *Podarcis gaigeae* (Werner, 1930), lives in proximity of gulls and Eleonora's falcons, but not mentioning explicitly the occurrence of interactions among these animals.

### Cabrera Archipelago (Balearic, Spain)

This group includes an island and some satellite islets situated around 10 km south of Mallorca (Balearic Islands) and hosting small colonies of Eleonora's Falcon (Suárez, 2001) and several populations of the endemic Lilford's Wall Lizard, *Podarcis lilfordi* (Günther, 1874).

A number of observations carried out at L'Imperial (30500 m<sup>2</sup>, 73 m a.s.l.), Estels Xapat Gran (11300 m<sup>2</sup>, 35 m a.s.l.) and Estels Xapat Petit (5700 m<sup>2</sup>, 45 m a.s.l.), off the S and SE coast of Cabrera Gran, have been reported by Salvador (1980), which visited these islets in early September 1976. In one case, two lizards have translocated a carcass of Reed Warbler, *Acrocephalus scirpaceus* (Hermann, 1804), from a nest where it had just been deposited by an adult falcon.

Other cases involve observations of lizards who took the remains of preys in the nests and were chased away by falcons, but also others in which the lizards eat the remains of preys directly into the nests without being molested by adults in the hatching of nestlings. In addition, Salvador (1980) has found remains of Song Thrush, *Turdus philomelos* (Brehm, 1831), European Robin, *Erithacus rubecula* (Linnaeus, 1758), and other three unidentified birds in the stomach contents of some lizards from the islet Estels Des Dos Cols (5100 m<sup>2</sup>, 35 m a.s.l.), where another small colony of *Falco eleonora* occurs.

### Il Toro Islet (Sardinia, Italy)

Il Toro islet represents the southernmost point of Sardinia and it is located 11 km S of Sant'An-

tioco Island. Its area is 132000 m<sup>2</sup> and maximum altitude is 112 m a.s.l.

The local colony of Eleonora's Falcon, composed by 70-80 nesting pairs, has a special historical significance, as the type-specimen on which was then described the species was captured in 1836 on this islet. Two episodes of interaction between the Tyrrhenian Wall Lizard, *Podarcis tiliguerta* (Gmelin, 1789), and Eleonora's Falcon have been documented by Fadda & Medda (2001).

During a visit to the islet in September 2000, these authors observed up to a maximum of six lizards engaged to contend the remains of a Blackcap, *Sylvia atricapilla* Linnaeus, 1758, a short distance from a falcon's nest.

Furthermore, some lizards were able to steal a prey, probably a warbler, brought by an adult in a nest, dragging out it despite the presence of nestlings. Similar cases were previously documented for the same site also by the naturalist photographer Domenico Ruju (in "Oasis", number 5, September/October 1998). For *Podarcis tiliguerta*, also Schneider (1986) has reported generically the occurrence of commensalism with Eleonora's Falcon.

### New records

#### Galita Archipelago (Tunisia)

The Galita (or Jālitah) Archipelago is situated 50 km off the northern coast of Tunisia. This island group harbours about 80 nesting pairs of Eleonora's Falcon (Azafzaf, 2005) and some lizard species, without those belonging to the genus *Podarcis* (Lanza & Bruzzone, 1959; Delaugerre et al., 2011).

Many observations were recorded by one of us (RO) on the islets of La Fauchelle (136000 m<sup>2</sup>, 137 m a.s.l.), Gallo (89000 m<sup>2</sup>, 119 m a.s.l.), and Gallina (31000 m<sup>2</sup>, 60 m a.s.l.), during several field researches carried out in September 1996, 1998 and 2001. In all the cases, the species interacting with *Falco eleonora* was the Ocellated Skink, *Chalcides ocellatus* (Forskål, 1775) (Fig. 2).

The activity of skinks resulted generally intense in the surroundings of the colonies where nestlings were aged between few days and about 2 weeks. Inside the nests have been seen up to seven skinks simultaneously consuming the remains of passerine.

This foraging activity took place exclusively on ripped preys; only in one case, not directly related to interactions with falcons and observed at La Fauchelle, a skink has attempted to extract a dead but intact nestling from a nest of warblers.



Figure 2. *Chalcides ocellatus* feeds on remains of passerine in a falcon's nest; Gallo Islet, Galita Archipelago, September 2001 (photo R. Ouni).

### Aeolian Archipelago (Sicily, Italy)

The archipelago is located 20 km off the north-eastern coast of Sicily and comprises some islands and a number of islets; one of these, Scoglio Faraglione (5700 m<sup>2</sup>, 33 m a.s.l.), is inhabited by the endemic Aeolian Wall Lizard, *Podarcis raffonei* (Mertens, 1952) and is frequently used as hunting territory and roost by the Eleonora's Falcon, which occurs nearby with 6-15 pairs in the island of Salina (Lo Cascio, 2000; Corso & Gustin, 2009).

During a visit on 28 October 2011, three of us (MD, FG & PLC) have observed for a long time several lizards eating the remains of a Common Stonechat, *Saxicola torquata* (Linnaeus, 1766), while they showed to ignore a killed but almost intact European Robin placed few centimetres away.

