Exotic effects of capital accumulation

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The accumulation of capital in Europe is strongly and positively associated with the accumulation of alien invasive species. In a study of the drivers behind biological invasions in Europe, Pyšek et al. (1) use European macroecological, economic, and demographic data to explain the variation in alien species richness of bryophytes, fungi, vascular plants, terrestrial insects, aquatic invertebrates, fish, amphibians, reptiles, birds, and mammals. They find only two significant explanatory variables of the stock of alien species: national wealth and human population density. They interpret these as proxies for the direct drivers behind invasions—propagule pressure along new pathways of introduction, along with the disturbance of both freshwater and terrestrial habitats.

The study is a timely and important contribution to our growing understanding of the role of economic activity in the dispersal of species beyond their natural range. It provides fresh evidence for the cumulative effects of anthropogenic stress along two axes. One is the role of trade in opening up new pathways and in developing the propagule pressure along existing pathways. The other is the role of the production of goods and services in native habitat disturbance and hence in the vulnerability of ecological systems to invasion. Just as interestingly, it also provides evidence of a less alarming kind—evidence that, where the threats posed by invasive species are high enough, they have been excluded.

The stock of wealth in any country is the cumulative effect of past investments and so is the best measure of a process that, in many countries, has deep historical roots. In Europe, current wealth reflects 2,000 y (and more) of efforts to build productive capacity—through pillage and plunder as often as through trade and investment. The net effect is a legacy of assets that bears the imprint of many sources, reflecting not just the ebb and flow of empires but the progressive integration of the global economic system. The latter process has been far from smooth, but it has been sure. Globalization means that few places have been untouched by world trade, and the European legacy carries the stamp of much of the rest of the world. As Pyšek et al. (1) show, that stamp includes an unrivaled collection of invasive species.

Recent analysis of the link between trade and biological invasions includes a number of economic studies on the relationship between the opening of new markets or trade routes and the introduction of new species and between the growth in trade volumes (the frequency of introduction) and the probability that introduced species will establish and spread (2–4). It has been shown that the volume and direction of trade are good empirical predictors of which introduced species are likely to become invasive (5, 6) and which countries are the most likely sources of particular species (7, 8). The second axis of anthropogenic stress, disturbance, is also well understood. Pyšek et al. (1) have elsewhere observed that, although some ecosystems are fundamentally more vulnerable to invasion than others, the vulnerability of all systems increases with fragmentation and disturbance (9). Direct habitat loss through land use change also affects the vulnerability of ecosystems to invasion (10).

There is, however, an important dimension of the problem that is not identified by analyzing what species are there. It is the effectiveness of efforts to exclude or eradicate harmful pests and pathogens. The movement of both goods and people is as strongly implicated in the spread of harmful species as it is in the spread of benign species. It is, for example, directly implicated in the emergence both of human diseases, such as H5NI (11), West Nile virus (12), and sudden acute respiratory syndrome (13), and a series of livestock diseases (14, 15). In all cases of this kind, however, the potential harm posed by the pest or pathogen has induced a response aimed at changing the likelihood of its introduction, establishment, and spread. The risk depends on both the likelihood of establishment and the resulting damage. Governments have undertaken measures to detect, intercept, eradicate, or control pests or pathogens, depending on their expectations of the harm they will cause. The risk reflects these measures (16).

Historically, Europe has been confronted by a long list of extremely harmful organisms. The bubonic plague introduced in the 14th century, for example, caused

