VII.9 Use of an Australian Parasite of Grasshopper Eggs as a Biological Control Agent

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Introduction

In order to increase the existing mortality level of any pest grasshopper, entomologists are generally limited to two biological control approaches: augmentation or introduction. In the former, some parasite or predator species must be reared in great numbers and distributed evenly over the crop or rangeland to be protected. The augmentation process must be repeated year after year as needed. In the introduction approach, a parasite or predator species, from outside of the system, is imported and colonized, with the intention of obtaining permanent establishment of the natural enemy. Ideally, the natural enemy species would be colonized only once and would spread and distribute itself once established.

Augmentative Approach

In my opinion, using insect parasites or predators augmentatively, as substitutes for chemical insecticides, is not feasible for the control of grasshoppers. The chief obstacle to this approach is the cost. Although certain *Scelio* egg parasites can be reared easily in the laboratory, the rearing process is dependent upon a constant supply of live grasshopper eggs of a certain age. Considering the immense areas that would require treatment with parasites, plus the logistics of rearing and delivery, it is certain that the costs of using *Scelio* wasps augmentatively would be unacceptable.

Classical Introduction Approach

Historical.—According to a worldwide review article by Prior and Greathead (1989), classical biological control of a grasshopper with scelionid wasps has been attempted on only one occasion. The attempt was made in Hawaii, during 1930 and 1931, against the Chinese grasshopper, *Oxya chinensis* (Thunberg), using two parasite species from Malaysia, *Scelio serdangensis* Timberlake and *S. pembertoni* Timberlake (Pemberton 1933, Clausen 1978). *Scelio serdangensis* failed to establish, but *S. pembertoni* became established and is reported to have successfully controlled the pest (Pemberton 1948, Clausen 1978). As pointed out by various authors (Commonwealth Institute of Biological Control 1981, Siddiqui et al. 1986, Greathead 1992), the possibilities for classical introductions against grasshoppers certainly have not been exhausted, particularly with scelionid egg parasites. Worldwide in distribution, the species of the genus *Scelio* are all egg parasites of acridid grasshoppers and there are no host records from any other group of insects (Greathead 1963, Muesebeck 1972, Galloway and Austin 1984).

Rationale for Classical Introduction.—Although there are several native *Scelio* spp. present in western North America, they cause only minor levels of egg mortality. The most abundant and most widespread of our native egg parasites is *Scelio opacus* (Provancher). During an 8-year study in Wyoming, Lavigne and Pfadt (1966) found only trace numbers of *Scelio* parasites in rangeland grasshopper eggs. Results of a long-term study in Saskatchewan (Mukerji 1987) showed that egg parasitism by *Scelio* averaged about 5 percent and had no detectable impact on field populations. In my own field studies in northeastern Montana and northwestern North Dakota from 1988 to 1994, egg-pod parasitism by native *Scelio* spp. averaged 10.7 percent (Dysart 1995), but parasitism of individual eggs was only 4.1 percent (Dysart 1994 unpubl.).

Although the ecological niche is occupied by several native parasites, their total impact on the eggs of pest grasshoppers probably does not affect infestations. Therefore, in 1989, I proposed to the Animal and Plant Health Inspection Service (APHIS) that I try to import and establish an additional species of *Scelio.* If this new parasite became established on one or more of the destructive grasshoppers in the West, it could increase egg mortality and thereby reduce initial densities of nymphs. That scenario could greatly enhance the probability of other indigenous (native) natural enemies maintaining suppression of pest grasshopper densities at or below economic thresholds for greater time intervals.

Periodic outbreaks probably would not be eliminated, but the interval between them might be lengthened or the duration of outbreaks might be shortened. Introduction of exotic parasites to help control indigenous pests is controversial, but as pointed out by Huffaker et al. (1971), there is no pest that should be judged in advance as not amenable to biological control. A good review article on this subject is presented by Carl (1982).

