Biol Invasions
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PERSPECTIVES AND PARADIGMS

The end of Invasion Biology: intellectual debate does not equate to nonsensical science

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Abstract Valéry et al. recently proposed to end the field of Invasion Biology on the grounds that it is based on an inadequate definition of the concept of biological invasion and that, as exotic species, native species should also be called invasive whenever they outbreak. We argue, on the contrary, that the sudden demographic dominance of native species cannot be termed invasion. Moreover, we claim that the suggestion of ending a fruitful and useful discipline because it does not conform to a subjective definition or because it still encompasses some debatable ideas and unresolved questions is both irrelevant and excessive. We believe that the thousands of researchers working in this discipline do not perform nonsensical science, and that their efforts to understand and limit biological invasions are compatible with debating on the key concept of that field.

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In a recent note, Valéry et al. (2013) called for the end of a discipline, Invasion Biology, on the ground that its delimitation is nonsensical and counterproductive. We strongly disagree with both their premise and their conclusion, and argue that the current limitations of, and debates within, Invasion Biology are inconsequential compared to their proposed dissolution of the field, and creation of an all-encompassing "super discipline".

The reasoning of Valéry et al. is based on the limited, self-created, and non-widely accepted definition of biological invasions being "the appearance of a state of dominance of a species and the rapidity of change observed" (Valéry et al. 2013). This logic is then extended to include native species within their home range. In other words, any situation whereby a species undergoes a population explosion would have to be considered a biological invasion. According to this rationale, lemmings in the tundra or gypsy moths in oak forests, which both periodically exhibit large population cycles or outbreaks, would then be considered as invasive in some years while they are not in others. For us, this meaning of biological invasion is neither usual nor logical.

The etymology of the word "phenomenon" was the only justification provided by Valéry et al. to define

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biological invasions as any sudden dominance of a species. This has no scientific or intellectual merit, especially because the etymology of the word says nothing on what is of concern in the debate, i.e. the cause of the state of dominance of a species. Moreover, this definition is based on two concepts that are not relevant to the process of invasion, as most ecologists define the phenomenon: dominance and rapidity. Although it is true that the sudden dominance of a species may serve to indicate the presence of an invader, a non-native species need not be dominant in its invaded environment, and actually most of them are not. Rapidity is consequently even less relevant. Recent work has even shown decade-long lags between the appearance of a species and the time when it eventually becomes invading (Essl et al. 2011).

Our greatest concern with the proposed amalgamation of natives and non-natives is that it would consider naturally dynamic cycles, characterised by a rapidly occurring state of dominance, to be invasions. We disagree that such events as predator–prey relationships, insect outbreaks, small mammals demographic cycles, mass-seedings, resurgent epidemics or whatever makes a species suddenly demographically explode, can be mechanistically considered to be biological invasions. The ecological, biogeographic, and evolutionary implications of endogenous versus exogenous environmental drivers are not the same and can have quite different roles for testing ecological theory, analysing biogeographical processes (e.g. dispersal) and conducting conservation science. Community-wide species interactions and evolutionary trajectories will certainly be quite different for exotic species compared to native ones. Therefore, it is realistic and desirable to keep a clear and univocal meaning of these key concepts. For the sake of etymology, the term "invade" originates from the Latin in-vadere, i.e. "to go into". The notion of a species colonizing a territory beyond its historic native range is fundamental in the concept of invasion, and differentiates it from a simple in situ proliferation.

Most of the arguments presented by Valéry et al. for supporting their extreme, all-inclusive definition of invasion seem to be in response to the term biological invasion only applying to species that have been dispersed across bio-geographic boundaries by human-mediation (Richardson et al. 2000, Pyšek et al. 2004, Wilson et al. 2009). It is within this other restrictive definition that the distinction of exotic *versus* native becomes important and that debate can arise. We disagree completely with Valéry et al. that the discipline should be abandoned because of some ambiguities producing hot debate within the field, and we do not believe that their definition removes such ambiguity. On the contrary, communication between managers and researchers and the public would become all the more difficult if terms differentiating nuances are forced to be lumped into a few all-encompassing terms. Valéry et al. claim that "*arbitrary dichotomies […] inopportunely complicate the analysis of the phenomenon of biological invasions*". Yet, they are proposing a definition based on dominance and rapidity, both of which ironically provide a good illustration of arbitrary dichotomies imposed on continuous variables (relative abundance, population growth rate).

Valéry et al. also argue that the discipline should be abandoned because phenomena like invasion time lags are currently not predictable and are therefore nonsensical phenomena. On that ground, we should abandon a lot of ecological disciplines and concepts, and forever forgo trying to understand or predict any apparently idiosyncratic phenomenon.

As in any discipline of life sciences, there are several debatable frontiers to the discipline of Invasion Biology, including the requirement for impact (commonly used by policy makers), the role of human transportation and the inclusion or not of changes in distributional ranges due to climate change. Yet, these issues should be a matter of rational debate, not of dismissal of the discipline. Proposing to unify concepts, terminology, and fields may in some cases be commendable, but we see no reason to do this at the expense of a flourishing and fruitful discipline that has brought much to conservation and fundamental ecology. Hundreds of studies have demonstrated the usefulness of the discipline of Invasion Biology for community ecology and conservation science (see for example, Simberloff et al. 2013). It is a distraction to place such focus on the issue of cryptogenic or pseudo-indigenous species and as a result to suggest that we need severe disciplinary restructuring. Instead of ending Invasion Biology, scientists should continue to put their efforts into endeavouring to end harmful biological invasions.

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