

At the edge of meridionalization:

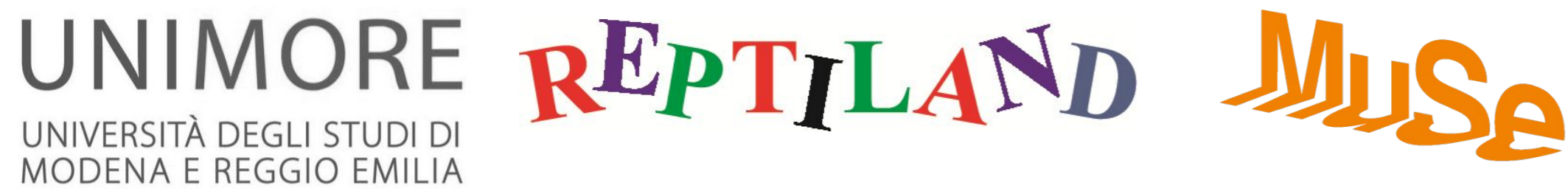
the case of alien lizards *Podarcis siculus*

Rafinesque-Schmaltz, 1810 (Sauria: Lacertidae)

around lake Garda



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The occurrence of the Italian wall lizard *Podarcis siculus* around Lake Garda was enlightened only very recently when “new” populations were discovered by authors (Nardelli et al., 2016) in the municipality of Arco (TN) and Limone sul Garda (BS), in three garden centres in Padenghe s/G (BS), Peschiera s/G and Castelnuovo d/G (VR), inside the historical garden park “Sigurtà” in Valeggio sul Mincio (VR), and in the pre-alpine hilly area *Colline Veronesi* (VR). We have re-confirmed the presence of *P. s.* on Trimelone islet (VR), while we failed verifying all the other historical data regarding the southern edges of Lake Garda and nearby areas; our intensive surveys in the localities of Calliano, Rovereto, Spino and Ala (TN), Castellarò Lagusello (MN) and Mt. Maddalena (BS) lead us to sadly assess, albeit with some obvious misgivings, the local extinction of the species. We did not find it even in other localities cited by literature on the Astico river (VI), on the Oglio river (BS) and in Montorio, Parona and Marcellise (VR).



Figure 1. *Podarcis siculus* males from **up:** Avesa (VR), **bottom:** Limone s/G (BS). Male-male competition for mate choice will be a big deal for smaller autochthonous, since exotic lineages reach bigger sizes and females can probably host more eggs in their body, resulting in a higher fitness.

The presence of *P. siculus* exotic lineages in northern Italy brings forward major considerations on their impact on native *P. s. campestris* and *P. muralis*, since exotic *P. siculus* seems capable of actively competing through species substitution and/or hybridization. Our episodic observations appears to be at least contradictory since in human inhabited areas colonized by alien *P. siculus* we found very rarely *P. muralis*. On the opposite, olive orchards and garden centres host both species, sometimes with high densities, and without any apparent habitat delimitation between them.

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We have inferred the geographical origin of the “new” *P. siculus* populations since preliminary analysis of chromatic dorsal patterns, ventral scales number and SVL evidenced typical traits of southern *P. siculus* lineages, not naturally occurring in the Po Plain. In addition, in most of cases lizards exclusively inhabit restricted man-made areas as olive orchards, parks, private gardens, factories or garden centres increasing the chance for a human mediated introduction. We have sequenced 935 bp of the mitochondrial *cyt-b* gene extracting lizard DNA from fecal pellets or pieces of dead skin collected in the field. Our results suggest an exotic origin of most of the analyzed populations. The Adriatic coast (FG), together with Sicily (AG), represent the two main areas from where alien *P. siculus* were imported to northern Italy.

