



Threatened by Legislative Conservationism? The Case of the Critically Endangered Aeolian Lizard

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OPEN ACCESS

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Specialty section:

This article was submitted to
Conservation,
a section of the journal
Frontiers in Ecology and Evolution

Received: 28 July 2017

Accepted: 05 October 2017

Published: 20 October 2017

Citation:

Gippoliti S, Capula M, Ficetola GF,
Salvi D and Andreone F (2017)
Threatened by Legislative
Conservationism? The Case of the
Critically Endangered Aeolian Lizard.
Front. Ecol. Evol. 5:130.
doi: 10.3389/fevo.2017.00130

Species-based conservation legislation needs to be based on sound scientific data and updated taxonomic knowledge. European Union environmental legislation is among the most advanced in the world, yet there is not a clear and regular mechanism to update species' lists of Habitats Directive Annexes according the latest available scientific data. Here we reviewed the situation of the endemic Aeolian lizard *Podarcis raffonei* and indicate it as a case-study of possible ongoing species extinction into the Mediterranean biodiversity hotspot as the result of failure to update lists of EU protected species. We recommend to implement a mechanism of periodical revision of the Annexes of the Habitats Directive with particular attention to endemic EU species included in the IUCN Red List as Critically Endangered.

Keywords: *Podarcis raffonei*, habitat directive, legislation, conservation, taxonomy

INTRODUCTION

Islands are well-known in shaping the perception and understanding of evolutionary processes (Lomolino, 2005). In fact, speciation and endemism of insular species are often linked to conservation priorities and are not only limited to well-known and celebrated tropical islands or archipelagos, but are also relevant in temperate environments. In such a context, lizards of the genus *Podarcis* show a remarkable pattern of diversity in the Mediterranean Region. Six endemic island species are currently recognized in the Western sector of the Mediterranean Region, while tens of endemic subspecies were described during the last century (Corti et al., 2011). Apart from their biological and ecological importance, *Podarcis* species are witnessing a relevant historical, cultural, and scientific value, since their study provided key insights to our understanding of evolutionary theory (Wallace, 1878) and for the identification of phylogenetic lineages (Arnold, 1989).

In the last years the amazing advances of molecular biology and integrative taxonomy are boosting our understanding of species evolution. As a consequence, hundreds of new species are described thanks to our ability to detect distinct evolutionary units, which were hardly identified on the basis of morphological characters only. However, the complexity of evolutionary dynamics is sometimes not fully appreciated by the legislative tools which are at the basis of biodiversity conservation (Marris, 2007). Indeed, there is the perception that legislation runs at a considerable lower velocity and, often, creates resistance in terms of taxonomic updates. This could lead to deleterious effects in terms of conservation, particularly for narrow-range species.

In the present paper, we review the peculiar case of the Critically Endangered Aeolian wall lizard (*Podarcis raffonei*) that highlights the limits of legislative mechanisms' ability to integrate conservation policy in Europe in light of scientific advancements in taxonomy. Since the improvement of taxonomic and evolutionary knowledge is quickly increasing or refining the number and the geographic distribution of recognized species (and genera), it is highly probable that similar considerations may be applied to other taxa and regions.

THE AEOLIAN LIZARD: A TAXONOMIC AND A BIOGEOGRAPHIC HISTORY

Podarcis raffonei (or *P. raffoneae* as it was also named after some recent nomenclatural discussions) (Figure 1) is endemic to the Aeolian Archipelago (Sicily, Italy). This lizard was first considered to be conspecific with congeneric *P. waglerianus* or *P. siculus*, but it has been recognized as a distinct species on the basis of genetical aspects and morphological comparisons (Capula, 1994, 2004). Currently, it survives with just four small isolated populations, and it was assessed as CR (Critically Endangered) by the IUCN Red List because its extent of occurrence is <100 km², its area of occupancy is <10 km², its distribution is severely fragmented, and there is continuing decline in the number of individuals (IUCN, 2009). The competition and hybridization with *P. siculus*, likely introduced in the archipelago by humans, is likely the major threat to its long-term existence.

The conservation emergency of *P. raffonei* is also coped with a taxonomic complexity, as witnessed by the occurrence of several phenotypically distinct allopatric populations. In fact, it inhabits one island (Vulcano) and three islets (Figure 2), and each of these populations was originally described as a distinct taxon. The nominal subspecies *raffonei* was described from the Strombolicchio Islet as *Lacerta sicula raffonei* by Mertens (1952), *alvearioi* from the Scoglio Faraglione Islet as *Lacerta sicula alvearioi* by Mertens (1952), *antoninoi* from the Vulcano Island as *Lacerta wagleriana antoninoi* by Mertens (1955), and *cucchiarai* from the La Canna Islet as *Podarcis sicula cucchiarai* by Di Palma (1980) (Figures 1, 2).

