PROSPECTS FOR BIOLOGICAL CONTROL OF ALFALFA WEEVILS* IN CALIFORNIA

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There is particular irony in today's Egyptian alfalfa weevil crisis because it didn't have to happen. By this I mean that the crisis could have been prevented by an intensive biological control program in the early stages of the pest's residence in California, particularly before it gained a strong foothold in the Central Valley.

Those of us who have worked with alfalfa weevils over the years, knew what would happen if Hypera-brunneipennis invaded the Central Valley, and we knew that such an invasion was inevitable. In the middle 1960's when it became apparent that the weevil populations in the Northern Sacramento Valley and the Porterville area of the San Joaquin Valley, were those of H. brunneipennis, Carl Koehler and I submitted a weevil "White paper" to University administration. In this paper we predicted the development of a major problem and pled for significantly increased financial support to intensify our weevil control research. I do not doubt that the brass recognized the seriousness of the problem, but the University had just entered an era of unprecedented fiscal austerity and our plea was met with a minuscile dollar droplet which evaporated after one year. The alfalfa industry was of no help either. We tried to make a pitch for support but met with complete frustration because the alfalfa growers have no overall organization through which to assess themselves and dispense emergency research funds. And, of course, as long as the problem hadn't surfaced it probably appeared as though we were just trying to hustle a few bucks by pressing the panic button. Well, the predicted crisis came and all that can be said about our efforts to forestall it is that we were pretty good prophets. And even that minor satisfaction pales in the shadow of the staggering economic and ecological havoc caused by the weevil. However, we are stubborn folks and despite the history of budgetary anemia we have continued to pick away at the weevil problem even though it has been like throwing dust into the teeth of a buffalo stampede.

This report, then, tells what has been done, what is being done, and what is planned for the alfalfa weevil biological control program in California.

Past Activities

Biological control efforts against alfalfa weevils in California date back to the 1930's when the parasitic wasp, Bathyplectes curculionis (Thoms.) was successfully introduced into the lowland central part of the State against the newly invading alfalfa weevil (Hypera postica). This program was an outstanding success; B. curculionis devastated the weevil in the San Francisco Bay area and Livermore Valley and strongly suppressed it in the northwestern San Joaquin Valley (Michelbacher, 1943).

In the case of the Egyptian alfalfa weevil, biological control efforts were initiated soon after its discovery in the Yuma Valley in the late 1930's. At that time B.curculionis obtained from the Salt Lake Valley of Utah, was released on the developing H. brunneipennis populations. B. curculionis is an old world species which had been successfully colonized on the alfalfa weevil in the Great Basin in the early part of the present century. Its introduction into the Yuma Valley was a success, in the sense that it became established there on H. brunneipennis. Later as the weevil spread into the Imperial Valley and to coastal Southern California B. curculionis moved along with it.

B. curculionis also occurs on the Egyptian alfalfa weevil in the Central Valley, presumably having moved over to H. brunneipennis from its historical host the alfalfa weevil. But no matter where it attacks H. brunneipennis in California, B. curculionis has had little impact on the weevil. There appear to be two major reasons for this, (1) the adverse effects of the hot, dry interior California climate on the parasite and (2) the loss of a substantial portion of the B. curculionis eggs to haemocytic (blood cell) encapsulation in parasitized H. brunneipennis larvae.

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*Alfalfa weevil, Hypera postica (Gyll), and Egyptian alfalfa weevil, Hypera brunneipennis (Boh.).

The matter of climatic inhibition is really not very well understood. A. E. Michelbacher who studied B. curculionis following its introduction against the alfalfa weevil, commented that the parasite did not perform as well in the San Joaquin Valley as in the coastal area because the "climate of the weevil-infested region in the San Joaquin Valley does not seem to be so well suited for the weevils activity" (Michelbacher 1943). He did not specify what the inhibiting conditions are but in all probability the most unfavorable conditions must be those which occur when the cocooned diapausing parasites are subjected to extremely low humidities and intense heat following the summer-time alfalfa mowings.

There is a good possibility that the adverse effects of encapsulation and climate on B. curculionis will be reduced as time passes. For one thing, the parasite appears to be overcoming encapsulation through natural selection as is evidenced by the low incidence of encapsulation in San Diego County (Salt and van den Bosch, 1967). Large numbers of these "adapted" B. curculionis have been colonized in the Sacramento and San Joaquin vallies by University entomologists. As for climatic inhibition of B. curculionis, it is hoped that this problem can be overcome by the colonization of adapted strains of the parasite obtained from hot arid areas of the Middle East. To this end, limited numbers of Egyptian and Iranian ecotypes of B. curculionis have already been colonized in California and more intensive colonizations are planned for the future.

