Chapter 9
The Establishment of Invasive Species

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9.1 Introduction

In the continuum of invasion phases, establishment stands at the interface between the initial introduction of propagules and the integration of the invader into the ecological community. Although the edges of this transitional phase tend to blur, invader establishment is generally related to the survival of initially-transported individuals to form reproducing and expanding populations, influenced both by the characteristics of the invader and the receiving ecosystem. In practice, however, it is often difficult to distinguish between the factors operating in the arrival and establishment phases, because most of the information available is for invaders that have successfully negotiated both and have survived to form conspicuous incursions (Chap. 7, Johnston et al.; Chap. 8, Miller and Ruiz). We often know relatively little about how many invasions fail, when they fail, and why.

9.2 Factors Influencing Numeric and Geographic Growth of Invasive Populations

Despite the often limited ability to distinguish between factors operating across invasion phases, it is likely that some of the traits that increase probabilities of successful transit, such as tolerance to harsh and variable environmental conditions, might also better equip invaders to survive and reproduce after their association with the vector. It is also likely, however, that different processes will be operating in the newly encountered ecosystem. In the preceding section, Johnston et al. (Chap. 7) and Miller and Ruiz (Chap. 8) began to address some of the traits that characterize successful invaders. In this section, Smith (Chap. 10) continues to develop the theme of individual characteristics increasing likelihood of invasion, treating phenotypic plasticity associated with both transit and species establishment.
The environmental characteristics to which species must respond can be broadly broken down into abiotic and biotic factors. In general, any successful invader must pass through the “abiotic filter,” representing the suite of physical and chemical properties in the receiving environment (Chap. 12, Olyarnik et al.). Understanding species tolerances and this abiotic filter informs efforts such as habitat- and climate-matching related to invasion success (e.g. Stachowicz et al. 2002; Stohlgren et al. 2005). In addition, there has been considerable discussion of how invaders respond to the quality of the environment, and there is often a noted propensity for invaders to do well in degraded or disturbed habitats. These relationships are discussed by Olyarnik et al. in this section (Chap. 12), as well as by Johnston et al. (Chap. 7) and Byers (Chap. 14) elsewhere in the book.

In order for incipient invasive populations to grow, they must also interact with biotic elements of their new ecosystem. For invaders that eventually become successful, this new ecosystem might be relatively benign if they leave their co-evolved predators and parasites behind during transit. This “enemy release hypothesis,” as well as the broader role of parasites in biological invasions, is reviewed by Torchin and Lafferty (Chap. 11). Another key factor influencing invader success is the resident species pool, either native or previously introduced, that new invaders must interact with. Olyarnik et al. (Chap. 12) review the topic of invasibility and how organisms affect it. This biotic resistance to invasion, influenced by such factors as species diversity and redundancy, has received much attention in recent years, given its roots in basic ecological theory. There is also a substantial practical benefit to understanding controls on invader success, in that it should allow us to manage systems so that they are more effective at intrinsically resisting invasions.

Once invaders have passed through abiotic and biotic filters, the dynamics of the establishment phase itself are one of the best studied aspects of invasion (e.g. Hengeveld 1989; Shigesada and Kawasaki 1997). The quantitative dynamics of increases in density and range, for example, has been an area of active and fruitful modeling. These build upon established concepts of population growth (e.g. exponential) and spatial spread (e.g. reaction-diffusion), with increasing complexities related to the dynamics of biological invasion. One establishment-related concept which remains somewhat vexing, however, is the prolonged lag sometimes noted between initial establishment and subsequent numerical and geographic growth of invasive populations (Kowarik 1995; Rilov et al. 2004; Crooks 2005). These modeling-related concepts are reviewed in more depth by Wonham and Lewis (Chap. 4).

References