The stonechat, although rather fresh, was already partially decomposed in the gash of the head, containing ants and some larvae of flies (probably calliphorids), while this latter perhaps had been just recently left over by a falcon disturbed by our coming. The occurrence of this food source has led to a series of complex intraspecific interactions (Figs. 4-5): a robust male lizard was very aggressive versus other males as they approached the prey

but, at the same time, allowing some females to feed on the carcass. Initially, lizards have surely ingested larvae and ants, but most time has been dedicated to an intense consumption of fleshy pieces (Fig. 3) and feathers (Fig. 6).

During the consumption, the prey is dragged from its original location by a lizard (Fig. 7); for another islet of the same archipelago, La Canna (3400 m<sup>2</sup>, 70 m a.s.l.), inhabited both by Aeolian wall lizard and by Eleonora's Falcon, Capula & Lo Cascio (2011) have previously reported that lizards often prey upon flies and other insects attracted by falcon pellets.

### DISCUSSION

The complex of interactions occurring between Eleonora's Falcon and lizards has been differently interpreted by authors, e.g. as mutualism (Schultze-Westrum, 1961; 2010), symbiosis (Salvador, 1980), or kleptoparasitism (Fadda & Medda, 2001), while only Walter (1979: 19) has regarded the lizards as "true commensals" of *Falco eleonora*.

Positive interactions among two species include all non-consumptive interactions benefiting at least one of the associated species but not impacting the other; especially in the case of commensal interactions, one species benefits and the other is unaffected (Dickman, 1992; Bertness & Callaway, 1994).

From this point of view, all the above mentioned cases which have been documented for lizards and falcons in the Mediterranean islets seem to fit well to the widely accepted mean of commensalism. Anyhow, access to food source by lizards has occasionally involved its removal, outlining an asymmetrical interaction that can be assimilated to kleptoparasitism, although it likely began as a non-antagonistic relationship among these species.

Possible or confirmed commensal interactions between birds and reptiles are quite uncommon (Thomas, 1890; Attwell, 1966; Christian, 1980 and references therein; Gehlbach & Baldrige, 1987; Gory, 2009), mostly of which may be truly referred to cleaning symbiosis (sensu MacFarland & Reeder, 1974) rather than trophic commensalism.

This is perhaps also the case of interactions between gulls and lizards reported by Kammerer (1925) for some Adriatic islets, where the latter have been observed eating ectoparasites of nestlings.



Figure 3. Two *Podarcis raffonei* on the carcass of a Common Stonechat preyed by Eleonora's Falcon; Scoglio Faraglione Islet, Aeolian Archipelago, October 2011 (photo P. Lo Cascio). Figure 4. Intraspecific interactions between two specimens of *Podarcis raffonei*: above, the first lizard feeds on the carcass of a stonechat while the second (top left) approaching that of a robin; in the middle, the second has neglected the robin and approaches the other one, even if already occupied by the first lizard; below, the first attacks the second, showing a territorial behaviour. Figure 5. Another territorial behaviour: a male (top left) and a female basking near the stonechat's remains while another female is feeding on the carcass. Figure 6. A male eats a feather; to better perform the swallowing, the lizard repeatedly rubs its snout on the rocky soil. Figure 7. During the consumption, the prey is dragged from its original location by a lizard.

In this perspective, the occurrence of commensalism between lizards and Eleonora's Falcon takes on particular interest, both for the extreme rarity of this interspecific relationship among these animals and its uniqueness in the context of the Mediterranean.

Eleonora's Falcon is a medium-sized, colonial raptor, which from April-June to October-November occupies its breeding sites distributed in an area ranging from Cyprus to Canary Islands.

Islets, especially those of the Aegean Sea that harbour about 70% of its global population (estimated as 6800-7400 pairs, see Burfield & Kreiser, 2004; Ristow, 2010), are crucial ecosystems for this species, which needs isolation and the feeling of security to nest and breed successfully. Indeed, the difficult access to remote slopes of small islands minimizes the human presence in these areas.

*Falco eleonora* is basically insectivorous; however, in coincidence with the hatching of chicks, it preys almost exclusively upon passerine birds that in late summer cross the Mediterranean during the migration (Walter, 1979; Ristow et al., 1986).

Lizards are widely represented on the Mediterranean insular ecosystems, in particular those belonging to the clade Gekkota as well as to some genera (such as the lacertid *Podarcis* Wagler, 1830 and the scincid *Chalcides* Laurenti, 1768), but islets are generally inhabited by few or even one species (see Corti et al., 2006; Delaugerre & Cheylan, 1992; Mateo, 1997; Mayol, 1997; Valakos et al., 2008).

Although their main food source is represented by a wide variety of invertebrates, lacertid and scincid lizards can have unusual feeding behaviours, especially among islet populations. They include herbivorism (Pérez-Mellado & Corti, 1993; Sáez & Traveset, 1995; Van Damme, 1999; Lo Cascio et al., 2008), kleptoparasitism (Cooper & Pérez-Mellado, 2003), cannibalism (Castilla & Van Damme, 1996; Pafilis et al., 2009; Dappen, 2011) or attacks to dangerous preys normally avoided from lizards (Castilla et al., 2008).

