BIOLOGICAL CONTROL **13,** 101–110 (1998)
ARTICLE NO. BC980644

Biology of *Mozena obtusa* (Hemiptera: Coreidae), a Candidate for the Biological Control of Mesquite, *Prosopis* spp. (Fabaceae)

J. P. Cuda[1] and C. Jack DeLoach

U.S. Department of Agriculture, Agricultural Research Service, 808 East Blackland Road, Temple, Texas 76502

Received July 11, 1997; accepted May 23, 1998

The leaf-footed bug *Mozena obtusa* Uhler is an important natural enemy of honey mesquite, *Prosopis glandulosa* Torrey var. *glandulosa*, in the southwestern United States and northern Mexico. The nymphs and adults severely damage mesquite by feeding on new vegetative and reproductive growth. The temporal distribution of all life stages indicated that *M. obtusa* has five nymphal instars and is bivoltine in central Texas. In the laboratory, the generation time for *M. obtusa* on honey mesquite was ca. 70 days: 12.7 days for the egg stage, 32.7 days for the nymphal stage, and a preovipositional period of 24.7 days. Adult longevity was ca. 167 days for females and 144 days for males. Females produced an average of 510 eggs in 39 masses with 13 eggs per mass during their lives. *Mozena obtusa* also developed normally on the Argentine vinal, *Prosopis ruscifolia* Grisebach, although the nymphal stage was longer (49.5 days). In the field, a complex of hymenopterous egg parasitoids [*Anastatus semiflavidus* Gahan (Eupelmidae), *Ooencyrtus johnsoni* (Howard) (Encyrtidae), and *Gryon atrum* Masner (Scelionidae)] and the tachinid fly *Trichopoda pennipes* F. appeared to be the principal biotic mortality factors regulating populations of *M. obtusa*. Parasitism of all life stages of *M. obtusa* was found to be 40%. Because it has the potential to significantly reduce seed production, this insect may be a good candidate for introduction into other countries for classical biological control of mesquite (*Prosopis* spp.) providing host range tests demonstrate that it does not damage beneficial or nontarget plant species. © 1998 Academic Press

***Key Words: Mozena obtusa; Prosopis;* mesquite; natural enemies; *Anastatus semiflavidus; Ooencyrtus johnsoni; Gryon atrum; Trichopoda pennipes;* classical biological control.**

INTRODUCTION

Mesquites, *Prosopis* spp., (Fabaceae) are thorny leguminous trees or shrubs that are considered weeds in many parts of the world. In southwestern United States, for example, the native honey mesquite, *Prosopis glandulosa* Torrey var. *glandulosa*, western honey mesquite, *P. glandulosa* var. *torreyana* (Benson) Johnston, and velvet mesquite, *P. velutina* Wooton, presently infest over 39 million ha and are responsible for losses to the livestock industry in excess of $200 million annually (DeLoach, 1985). Historical evidence suggests these native plants have become weedy primarily as a consequence of the introduction and improper management of grazing livestock by western man, the suppression of range fires, and periodic droughts (Buffington and Herbel, 1965). Carbon dioxide enrichment of the atmosphere during the last century may also have contributed to the mesquite problem (Mayeux *et al.*, 1991; Johnson *et al.*, 1993).

Apart from the situation in North America where the native species of *Prosopis* have become noxious as a result of environmental or habitat changes, these same species have also become invasive weeds following their intentional introduction into other parts of the world as shade trees, source of fuelwood, and food for livestock (Neser and Moran, 1985; Panetta and Carstairs, 1989; Parsons and Cuthbertson, 1992; Zimmermann, 1991; 1995). The cause of weediness in these situations is the lack of natural enemies in the areas of introduction compounded by disturbances and other habitat changes due to poor rangeland management.

Although many native insect species attack honey and velvet mesquite in North America (Ward *et al.*, 1977), these woody plants have not been effectively held in check by the existing natural enemy complex. Consequently, DeLoach (1985) reviewed an extensive body of literature to determine the feasibility of classical biological control of mesquite in North America. The rationale for this approach is that chemical and mechanical control methods are not cost effective in southwestern rangelands where the production per unit area is low, the herbicides used to control woody species may contaminate the environment, and the cost for augmenting populations of the indigenous natural enemies in rangeland ecosytems is prohibitive (DeLoach *et al.*, 1986; Cuda, 1988). Cordo and DeLoach (1987) surveyed

[1] Present address: University of Florida, Gainesville, FL 32611-0620.

1049-9644/98 $25.00
Copyright © 1998 by Academic Press
All rights of reproduction in any form reserved.

the insects that attack southern South American mesquites and found at least 15 promising biocontrol species. The theoretical and practical aspects of classical biological control of mesquite and other native weed species in the United States have been thoroughly reviewed by DeLoach (1978; 1981b; 1985; 1995).