But even if its future performance is more efficient, it is doubtful whether B. curculionis, by itself, can effectively control H. Brunneipennis in many if not most of California's alfalfa growing areas. Additional parasite species are needed, and fortunately these are available. In fact, in recent years several of these species have been colonized in California. These parasites and the numbers that have been colonized are listed in Tables 1 and 2.

Status of Recently Imported Parasites

In the early and mid 1960's, European ecotypes of several of the alfalfa weevil parasites were heavily colonized in California, particularly in the southern part of the state. None of these was ever recovered from the field, which probably reflects the poor adaptation of the European strains to California conditions. The failure of the European ecotypes led us to shift emphasis to the importation of strains from the Middle East. As a result, colonizations of alfalfa weevil parasites in California over the past five years have been predominantly of Middle Eastern strains.

The following discussion of the several parasite species reveals that this shift in policy is beginning to have positive results.

Dibrachoides druso

This parasite was obtained from Southern Iran in 1960, and heavily colonized in Southern California over the ensuing several years. Among the middle eastern parasites, D. druso is the only species considered to be definitely established. This is based on a survey conducted in 1968 which showed it to be widely active in San Diego County six years after colonization had been terminated (Gonzalez et al., 1969). This species is not an important enemy of alfalfa weevils in the Old World, and its performance so far in California does not indicate that it will be of great significance here. However, it takes its toll and although this is quite low, it represents weevil mortality that did not previously occur in California.

Bathyplectes anurus

This species has been recovered from the field at three localities, Albany, Contra Costa County, Salinas, Monterey County and Sanger, Fresno County. At present the parasite seems to have gained its strongest foothold at Albany since it was recovered in goodly numbers there in both 1970 and 1971. However, the Albany population was not monitored in 1972 and thus it is not known whether B. anurus has spread from the colonization site (a small alfalfa field on the University's Gill Tract) or even retained its foothold. The Salinas recovery was of a single cocoon in 1971 and that at Sanger of two cocoons in 1972.

A large series of recovery collections made during 1972 is still being processed and

thus it is yet too early to report whether B. anurus has been recorded from any other areas of California. It should be noted here that B. anurus is a univoltine species, that is, it has but a single generation each year. This means that its increase following establishment at any given locality will be slow, with a strong upsurge occurring only after a lapse of several years. For this reason the recoveries at Salinas and Sanger are of greater significance than the small numbers would indicate. If, indeed, the parasite is established at these places it could well erupt in a population explosion within a few years. Hopefully, if enough establishment foci can be created a pattern of such population explosions will ensue, assuring the rapid rise of B. anurus to major status as a parasite of alfalfa weevils in California.

The creation of widely scattered B. anurus establishment foci, then, is our basic strategy with this species.

Tetrastichus incertus

This species which was imported from Iran, has been the most heavily colonized of the alfalfa weevil parasites. It became very abundant in the Albany alfalfa field in the autumn of 1970, when peak parasitization rates of approximately 70 percent were recorded on several occasions. However, the parasite was not recovered from samples taken in the spring of 1971, and since no sampling was done in the autumn of that year or the spring of 1972, its status is currently somewhat of a mystery. We are now attempting to assess the situation to determine whether T. incertus has maintained itself at Albany but at this time there is nothing to report. No recoveries of T. incertus have been made outside Albany, but this negative record is largely meaningless because prior to 1972 there had been no attempt to mount a serious recovery effort, and the extensive 1972 samples have not yet been processed.

Other parasite species

No serious effort has yet been made to recover, Microctonus aethiops, M. colesi, the Iranian Bathyplectes curculionis and B. stenostigma, consequently there is nothing to report on their status.

The Future

I opened this discussion with the statement that today's Egyptian alfalfa weevil crisis could almost surely have been prevented by an intensive biological control program in the early stages of the pest's residence in California. In light of what I have since reported this perhaps appears to have been a rather rash statement. Nevertheless, I stand by my earlier words and will invoke a bit of history and observation to support my obstinacy.