Also, a certain propensity to the consumption of blood, fleshy remains and organic matter of vertebrates by insular lizards has been empirically documented: e.g., on Lampione Islet (Channel of Sicily), Moltoni (1970: 167) has found a maltese wall lizard, *Podarcis filfolensis* (Bedriaga, 1876), licking "i liquidi che uscivano da un uovo nel quale il piccolo aveva già rotto il guscio" [the fluids issuing

from an egg in which the chick had already broken the shell]; and on Galitone, one of the islets belonging to the Galita Archipelago, Captain Enrico D'Albertis noted that two lizard species, *Chalcides ocellatus* and the Large Psammodromus, *Psammodromus algirus* (Linnaeus, 1758), were mighty attracted by the blood of falcons stored into his game-bag: "allora spiumato un uccelletto che avevo trovato presso un nido ne posi il corpicino nella reticella da farfalle che portavo meco e tenni il manico di questa in una mano ... non tardarono le incaute bestiole a slanciarsi sulla preda" [then, plucking a bird that I had found in a nest, I put it in a butterfly net that I had and held the handle in one hand ... the misguided creatures were not slow to rush on the prey] (D'Albertis, 1878: 307).

A first, distinctive trait of the commensal interaction between Eleonora's Falcon and lizards is its brief temporal context. Indeed, all the reported observations were done in September-October, when i) the diet of falcons becomes strictly ornithophagous, and ii) the prey availability for lizards is substantially reduced (see Lo Cascio & Capula, 2011) and, therefore, the organic material carried onto islets by falcons may represent a significant nourishment.

Lizards can use this additional source of food not only if they live near the colonies, but also when inhabiting areas regularly used as roosts by falcons, such as in the case of Scoglio Faraglione Islet. Other noteworthy trait is represented by the relatively large number of species so far recorded to be involved as commensals in this interaction: five of these belong to the lacertid genus *Podarcis*, and one is the scincid *Chalcides ocellatus*.

This latter differs greatly from the others both morphologically and ecologically: in fact, the ocellated skink is described as semi-fossorial, sit-and-wait forager in plant litter or under stones (Arnold, 1984; Kalboussi & Noura, 2004; Lo Cascio et al., 2008), whereas the foraging activity of lacertids mainly occurs on the surface (Pérez-Mellado & Corti, 1993).

Nevertheless, both for *Podarcis* and for *Chalcides*, access to this food source involves an outstanding effort in bite performance, because their dentition smoothed and sharp mainly facilitates the crushing (see Caputo, 2004; Metzger & Herrel, 2005). Observations carried out at Scoglio Faraglione, where lizards have preferred a partially gashed bird but

completely avoided another intact prey, may be explained with this morphological constrain and, especially, with the difficulty of ripping fleshy pieces from a plumed and more compact tissue.

A still open question, however, is whether this seasonal switch from insectivory/arthropodivory to true carnivory may be accompanied by phenotypic specialisations in the trophic apparatus (Schwenk, 2000). Gut anatomy, enzymatic activity, microbiota of the gastrointestinal tract may be involved by physiological adjustments to a different diet (Karasov & Diamond, 1988; Karasov et al., 2011; see also Pough, 1973).

Little information available on gastrointestinal parasites of some lizard populations have so far shown just their characterization as species typically associated to animals with insectivorous rather than herbivorous diet (Roca & Hornero, 1994; Roca et al., 2006), but didn't give any indication on this concern.

In contrast, a factor which may have encouraged the establishment of these interactions is represented by the low risk for the lizards to be predated by falcons.

Although some cases are given in literature (Krüper, 1864; Araujo et al., 1977; Walter, 1979; Salvador, 1980; Dolç Garcia & Dies Jambrino, 1991; Lo Cascio, 2000), there are no doubt that lizards appear with negligible percentages in the trophic spectrum of Eleonora's falcon; Walter (1979) also observed that all the died lizards found in nests were essentially untouched except for head and back injuries, and remarks that these evidences suggest as lizard should not be a food item of falcons, but an occasional nuisance.

Besides, attendance in proximity to colonies may provide an indirect protection from other bird species that are primarily lacertophagous, such as the Kestrel, *Falco tinnunculus* Linnaeus, 1758, which usually are chased out from the breeding sites by the Eleonora's falcon.

The balance among these factors has probably enhanced the development of commensal interactions between lizards and falcons, both characterized by a long history of coexistence in small insular ecosystems since many thousands of years (Bailón, 2004; Sánchez Marco, 2004 and references therein). The occurrence of these interactions has been so far documented for some islets, as reported in this paper, but it could result probably more widespread

in the Mediterranean, as suggested by the recurring finding of feathers and small plumes in the examined faecal pellets of lizards cohabiting with *Falco eleonora* on islets such as Strombolicchio, in the Aeolian Archipelago, and Lampione, in the Channel of Sicily (PLC, unpublished data).

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