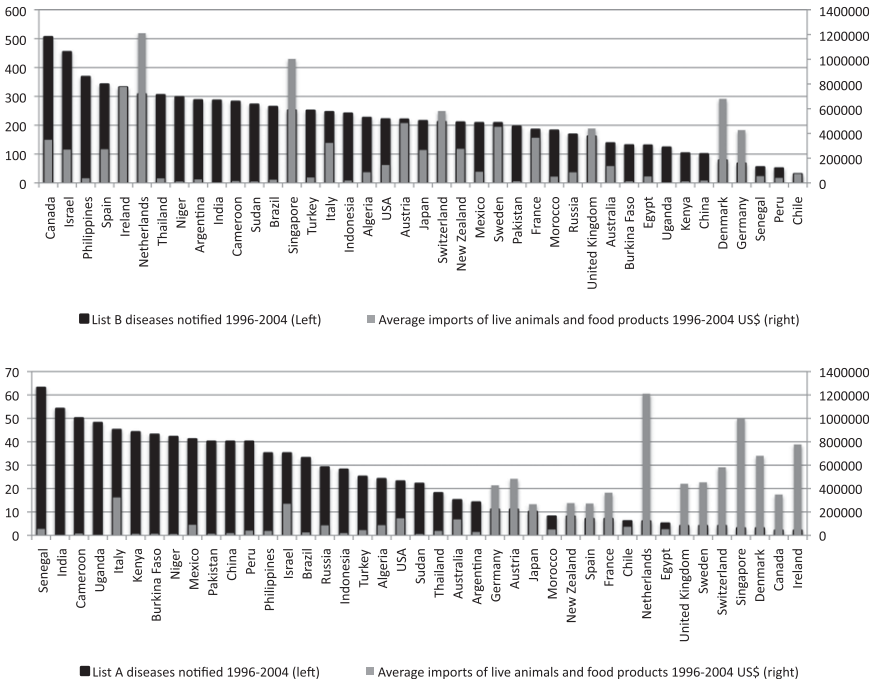

Fig. 1. Data on two categories of animal disease reported to the World Organization for Animal Health during the period 1996–2004. List B disease outbreaks (*Upper*) and list A disease outbreaks (*Lower*) are reported against the value of average imports of risk materials in the same period. Data are ranked by disease outbreaks. Sources: Disease outbreaks, World Organisation for Animal Health at http://www.oie.int/eng/info/en_infold.htm?e1d5. Trade volumes, Comtrade database at http://comtrade.un.org/db/.

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human populations to decline for more than 100 y, and for 300 y it was "normal" for outbreaks to kill up to half the population of infected cities. Although measures to limit the spread of the plague were of limited effectiveness, it is worth noting that this was the pathogen that led to the development of quarantine as a risk-minimizing measure (17). Pathogens that affect the production of crops or livestock have also had a significant and long-lasting effect. Rinderpest (cattle plague), for example, has historically been especially destructive. Three epidemics in the 18th century severely affected meat production in Europe, with mortality approaching 100% in immunologically naive populations. Bringing rinderpest under control has been a protracted process. Only now, more than a century later, has the disease been finally eradicated (18).

Williamson's "tens rule" reflects the fact that only a small proportion of established invasive species are harmful (19). However, observations based on the invasive species that remain after years of control are necessarily biased in favor of those species that have attracted the least attention. Because the effort that countries put into inspection, interception, eradication, and control depends on the potential value at risk and the resources available for these efforts, we would expect this effect to be greater in high-income countries than in low-income countries. In fact, harmful species introductions are frequently inversely related to income. Consider, for example, the animal diseases reported to the World Organization for Animal Health. Until recently, these were reported in two categories, with list A being more harmful and list B being less harmful (Fig. 1). Because animal diseases are dispersed through trade in animal products, outbreaks would be expected to be increasing in trade volumes. However, the number of introduced species that are undetected, established, and spread is reduced by the sanitary and phytosanitary efforts undertaken by countries. It has been found that, whereas list B diseases were increasing in imports of risk materials during the period 1996–2004, list A species were decreasing (20). Sanitary and phytosanitary controls outweighed the effect of increasing imports.

Biological invasions are frequently the unintended consequence of trade.

What accumulates with capital is a set of introduced species whose eradication is either infeasible or undesirable. In some cases these impose net costs, in others net benefits. In all cases, it is the residual after efforts to control the introduction, establishment, and spread of the most harmful species. The economic problem associated with the findings of Pyšek et al. (1) is not that the accumulation of capital in a globalizing world is, at the same time, the accumulation of exotic species. It is that the level of control exercised by both individuals and governments is less than it should be if all costs and benefits were taken into account. Biological invasions are frequently the unintended consequence of trade. The costs they impose are generally born by people other than those responsible for their introduction or spread, and the optimal level of control should ideally take those costs into account. Indeed, finding ways to reduce the burden of biological invasions associated with the closer integration of the global system is among the most pressing environmental problems we face today.

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