Developing Models of Disease Transmission: Insights from Ecological Studies of Insects and Their Baculoviruses

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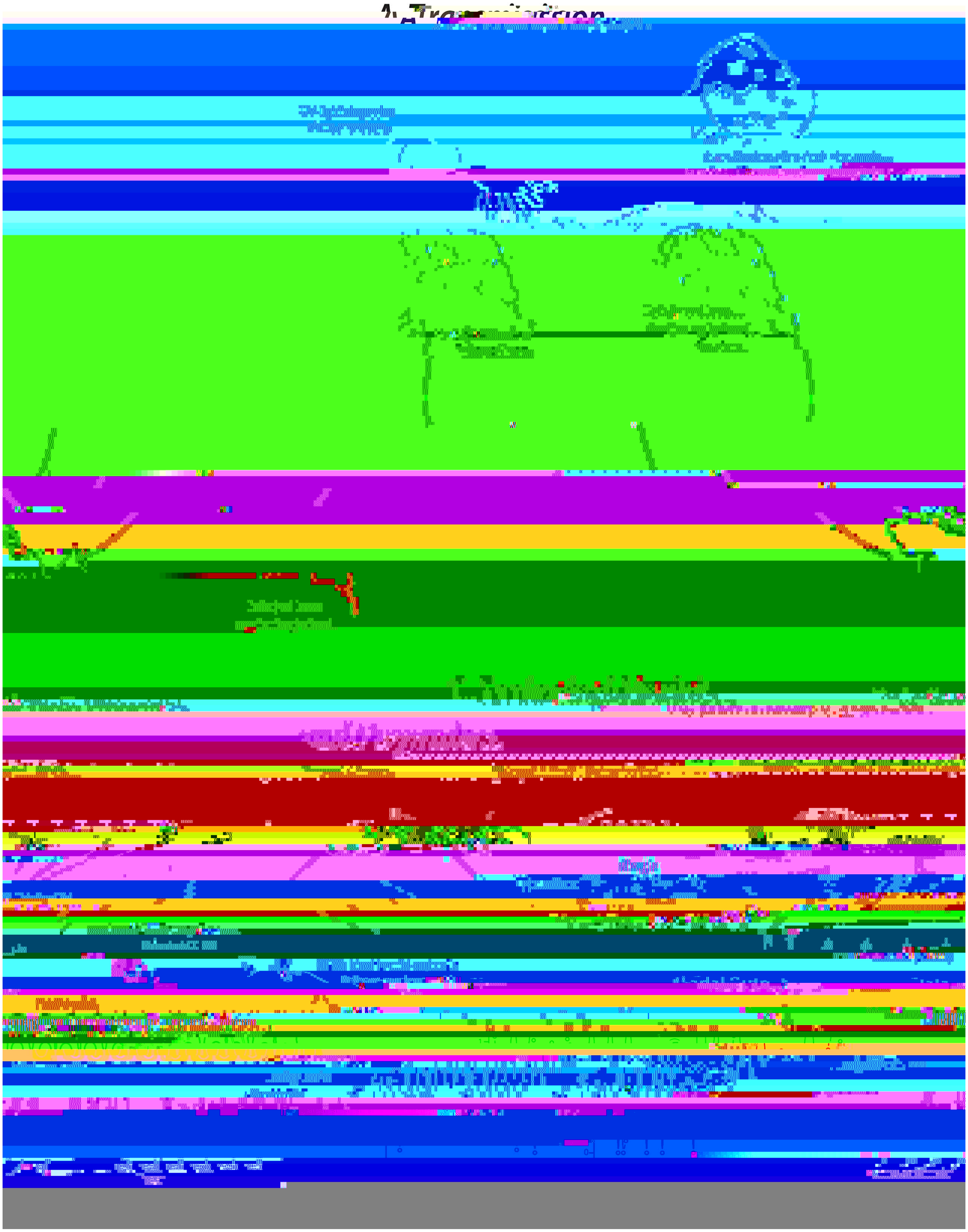

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plant species, such as oak trees, produce secondary compounds when eaten by insect herbivores that affect baculovirus infection rates [14], which can change the timing and intensity of an epizootic [15]. Additionally, predators play an important role in controlling the insect. Depredation of larvae and pupae by predators keeps populations at lower densities than would be expected if the virus alone determined the boom-and-bust cycles [7,16]. Interestingly, one of these predators, the white-footed mouse (*P*[illegible]), whose populations are enhanced by feeding on gypsy moth pupae, has been linked to increased incidence of Lyme disease due to its own boom-and-bust cycles [17]. In general, baculovirus transmission dynamics can be driven by both evolutionary and ecological processes, which may also be prevalent in other host-pathogen systems.

While a great deal of research has focused on the host, an epizootic, insight into how environmental change affects disease transmission and which mechanisms may be responsible for the changes observed can be easily gained.

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Control of insect pests of crops and forests has historically depended on the use of synthetic pesticides [27]. Bioinsecticides have emerged as a potential alternative to their chemical cousins, especially given the rise in organic agriculture and due to environmental concern [28]. In general, bioinsecticides vary in their effectiveness and host specificity. Some bioinsecticides are able to kill a broad range of insects, such as the common bioinsecticide *B* (Bt) [29]. However, broad range chemical or biological insecticides may be undesirable because beneficial insects may also be affected. Baculoviruses hold promise as a viable potential alternative since they have much narrower host ranges and many are species specific [12]. This comes with an important caveat: to date, little attention has been paid to evolution of host resistance or virus virulence when developing baculoviruses for biocontrol. The rapid decrease in virulence of myxoma virus in controlling introduced European rabbit (*O*) populations in Australia stands out as a cautionary tale of how evolutionary responses of the host and the pathogen render the virus essentially ineffective [30]. In general, the development of baculoviruses as an effective bioinsecticide or a biological control agent has met with mixed success [31,32]. Yet, given their potential, the development of these viruses for biological control is an active area of research that could lead to better management practices in both agriculture and forestry.

These relatively common viruses have been the focus of research efforts for over a century. This research has led to a deeper understanding of the causes behind some of the more dramatic population cycles in nature and has shown that pathogens can indeed control the populations of their hosts [4]. Research into the mechanisms driving host-pathogen dynamics has resulted in the development of disease transmission models with broad applicability [6]. Additionally, these viruses may even lead to reduced dependence on pesticides and enhanced agricultural production methods and may be a viable alternative to pesticide dependence [8]. Further research is needed, however, to translate breakthroughs in basic science into applications.

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