Before introducing exotic insects into the United States for classical biological control, conflicting interests over the beneficial and harmful aspects of mesquite must be resolved (DeLoach, 1985). Furthermore, the biology and impact of the most damaging insects attacking mesquite in North America must be determined. Such information will facilitate the selection of foreign organisms that would best complement the impact of the native species to halt the spread of mesquite or reduce the density of the mesquite stands. In addition, these North American insect species could become candidates for introduction into other countries where mesquite has been introduced without its natural enemy complex, especially South Africa (Neser and Moran, 1985; Zimmermann, 1991; 1995) and Australia (Panetta and Carstairs, 1989; Parsons and Cuthbertson, 1992).

We have investigated the biologies of several lepidopteran foliage feeders and their impact on mesquite in Texas (DeLoach, 1981a; 1982; 1983a,b; Cuda *et al.*, 1990; DeLoach and Cuda, 1994; DeLoach, 1994). However, one of the most important insects attacking mesquite is the leaf-footed bug *Mozena obtusa* Uhler. This insect was first described as a new species by P. R. Uhler (1876) and is now placed in the New World tribe Nematopodini of the subfamily Coreinae (O'Shea and Schaefer, 1978). Hossain (1970), in his revision of the genus, reported that all life stages of *M. obtusa* occur on mesquite (*Prosopis*). The known distribution of *M. obtusa* in the United States and northern Mexico (Fig.1) is based on museum records compiled by Hossain (1970).

This insect appears to be restricted to the genus *Prosopis* (Ward *et al.*, 1977; Schaefer and Mitchell, 1983), but Schaefer and O'Shea (1979) list only *P. glandulosa* as a host plant of *M. obtusa*. Adults and nymphs feed by inserting their piercing-sucking mouthparts and withdrawing the plant's juices from tender, rapidly growing vegetative and reproductive structures where nutrients are most highly concentrated. McCullough (1973) observed that this insect was most abundant on mesquite in Travis Co., TX, from May to October. In another study, Ueckert (1973) showed that feeding by *M. obtusa* increased the abortion of immature mesquite pods and significantly reduced the vigor and survival of germinating seedlings in Texas.

Recently, Parsons and Cuthbertson (1992) reported that *M. obtusa* is being considered as a potential biological control agent for mesquite in Australia. Because of its possible value in a biological control program in this country and abroad, we report here the results of field and laboratory studies that examined

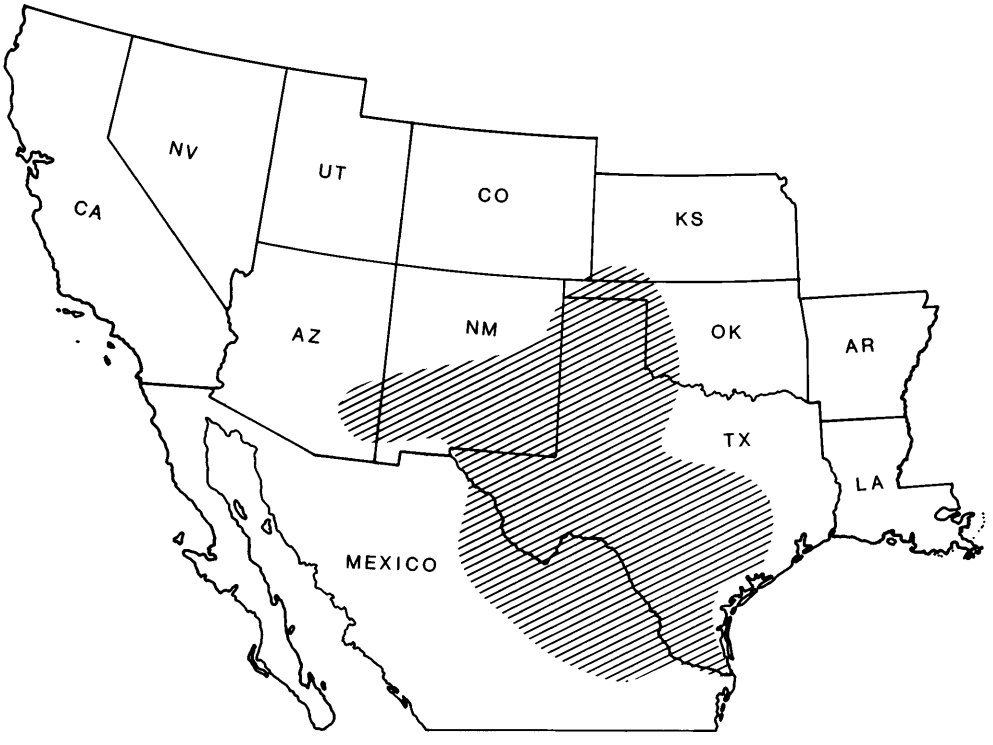

FIG. 1. Distribution of *Mozena obtusa* in North America (after Hossain, 1970).

the population dynamics of *M. obtusa* in Texas and discuss its suitability as a candidate for introduction into South Africa and Australia for classical biological control of mesquite.

