

Alien challenges in Greece: an overview of the terrestrial species

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Although the phenomenon of biological invasions has been noted for some time (Elton 1958), it is only during the last two decades that the biological consequences of exotic invasions have been researched extensively. Invasive species can threaten biological diversity in various ways, from reducing genetic variation and eroding gene pools, through the extinction of endemic species, and by altering habitat and ecosystem functioning. Biological invasions also cause economic impacts that can be valued as financial costs, based on expert extrapolations of high-profile alien pests. A conservative estimate of the annual damage caused in the European Union (EU) by alien species is € 12 billion.

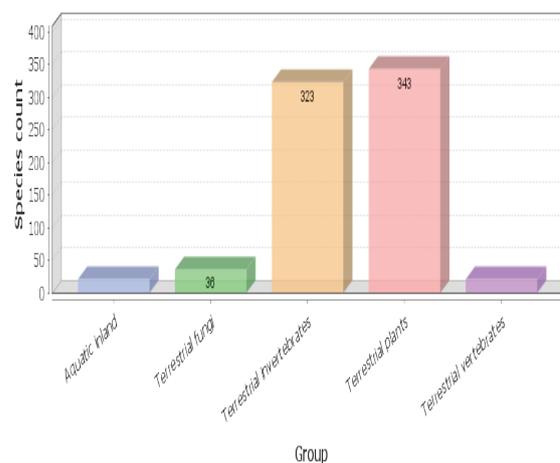
The Convention on Biological Diversity (CBD) calls for the "compilation and dissemination of information on alien species that threaten ecosystems, habitats, or species, to be used in the context of any prevention, introduction and mitigation activities" (CBD 2000). The objective set by Aichi Biodiversity Target 9 is that "by 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment". This objective is reflected in Target 5 of the EU Biodiversity Strategy (EU 2011).

To effectively support policies and scientific research on biological invasions in Europe, and to efficiently use the already accumulated knowledge, there is a need for standardization, harmonization and integration. To achieve this goal, the European Commission's Joint Research Centre (JRC) launched the European Alien Species Information Network (EASIN) in 2012 (<http://easin.jrc.ec.europa.eu>). This network aims at facilitating the exploration of existing alien species information from distributed sources through a network of interoperable web services, and to assist the implementation of European policies on biological invasions (Katsanevakis et al. 2015).

The DAISIE Project

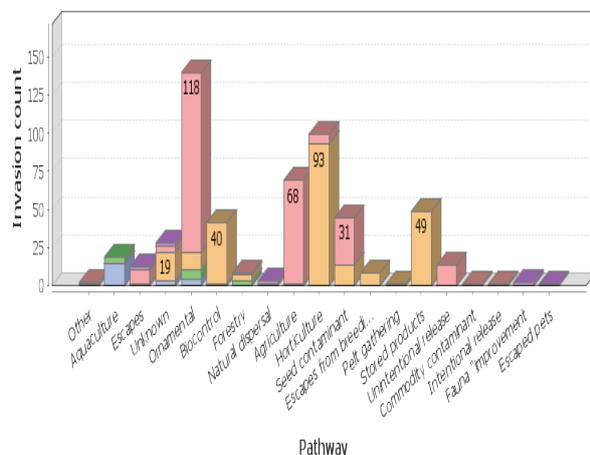
The first pan-European assessment of the impacts of alien species (plants, vertebrates, and invertebrates) in terrestrial, freshwater, and marine environments on ecosystem services was made possible through comprehensive data produced by the DAISIE project (www.europe-aliens.org). This assessment stated that there are 1094 species with documented ecological impacts and 1347 with economic impacts (Vilà et al. 2009). The two taxonomic groups with the most species causing impacts are terrestrial invertebrates and terrestrial plants. The North Sea is the maritime region that suffers the most impacts. Across taxa and regions, ecological and economic impacts are highly correlated. Terrestrial invertebrates create greater economic impacts than ecological impacts, while the reverse is true for terrestrial plants. Alien species from all taxonomic groups affect "supporting", "provisioning", "regulating", and "cultural" services and interfere with human well-being. Terrestrial vertebrates are responsible for the greatest range of impacts, and these are widely distributed across Europe.

Figure 1
Data on alien species counts



Source: DAISIE web site for Greece (www.europe-aliens.org)

Figure 2
Data on alien species pathways of introduction



Source: DAISIE web site (www.europe-aliens.org)

The same database provides also fact sheets on the most invasive species organized by habitat, e.g. terrestrial plants, terrestrial invertebrates, terrestrial vertebrates, terrestrial fungi, aquatic marine and aquatic inland. In these fact sheets information on taxonomy, synonyms, ecology and habitat of the species in reference can be found.

Alien species occurring in Greece are not few and have occupied the scientific interest for many years. The most advanced work has been performed on the marine taxa and has been undertaken by the Hellenic Center of Marine Research. Quite a substantial deal of publications has come out of this work, the most recent of which have been published by Pancucci-Papadopoulou et al. 2005a; Pancucci-Papadopoulou et al. 2005b; Zenetos et al. 2007; 2009a; 2011). Compilation of information on freshwater species has been carried out by Zenetos et al. (2009b), and amended by Koutsikos et al. (2012).

The situation in Greece

The first comprehensive checklist of terrestrial alien plant species in Greece was produced upon completion of the DAISIE project in 2008 and was published in Arianoutsou et al. 2010a. In this paper the state-of-the-art assessment of the alien flora of Greece and its traits is presented. The checklist consists of a total of 343 alien taxa, including 49 archaeophytes. The taxonomy, life traits and habitat of the 294 neophytes are analyzed vs. their naturalization status. Poaceae, Asteraceae, Amaranthaceae, Solanaceae, Fabaceae, and Polygonaceae are the plant families richest in alien taxa. The majority of them are of American origin, followed by those of Asiatic and Mediterranean origin. The neophytes are predominantly herbs, most of them annuals. Although data available are not sufficient, there is strong evidence that most neophytes (75%) are introduced intentionally for agricultural or ornamental purposes. On the other hand, contamination of crop seed propagules has apparently been a main pathway of accidental introduction.