Search for a Candidate *Scelio* in Australia.—In September 1990 and again in 1992, my Australian colleagues and I collected egg-pods of several different grasshoppers and locusts at 10 localities in the States of New South Wales, South Australia, and Western Australia. In September 1992, we made collections in 11 different localities in the same states. A summary of these collections is found in Dysart (1993 unpubl.) and in Baker et al. (in press). In 1990, overall parasitism of egg-pods by *Scelio* spp. was 28 percent (128 of 460 egg-pods), but was highest (36 percent) in Western Australia (66 of 181 egg-pods). During 1990, *Scelio parvicornis* Dodd was the most abundant parasite of the five species reared, and at one locality, Nungarin (Kittyea ranch), in Western Australia, it parasitized about 25 percent of the host egg-pods (Australian plague locust, *Chortoicetes terminifera* [Walker]). Two articles, Baker and Pigott (1993) and Baker et al. (in press), provide additional parasitism and host-range information on *S. parvicornis.* The egg-pod parasitism figures from Australia are considerably higher than those reported above for western North America.

Quarantine Screening in the United States.—Grasshopper egg-pods collected in Australia were kept chilled and were hand-carried to the Montana State University quarantine facility in Bozeman. There the eggs were allowed to hatch, and all Australian grasshopper nymphs were identified and then destroyed. Of the five species of *Scelio* that emerged from the 1990 collections, we investigators selected *Scelio parvicornis* (Nungarin strain) as our primary candidate, based on its dominant position in the Australian collections and its ease of rearing in the quarantine laboratory.

Rearing and Host-Range Tests.—Using nondiapausing eggs of a native pest grasshopper, *Melanoplus sanguinipes* (Fabricius), as hosts, my research team was able to propagate a nondiapausing culture of *S. parvicornis* in the laboratory. Under our lab conditions, we produced a new generation of parasites about every 32 days. In laboratory comparison tests with the native *S. opacus,* females of the Australian *S. parvicornis* were clearly superior: they parasitized more egg-pods and killed more eggs during their respective lifetimes (Dysart 1991 unpubl.). In laboratory host-range tests, we exposed the Australian parasite to about 1,808 egg-pods of 49 species of North American grasshoppers. We obtained emergence of adults of *S. parvicornis* from 33 species, and it failed to emerge from egg-pods of 16 grasshopper species (Dysart 1993 unpubl.). About half of the 33 successful lab hosts of *S. parvicornis* are considered to be our most serious rangeland pests (Hewitt 1977) (see also chapter VI.6).

Plans for Field Releases and Recovery Attempts.— Assuming that permission to release parasites was granted by the Federal and State authorities, I had planned to proceed as follows: colonies of several thousand adult parasites would be released over a period of several weeks at one or more sites in Arizona, Montana, and North Dakota. Prior to releases at proposed sites, screened cages would be erected on sandy soil and furnished with wild female grasshoppers *(M. sanguinipes).* After egg-laying was well under way, adult parasites would be introduced into the cages. The cages would be removed the following spring, and during the next two seasons, egg-pods would be excavated at the site and held for emergence in the laboratory to determine if the Australian parasite had successfully overwintered. If *Scelio parvicornis* is released and becomes established, it will be necessary to conduct additional field studies to assess its impact on pest grasshopper populations.

Addendum.—I made my initial request to U.S. Department of Agriculture, APHIS, Plant Protection and Quarantine, Biological and Taxonomic Support (USDA, APHIS, PPQ, BATS) for permission to release *Scelio parvicornis* in the summer of 1991. Periodically during 1992 and 1993, I provided BATS with revisions and support documents as they continued to prepare their risk assessment (Lakin 1994 unpubl.). The question of whether or not the Australian parasite should be released in North America has been the subject of active debate in the literature, between Lockwood (1993a and b) and Carruthers and Onsager (1993). Lockwood is opposed to the field release of the parasite because he feels that its potential host range is too broad, and he speculates that it might have a detrimental effect on benign, nonpest grasshoppers as well as a few grasshoppers thought to be beneficial because they feed on rangeland weeds. Carruthers and Onsager believe that the release of the Australian egg parasite is warranted and that the risk of harm to nontarget species is negligible at best.

On April 6, 1994, I received word from the permitting agency, USDA, APHIS, PPQ, BATS, that my application for the release of *Scelio parvicornis* had been denied. As a result, I have destroyed the laboratory colony and have abandoned my plans for field releases of the parasite. I still believe that the overall benefits of the proposed biological control introduction would outweigh any potential risks, but for the time being, the outcome will remain a matter of conjecture.

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