The population size for *P. raffonei* is also apparently very small: estimated numbers are of around 500–700 individuals for Strombolicchio Islet, 200–400 individuals from Scoglio Faraglione Islet, while in the diminutive La Canna Islet the population is likely <30 individuals (Capula and Lo Cascio, 2006; Lo Cascio, 2010a). On Vulcano the species is reported to survive in one tiny peninsula only, with perhaps <200 individuals (Lo Cascio, 2010b). Last but not least, the regular observation of hybrids between *P. raffonei* and *P. siculus* also suggests that *P. raffonei* was originally present in most of the Aeolian archipelago (Figure 2), but went extinct in most of the range because of interspecific interactions with *P. siculus* (Capula, 1993). Currently, the invasive *P. siculus* is the only lacertid occurring on the large islands of the archipelago (Capula et al., 2002), and ecological competition with exclusion has been demonstrated on Vulcano, where *P. siculus* is currently widespread and very abundant, whereas *P. raffonei* was no more

found in the historical localities quoted by Mertens (1955) and Capula and Lo Cascio (2006), and is obviously close to extinction.

THE HABITATS DIRECTIVE AND THE LAUNCH OF AN URGENT ACTION PLAN

The scenario here depicted clearly shows that *P. raffonei* is one of the most threatened terrestrial vertebrates in Europe. For this, immediate and urgent conservation actions and efficient legislative tools are badly needed and expected. The Habitats Directive (HD) of the European Union (EU) (Council Directive 92/43/EEC), first enacted in 1992, is one of the most powerful legislative tools for conservation in Europe, since it protects >1,200 species and their habitats. The HD lists in its Annex IV both *P. siculus* and *P. waglerianus*, which are consequently strictly protected. Until its recognition as a separate species in 1994 *P. raffonei* was implicitly protected as a subspecies of *P. waglerianus*. Surprisingly enough, when recognized as a different species, *P. raffonei* was not explicitly stated and named in the HD. According to the HD, anyhow, when a species is separate from another species and gains taxonomic identity (as it is the case of *P. raffonei*) it keeps the original conservation status. In other words, *P. raffonei* since the moment of being recognized as a separate species maintained the legal protection that it had when considered a subspecies of *P. waglerianus* or *P. siculus*. The European Commission has long accepted the principle that when a taxon listed on one of the annexes is split as a result of a taxonomic revision, then all the new taxa are also considered as listed (Evans and Arvela, 2011).

Of course, we agree that this is better than nothing, and theoretically warrants a certain degree of protection for *P. raffonei*, but there are some major constraints facing this situation. First of all, the species is not explicitly reported and visible in the HD. In our opinion this is a great obstacle and heavily hampers organizations and researchers to ask for economical supports for conservation and/or research, simply because *P. raffonei* is not perceived as a protected species, and even make people believe that it is not protected. Then, the change from supposed subspecies of *P. siculus* and *P. waglerianus* showed that the species gained a particular status and rank (from subspecies to species) and stressed its narrow endemism. Since *P. raffonei* is declining and present in the Aeolian archipelago only reduced the area of occurrence and extent of occurrence, its Red List status (Critically Endangered) is strongly different from both *P. siculus* and *P. waglerianus*. These species are both assessed as Least Concern, and one of them (*P. siculus*) actually is a very widespread and locally abundant species and is also the main agent of *P. raffonei* lowering and potential extinction. For this, the inclusion of *P. raffonei* in the HD can be seen as just a casual consequence of this, and not a tailored action due to its peculiar conservation status. Conversely, we reaffirm that it would be more appropriate explicitly listing *P. raffonei* in the Annex II of the directive, which ensure conservation measures including habitat protection through the Natura 2000 network.

Furthermore, it must be stressed that, were the taxonomic status of the taxon *raffonei* not re-evaluated, very little attention



FIGURE 1 | *Podarcis raffonei raffonei* from Strombolicchio Island (photograph by D. Salvi) and *P. r. alvearior* from Vulcano Island, Aeolian Archipelago (Italy) (photograph by G. F. Ficetola).

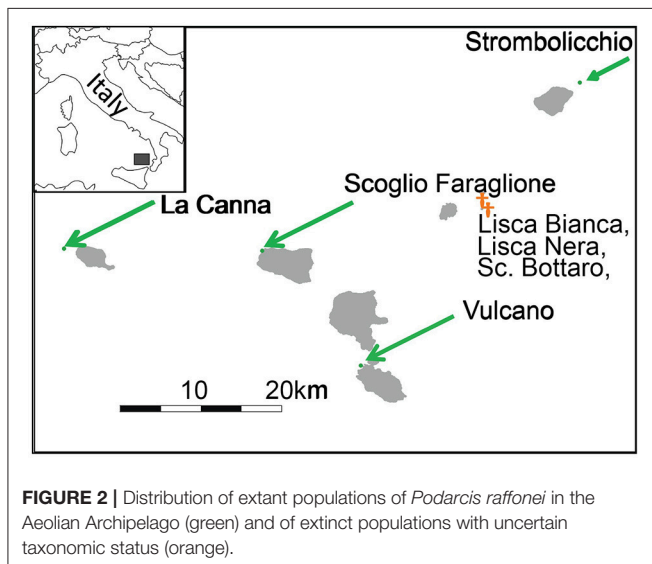


FIGURE 2 | Distribution of extant populations of *Podarcis raffonei* in the Aeolian Archipelago (green) and of extinct populations with uncertain taxonomic status (orange).