Artificial habitats, especially cultivations and road networks, host the highest numbers of neophytes. Plant habitats of urban and inhabited rural areas such as walls, pavements, construction sites and abandoned constructions are also often colonized by neophytes. The natural habitats that host the highest numbers of neophytes are the coastal zones and inland surface waters. Artificial habitats host the highest numbers of naturalized taxa, as well. However, the naturalized neophytes occur more frequently in natural habitats than casuals, especially in coastal and water related ones.

The total number of the alien plant taxa reported for Greece (343) is relatively low compared to those of other Mediterranean and Southern European countries, namely Italy, Spain and Portugal (1023, 933, 547, respectively – for detailed citations see in Arianoutsou et al. 2010b). The smaller number and density of alien plant species observed in Greece may be related to the fact that it has lower levels of industrialization and of transportation network development, a higher proportion of scarcely if at all populated or cultivated mountainous areas, and a highly dissected physiography with many high and often inaccessible mountain ranges spreading across the mainland.

Out of the 122 naturalized neophytes, 50 are identified as exhibiting invasive behaviour. *Ailanthus altissima*, *Amaranthus albus*, *Chenopodium ambrosioides*, *Datura stramonium*, *Eleusine indica*, *Erigeron bonariensis*, *Nicotiana glauca*, *Opuntia ficus-barbarica*, *Oxalis pes-caprae*, *Paspalum distichum*, *Solanum elaeagnifolium*, *Symphytotrichum squamatum* and *Xanthium spinosum* are typical cases of plants characterized as invasive, having established in a variety of habitats.

Opuntia ficus-barbarica (Figure 3) and *Ailanthus altissima* invade abandoned rangelands, very often excluding the native herbs and shrubs that would have otherwise been the pioneer plants in this old field succession.

Figure 3
Opuntia ficus – barbarica invasion in abandoned rangeland of Central Greece

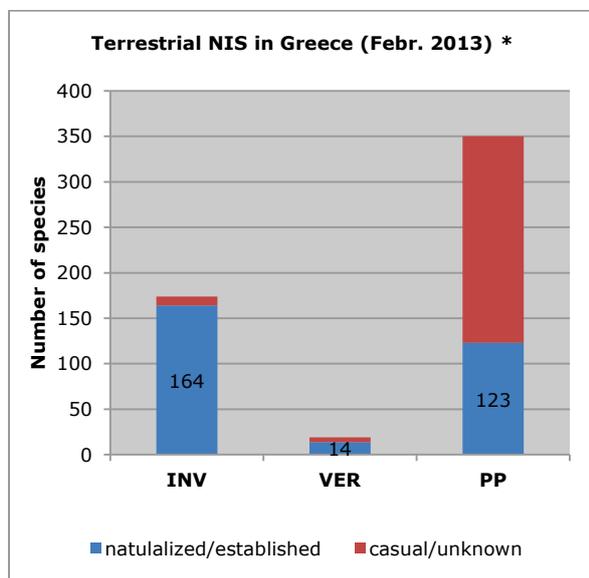


Photo: M. Arianoutsou

Extended areas in Central and South Greece, many of the islands of the Aegean, previously used as grazing lands, and now abandoned are heavily contaminated by the prickly pear (*Opuntia ficus-barbarica*), which has no natural predator to control its population spread. However, and despite these problematic landmarks of the Greek landscapes, most aliens are found in artificial habitats, leaving the natural ones relatively intact. The renowned *Oxalis pes-caprae* is becoming increasingly common at urban and suburban ruderal sites, olive groves and shrub and forest edges where it forms dense mats preventing the growth of other species, especially during the important for the Mediterranean habitats autumn to early spring growth period. However, it rarely penetrates natural habitats and is actually restricted to disturbed sites, such as the remnant forest stands on islands or near towns and the reed beds at wetlands with degraded hydromorphology. Nevertheless, *Oxalis pes-caprae* constitutes a serious threat for species of transitional zones and for those species (including orchids and rare bulbs) that use to find a refuge in traditional olive groves.

Regarding the other terrestrial taxa DAISIE database provides a number of 164 naturalized invertebrates and 14 vertebrates (see Figure 4).

Figure 4
Number of alien taxa occurring in terrestrial habitats in Greece



NIS = Non-Indigenous Species, INV = invertebrate species, VER = vertebrates, PP = Primary Producers = Plants

* Data on invertebrates and vertebrates were obtained from the DAISIE database; data on plants derive from Arianoutsou et al. 2010) and the updated 'Alien' database on terrestrial plants held at School of Biology, University of Athens (2014).

A list of the worst invasive alien species (WIAS) threatening biodiversity in Europe across environments and taxonomic groups has been compiled by the SEBI 2010 expert group. Eighteen (18) of the 100 (WIAS) species threatening biodiversity in Europe (according to the DAISIE database <http://www.europe-aliens.org>) had been established in the terrestrial environment of Greece (6 plants, 7 invertebrates, 5 vertebrates).

Conclusion

Systematic monitoring of alien species continuation is of high importance. Priority should be given to the prevention of the establishment of aliens, through an improvement of the existing international legal framework, better coordination of international cooperation and the immediate elaboration of a targeted national strategy, which will improve the control of pathways of introduction and will establish an effective early warning system.

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