The history to which I allude is that of the successful biological control of the alfalfa weevil, first in lowland Central California and more recently along the eastern seaboard (U.S.D.A., 1970). The observations are those of University entomologists on parasites of alfalfa weevils in the Old World. I have particularly in mind, Bathyplectes anurus and Microctonus aethiops both of which heavily attack alfalfa weevils over wide areas of the Middle East. For example, in my own surveying in Iran I often found B. anurus to be the dominant parasite of alfalfa weevil larvae. In several places parasitization by this species exceeded 80 percent.

A similarly high level of parasitization by Microctonus aethiops (approximately 70 percent) was recorded in the area from which our colonization stock of this wasp was obtained in Iran. The climates of the central plateau of Iran and its surrounding mountains virtually duplicate those of California's Central Valley and intermountain area. And so, we can assume that both B. anurus and M. aethiops along with appropriate strains of B. curculionis will find our interior climates to their liking. If they even approach their performance in Iran and other areas of the Middle East they should, in time, become important natural enemies of both the alfalfa weevil and Egyptian alfalfa weevil in Central and Northern California and along the coastal plain of Southern California. Their future performance in the extremely hot southern desert vallies is somewhat dubious, but even here we can perhaps plug the loophole with climatically adapted parasite strains from the hot lowlands of Iraq and Iran and from the Nile Delta.

The speed with which maximum effect from these introduced natural enemies can be attained will depend directly upon the intensity of the colonization program. If we were to massively colonize these species in all weevil affected areas, significant biological control might be realized in as little as three to five years. But if we are forced to dawdle along at our current pace, the moment of full parasite impact will be greatly delayed. I am convinced that we have the natural enemies to break the back of Egyptian alfalfa weevil and for that matter the alfalfa weevil too. Thus, anything short of a maximum biological control effort will simply be an economic and ecological tragedy. But I can perceive no developing miracle that will enable us to mount a crash program. And so it seems that we are fated to watch the weevils chew, and suffer the stench of organo-phosphate insecticides while the dollars dribble away and the environment bleeds just a little bit more.

Table 1. Parasites of Alfalfa Weevils Colonized in California

Host stage affected	Parasite	Status
Egg	Patasson sp.	not established
	Peridesmia discus (Walk.)	not established
Larva	Bathyplectes curculionis (Thoms.)	widely established
	B. anurus (Thoms.)	locally established
	B. stenostigma (Thoms.)	not yet assessed?
	Tetrastichus incertus (Ratz.)	locally established?
Pupa	Dibrachoides druso (Walk.)	well established in coastal Southern California
Adult	Microctonus aethiops (Nees)	not yet assessed
	M. colesi Drea	not yet assessed

Table 2. Numbers of Parasites Colonized Against Alfalfa Weevils in California during recent years--(1967-72)

Parasite	Numbers colonized	Counties where colonized
Bathyplectes curculionis (Iranian strain)	294	Glenn, Fresno, Monterey, Riverside, Siskiyou.
B. anurus (Iranian strain)	1,191	Alameda, Contra Costa, Fresno, Lassen, Modoc, Monterrey, Riverside, Siskiyou, Yolo.
B. stenostigma (European strain)	49	Alameda
Tetrastichus incertus (Iranian strain)	227,896	Alameda, Butte, Colusa, Contra Costa, Fresno, Glenn, Kern, Lassen, Madera, Modoc, Monterey, Placer, Plumas, Sacramento, San Diego, San Joaquin, Sierra, Siskiyou, Shasta, Stanislaus, Sutter, Tulare, Yolo.
Microctonus aethiops (Iranian strain)	4,853	Alameda, Fresno, Lassen, Modoc, Tulare, Yolo.
M. aethiops (European strain)	1,461	Alameda, Lassen, Sierra, Shasta
Microctonus colesi (New Jersey strain)	64	Alameda, Siskiyou

References

Gonzalez, D., R.van den Bosch and L. H. Dawson. 1969. Establishment of Dibrachoides druso on the Egyptian alfalfa weevil in Southern California. Jour. Econ. Entomol. 62: 1320-1322.

Michelbacher, A. E. 1943. The present status of the alfalfa weevil in California. Calif. Agr. Expt. Sta. Bull. 677. 24 pp.

Salt, G. and R. van den Bosch. 1967. The defense reactions of three species of Hypera (Coleoptera, Curculionidae to an ichneumon wasp. Jour. Inv. Pathol. 9: 164-177.

U. S. Dept. Agr. 1970. A biological control triumph--wasps vs. alfalfa weevils. Agr. Res. U.S. Dep. Agr. 1833-4.