would have been paid to the extinction of some other subspecies of a wide-ranging non-threatened species such as *P. waglerianus* (Gippoliti and Amori, 2007). Currently, the extinction of insular-endemic subspecies occurred several times, without major conservation concerns being raised. This was for instance the case with *Podarcis siculus sanctistephani* (Mertens, 1926), a subspecies typical of Santo Stefano Islet in the Pontine Archipelago (Latium, Italy). According to Lanza and Corti (1993), by 1954 this taxon was no more found on the islet, where it was replaced by *P. s. siculus*. Moreover, the case of *P. raffonei* is not isolate and it can be seen as a remarkable example, since many other palaeoendemic species still remain over-neglected by EU legislation (e.g., Gippoliti and Amori, 2004, 2006).

Considering the available evidence about the main cause of *P. raffonei* range contraction and the possible complete extinction of the species in Vulcano in a few years, we are in the urgency to act very quickly for assuring its conservation. So far, we strongly support the preparation and application of an action

plan including a detailed monitoring program of the species and immediate management actions (Lo Cascio and Ficetola, 2016). The populations of *P. raffonei* living in the different islands are characterized by genetic and morphological differences, so they need to be managed as distinct Management Units. Moreover, captive breeding programs are to be considered in the recovery plan for the species as complementary tool to preserve as much as possible of the diversity of these lineages (Gippoliti and Capula, 2014). Furthermore, the possibility to eradicate (or at least containing) *P. siculus* from some islets to allow reintroduction of *P. raffonei* should also be taken into account. Available evidence with other lizards suggests that release of captive-bred individuals may be a viable and economically feasible option for the Aeolian wall lizard (Santos et al., 2009).

THE HABITAT DIRECTIVE AND THE FLUID TAXONOMY

Although, the EU has an advanced environmental policy, the complex political history and structure of the EU produced tools for biodiversity conservation that are not always able to cope with the fluid state of knowledge arising from biodiversity, ecological and evolutionary research (Battisti and Fanelli, 2015). *Podarcis* lizards are a good example of Mediterranean endemic diversity that is increasingly appreciated thanks to a scientific interest and to the availability of new taxonomic techniques. So far, species lists of the HD need updating and identification of new methods of species selection (Cardoso, 2012; Prie et al., 2012). The HD annexes have been the basis to establish the Natura 2000 Network, a number of conservation sites of European importance to assure the future of biodiversity on the continent. It is evident that if we fail to recognize narrow-range threatened lineages we are unsuccessful in protecting an important part of current biodiversity.

The idea that we have a definitive knowledge of European biodiversity and taxonomy is simply an implicit (but largely erroneous) assumption of European environmental legislation (Dubois, 1998), as we have to recognize today that biodiversity

information is still imperfect. An accurate taxonomy reflecting current knowledge on phylogenetic systematic is crucial to indicate conservation priorities and management (Thuiller et al., 2015). In our opinion tools and legislation aimed at conserving biodiversity thus require periodical updates in order to integrate state-of-the-art knowledge from taxonomic research. It is pivotal that scientific organizations, environmental NGO's, and zoos in Europe are guided in the allocation of conservation resources by the most scientifically sound tools now available (as the periodically updated IUCN Red List) and not just by the outdated annexes of the HD, at least until they are carefully amended. In the last years, the annexes were subjected to some updates, for instance when new member states become EU members, or to take into account some taxonomic revisions. However, these updates have not been performed in a regular basis and are still heterogeneous. Nevertheless, the HD requires that, every 6 years, countries shall draw up a report on the conservation status of all the listed species. We believe that such reporting should be accompanied by a regular update of the annexes. Such updates are imperative for the conservation of European biodiversity, and

must pay strong attention to taxonomic updates and to species that are identified as threatened or with decreasing conservation status.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

ACKNOWLEDGMENTS

The authors thank A. Nistri, D. Fontaneto, L. M. Luiselli, and G. Amori for useful discussions on Directive Habitats and P. Lo Cascio for updates about the conservation status of *P. raffonei*. C. Rondini was much helpful in commenting a first draft of this paper. GF and DS received funding from the Mohamed bin Zayed Species Conservation Fund (Eolizard Project, 162514415). DS is currently supported by the program "Rita Levi Montalcini" for the recruitment of young researchers at the University of L'Aquila.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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