
INTRODUCTION TO BIOLOGICAL INVASIONS: CONCEPTS AND DEFINITIONS

The movement of biological species has been one of the phenomena that shaped the history of life on Earth. Horses, mastodons and bison came from Siberia into America across the Bering Strait, probably following the same route of our human ancestors. In a similar way, North and South America interchanged complete sets of species in the successive outcrops and sinks of the Panamá isthmus. In this way, the distribution of species in a given age results from the balance between migration and extinction.

Nevertheless, in the last years an unprecedented force has changed in a definitive way the distribution of species on the planet. This new biogeographic dynamic has humans playing the main role. Along its history, humanity has transported thousands of species away from their original distribution ranges. Many animals and plants were and are moved voluntarily as an intent to warrant food security or the availability of fuel, building materials and other needs for different human activities. Others, instead, travel unnoticed in seeds or wood shipments or in ballast water. Also frequent are introductions of exotic species promoted by economic development projects based on technical arguments of doubtful legitimacy that promise great rewards derived from the introductions and do not consider, or avoid to point out, the potential risks on cultural, economic and environmental values.

The growing movement of species away from their natural ranges by human means has also led to the appearance of a set of terms intended to define the different variants of this phenomenon.

An **alien** or **introduced species** is one coming from a different habitat or region. Sometimes this definition coincides with the political borders of a country and so, a species is considered exotic if it was brought from another country. This concept is adequate to set politics and regulations at the national level but it has important restrictions from the point of view of managing biological invasions because the movement of organisms inside a country can be a problem of great concern, just as bad as the importation of a new species. For instance, the translocation of the "tucunaré" (*Cichla ocellaris*) from the Amazon basin to the Paraná river in the South of Brazil turned it into an invasive species in the new habitat, even though it never exceeded the national borders. The same happens with *Mimosa caesalpiniiifolia*, native to the dry Caatinga ecosystem in Northeastern Brazil, used for hedges in other ecosystems, and invasive especially in the Atlantic rainforest. From a biological standpoint, it makes far more sense to prevent the movement of species between ecosystems or biogeographic regions than to keep a concern only with the transposition of national borders.

As a proportion of these alien introduced species manages to establish self-sustaining populations in the new range, they are called *established species*.

Finally, some of the established species are able to advance over natural or semi-natural environments, becoming *invasive*. According to the International Convention on Biological Diversity, an invasive species is "an introduced species that advances without direct human assistance and threatens natural or semi-natural habitats outside its natural distribution range", causing economic, social or environmental impacts.

These previous definitions draw a dynamic framework in the process of growth of an invasive species. In this sense, an introduced species can survive without harm for an unknown period of time until it is able to override certain environmental restrictions, reproduce and form a population, becoming established. With time this species can advance notably over natural environments, becoming invasive. This time frame depends on the species and on local conditions, not being predictable. The technical term for this period of time is "lag phase", referring to the time a species, under certain circumstances, needs to adapt, reproduce and spread. Therefore, it is important to note that to assess the situation of an invasive alien species one cannot consider only the present moment. There is always an evolutionary tendency for adaptation, establishment and invasion, especially if the species has a history of invasion elsewhere.

The main reason why biological invasions are presently more visible and produce wide-range impacts lies in the ease for trespassing natural barriers that formerly limited their dispersal. Human movement across the planet increased significantly with the advance of aerial, fluvial, maritime and road transport all over the world. These commercial routes also facilitate the transport of invasive species and are technically defined as *pathways*, which include roads, commercial routes, the ornamental, fishing, agriculture and forestry trade, among many others. The ways or materials through which species are transported are defined as *vectors*, such as ballast water, the vector for the establishment of the golden mussel *Limnoperma fortunei* in Argentina, ship and boat hulls, soil, animals, wood or other materials used for packaging, fishing or diving equipment, trash, machinery, vehicle tyres and many others.

It is important to note that not all alien species become invasive and that impacts vary according to species and habitats. Still, some species cause serious impacts of wide-range consequences, especially as left uncontrolled. Invasive alien species, rated as the second cause of biodiversity loss in the planet, need to be treated under the precautionary principle advocated by the Convention on Biological Diversity.

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