BIOLOGICAL CONTROL OF WILDLAND WEED PESTS IN HAWAI'I--IS IT A FEASIBLE SOLUTION?[1]

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The problem of aggressive exotic weed species invading native Hawaiian ecoysystems and overwhelming or out-competing endemic plants has been a recurrent one since man's arrival in these islands. The Polynesians brought with them the hau and the kukui, among others, which have since become widespread and abundant elements of the Hawaiian flora. These at least are plants which at the time were useful. Since the arrival of the Europeans, we have seen Hawai'i's forests invaded in successive waves by lantana (Lantana camara), the guavas (Psidium guajava and P. cattleianum), rose myrtle (Rhodomyrtus tomentosa), the firetree (Myrica faya), blackberries (Rubus spp.), melastoma (Melastoma malabathricum), banana poka (Passiflora mollissima), Koster's curse (Clidemia hirta), and New Zealand tea (Leptospermum scoparium), to mention a few of the more obnoxious species. Several of these are still rapidly extending their ranges and some, such as banana poka and Koster's curse, appear to be causing the rapid decline and disappearance of elements of the endemic flora in those areas which they have invaded. I am sure that the botanists could name additional species which invaded wildland ecosystems within the past few decades, and I am almost certain that we will be seeing other species, which are not yet considered to be problems, developing into serious pests in the future.

Biologists concerned with the preservation of native Hawaiian ecosystems and the individual elements thereof, are faced with a serious dilemma. The cost of physically or chemically removing or killing invading weed species which threaten native ecosystems is generally prohibitive, given the budgetary limitations under which most of us must operate, and excepting incipient infestations which involve relatively small and accessible areas. Furthermore, physical and chemical methods often have undesirable side effects such as the inadvertent destruction of native plants. Also, such methods are rarely 100% effective, which means that within a few years the treated area, in all probability, will have been reinvaded from adjacent untreated

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1 Published with the approval of the Director of the Hawaii Agricultural Experiment Station as Journal Series No. 2249.

lands; or a few surviving plants, or their seeds, will have reestablished the weed infestation. In most situations, it seems to me, the application of physical methods or herbicides to combat well-established aggressive weed species in Hawaiian wildland ecosystems is, in the long run, doomed to failure. I believe that the biological method of control offers a practical alternative to physical and chemical methods which can be successfully utilized against many of the weed pests in Hawai'i which compete with native plants.

It has been repeatedly observed that in those areas in which they are endemic, plant species which have become aggressive weeds in Hawai'i are, in general, relatively minor and innocuous elements of the floras in which they occur. Thus, in Mexico, the exploratory entomologist Albert Koebele found Lantana camara occurring only sparingly as scattered shrubs, but not in continuous stands (Perkins & Swezey 1924). Similarly, it has been stated that in tropical America Passiflora species, such as P. mollissima, occur primarily as scattered individuals in forest environments, not as overwhelming canopies (Gilbert, pers. comm.).

There is an increasing body of evidence that, in many instances, the distribution and abundance of a particular plant species is determined not only by parameters of the physical environment and by competition from other plants, but also by the predators and parasites which feed upon it (i.e., herbivorous animals and pathogenic microorganisms). In the case of tropical passion vines, for example, Gilbert (1975) has shown that heavy herbivore pressure from the larvae of Heliconius butterflies has resulted in the hyperdispersion of Passiflora populations in Central American forests. Furthermore, in the case of many, perhaps most, phytophagous arthropods and plant diseases, long coevolution between the plant and its natural enemies has resulted in highly specific host/herbivore and host/parasite relationships.

When a potential weed species is brought to Hawai'i, usually in the form of seed, it leaves behind virtually all of these specific types of associated arthropods and disease organisms. Thus, freed from the constraints exercised by these specific natural enemies, it is able to flourish and reproduce far beyond what would be possible in those areas where it is endemic, outcompeting and overwhelming native species which bear their own burdens of specific native herbivores and parasites.

The classical biological control strategy for combating an introduced pest organism, be it arthropod or weed, involves seeking out natural enemies of the pest in those areas where it is endemic, and establishing these in areas which the pest has invaded. The method has worked extremely well against several very serious range and pasture weeds (e.g., Opuntia spp. in Australia and Hawai'i; Hypericum perforatum in Australia and California; Lantana camara in several tropical areas, including Hawai'i). Lantana, although it cannot be said to have been completely controlled in all situations in Hawai'i, is today, with

15 species of introduced insects established on it, under a great deal of herbivore pressure which did not exist prior to these introductions, and is far less prevalent than it was at the turn of the century (Perkins & Swezey 1924).

I believe that the reason why the majority of the serious weeds which affect native ecosystems in Hawai'i have not been brought under biological control is simply that, for most of them, little or no effort has yet been expended. Work which has been done on controlling Lantana and Clidemia, was directed at these species primarily as range pests; hence the natural enemies best suited to control these species in non-rangeland ecosystems may still be undiscovered.

A major concern, often expressed by biologists and non-biologists alike, is that organisms which are imported for biological control of weeds will themselves become pests by attacking economic plants, ornamentals, or elements of the native flora. Careful research and testing carried out in the areas of origin, and under quarantine at the destination, can almost completely eliminate this possibility. About 40 species of phytophagous insects have been successfully introduced into Hawai'i to combat weeds since this phase of biological control was initiated in 1902. Of these, one of the earliest introductions, made before adequate procedures for testing candidates for introduction had been developed, became a very minor pest of eggplant, and another, also among the first introductions, has twice been reported feeding on a native tree (Myoporum). These are the only exceptions I know of to an otherwise unblemished record. The generally high degree of host specificity which is characteristic of many phytophagous arthropods and disease organisms, plus the fact that many of the important forest weeds have no close relatives among the endemic flora, reduces the chance of unforeseen host transfer by well selected biological control organisms to the realm of a remote possibility. Even in the case of a weed such as banana poka, where a member of the same genus is a food plant of minor economic importance, there is still a good possibility of achieving biological control without materially affecting commercial passion fruit production. Species-specific insects or diseases may exist which will not affect the cultivated passion. Furthermore, ecological isolating mechanisms may exist which would prevent species introduced to combat a wildland weed from attacking a related crop plant growing in an agricultural or urban environment. Thus, among Heliconius the specific ecological and host requirements (i.e., ovipositional stimuli) of the adult butterflies limits their oviposition to specific Passiflora species within certain forest environments, even though the larvae themselves may be capable of feeding on other species of Passiflora.

In the case of weeds such as the introduced grasses which grow in environments similar to those of native grasses, or the introduced Rubus species which may occupy habitat similar to that of the endemic R. hawaiiensis, there is perhaps less chance of achieving satisfactory biological control without some damage to

the native flora, although the possibility of finding phytophagous forms with a sufficiently high degree of host specificity still exists. For example, the various species of smut fungi which attack grasses usually are highly host specific.

The biological method of weed suppression is, of course, no panacea. Even in the most successful programs the target weed remains present in the environment, although reduced to the status of a relatively minor element of the flora, limited to those special sites where it can survive and compete successfully despite the pressure of its introduced natural enemies. However, barring some major ecological upset, control, once achieved, is permanent and self-perpetuating. In achieving control we will have added some additional elements to the total biota, even though these elements are restricted to close association with the target weed. These consequences must be accepted if a biological control program is to be undertaken.

To me, the choice, with respect to many of our more aggressive wildland weeds, is obvious. Either we opt for biological control, or we accept the fact that there is no economically feasible control available. I believe that biological control is an acceptable, and perhaps the only practical alternative for controlling many of the more serious wildland weed pests in Hawai'i.

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