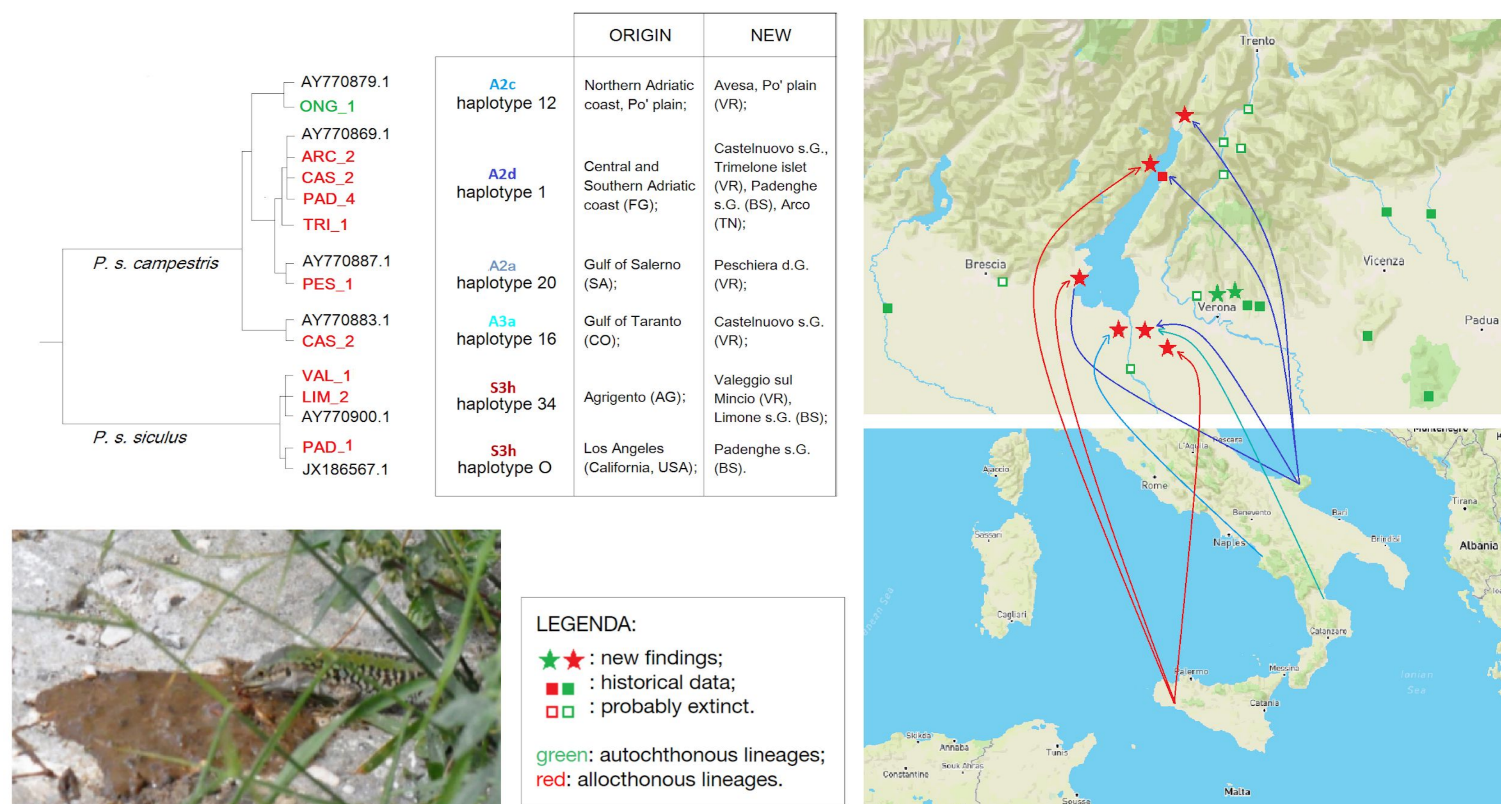


Figure 3. **Reduced phylogenetic tree:** the presence of different haplotypes ensure the occurrence of multiple separated colonization events, even in the same locality. In at least two sites, this has probably brought to hybridization, offsetting the negative consequences of the founder effect. **Upper right:** localities where “new” *P. siculus* populations were found around Lake Garda. The presence of the lake clearly affects their climate favouring lizards survival. **Bottom right:** localities from where alien *P. siculus* were imported. **Bottom left:** An adult male of exotic *P. siculus* eating bird faeces on Trimelone islet (Assenza, VR) (Ph. G. Bombieri); the diet of this alien lizard around Lake Garda seems to vary, sometimes including exotic fruits (eg. *Passiflora sp.*, *Capparis spinosa*, *Opuntia sp.* and *Trachycarpus fortunei*). Eating fruits means spreading their seeds and this makes *P. siculus* an invasive alien species able to favour other invasive alien species throughout a positive feedback which starts from aged olive tree importation and end up in a faster habitat meridionalization of the area. On the contrary, autochthonous *P. s. campestris* lineages can be considered extremely sensitive to habitat alteration and also to the colonizing power of allochthonous entities as *Ailanthus altissima*, *Robinia pseudoacacia* and *Buddleja davidii*. Each of these plant species are able to rapidly cover open areas specifically on sandy substrates (riverbanks or arenaceous deposits in hilly areas), which both apparently seems to be essential to the survival of autochthonous *P. s. campestris* at the northernmost limit of its distributional range.



Figure 2. **On the right:** aged olive trees trading clearly represent the main way by which *P. siculus* was imported, because these old plants perfectly host *P. s.* acting as a Trojan horse for the colonization of new hostile environments, representing an all-in-one microhabitat, where lizards can find food and basking sites, lay eggs and better survive to cold climate conditions during winter. Aged olive trees are frequently sold to private citizens for ornamental purposes so garden centres act as stepping stones for a rapid and unpredictable lizard invasion, which could affect a large portion of northern Italy, firstly south of the 46° parallel. **On the left:** two exotic *P. siculus* males from Padenghe s/G exhibiting intermediate traits between *P. s. campestris* and *P. s. siculus*. Molecular data confirmed the presence of both the spp. in this locality and in Castelnuovo d/G, suggesting the presence of hybrids.

It is therefore important to emphasise that, as far as we know, to these days the only remaining autochthonous *P. s. campestris* populations in southern Alps around Lake Garda are those located in the *Colline Veronesi*, which are on its own restricted to very small ecologically suitable areas, and are at risk to be completely replaced by *P. siculus* exotic lineages, which reach bigger sizes and are clearly better adapted to the current Po Plain climate. Unless conservation strategies are taken, we can expect the same fate for the remaining autochthonous *P. s. campestris* populations north of the Po river, resulting in the complete loss of autochthonous lineages endemic of this area.

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