MATERIALS AND METHODS

Field studies. Population samples of *M. obtusa* were collected weekly from March to November 1985 in a stand of honey mesquite located 10 km east of Temple, Bell Co., TX, U.S.A. A 4-ha plot (2 × 2 ha) was established at the site and four contiguous 1-ha subplots were delineated with the aid of wooden stakes. The whole tree was selected as the sampling unit because it satisfied several of the criteria recommended by Morris (1955). Each tree in the sampling area was readily identifiable, had an equal chance of being selected, and could be expressed as the number per ha. We used the stratified random sampling technique (Southwood, 1978) to locate individual sample trees within each subplot. Five trees were randomly selected from each of the four adjacent subplots in the following manner. Sampling locations within each subplot were identified by drawing pairs of random numbers to serve as coordinates for locating individual sampling trees with reference to the inner boundaries of the 1-ha subplots extending perpendicular to each other from the center of the 4-ha plot. A total of 20 trees was sampled on each date.

Each tree was carefully searched for the presence of *M. obtusa*, counts of the immatures and adults were made, and evidence of predation was recorded. A subsample of all life stages was also collected and maintained in the laboratory to determine the incidence of parasitism. In addition, a 0.5-m terminal branch was randomly selected on each sample tree and examined for evidence of feeding damage by *M. obtusa*. Because the field counts on *M. obtusa* provided only a measure of the population intensity of the insect (number per tree) instead of an absolute population estimate (number per unit area) (Southwood, 1978), we used the point-quarter method (Smith, 1966) to estimate the density of mesquite trees inside the plot. By counting the number of insects per tree and then measuring the number of trees per ha, we could then calculate the absolute population estimates for *M. obtusa*. Maximum and minimum air temperatures occurring during the collection of samples were also recorded in the center of the mesquite stand with a portable thermometer.

Laboratory studies. We conducted laboratory studies on *M. obtusa* between April 1985 and June 1987. Nymphs and adults collected from the field for the parasitoid survey were caged on glasshouse-grown honey mesquite plants germinated in 15.5-cm-diameter plastic pots containing potting soil (for cage description, see below). Field collected eggs were placed in 9-cm glass petri dishes with moistened filter paper. Parasitoids that emerged from all life stages were recorded, preserved, and submitted to systematic institutions for identification. Unparasitized nymphs that eclosed to the adult stage were used in subsequent experiments to determine adult longevity, fecundity, and to obtain eggs for laboratory rearing tests.

The cage used for the parasitoid survey and fecundity/longevity studies consisted of an aluminum window-screen cylinder (50-cm height × 15.5-cm diam.) placed over individual potted plants. The top of the cage was closed with a plastic petri dish lid. The insects were transferred to new plants when the condition of the host plant deteriorated due to the feeding damage. To calculate generation time and capacity for increase, r_c (Laughlin, 1965), a single male of *M. obtusa* was caged with a newly eclosed female. Information on mating and the number of eggs deposited during the life of the female was recorded. The male was replaced if he died before the completion of the test. The cages used to measure the population growth rate of *M. obtusa* (n = 11 females) were held in an environmental chamber at a temperature of 24 ± 1°C and a 16:8 (L:D) photoperiod.

Glasshouse studies. Rearing experiments were conducted on honey mesquite and also the South American vinal, *Prosopis ruscifolia* Grisebach, in separate air-conditioned glasshouses under natural light conditions. In Argentina, the vinal is as invasive and aggressive a weed as honey mesquite is in North America and is included on both state and federal noxious weed lists in the United States (K. C. Burks, Florida Dep. Env. Protection, Tallahassee, unpublished). The rationale for conducting rearing experiments on vinal in quarantine was to determine whether *M. obtusa* was capable of utilizing a weedy species of *Prosopis* other than its natural host. Temperature and relative humidity in each glasshouse were recorded with a hygrothermograph.

Previously mated females of *M. obtusa* were placed on individual potted plants of each species and covered with a rectangular screen cage (80 × 60 × 60 cm) and allowed to deposit several cohorts of eggs. The survival and development of the immature stages on each host plant species were then monitored. The plants were maintained for at least 1 year in 19-liter plastic pots before they were used in the rearing experiments. Because the rearing conditions on honey mesquite and vinal were not identical, the data obtained on the developmental rates of *M. obtusa* from the two different mesquite species were not statistically comparable. Unless otherwise indicated, data are reported as means ± SEM.

RESULTS AND DISCUSSION

Mesquite stand characteristics. We sampled a total of 720 honey mesquite plants during the course of this

study. The plants were small in stature, averaging only 1.81 ± 0.11 m in height. Their small size allowed us to quickly examine the entire plant for all life stages of *M. obtusa*. We calculated a stand density of 620 ± 89 plants per ha at the study site. Maximum temperatures recorded in the mesquite stand after the last tree was examined on each sample date ranged from 21.1°C on 20 March to 37.8°C on 21 August 1985 (Fig. 2). Similarly, minimum temperature extremes occurred prior to examination of the first tree on each sample date on 10 April (18.9°C) and 14 August 1985 (30°C).

Eggs. The eggs of *M. obtusa* are ovoid and saddle-shaped in appearance. The chorion is dark brown, shiny, and sculptured with fine, hexagonal reticulations. A sample ($n = 25$) of field-collected eggs measured 1.93 ± 0.01 mm in length and 1.31 ± 0.01 mm in width. All eggs were deposited on honey mesquite in the field except for one egg cluster examined on 26 June 1985. This single mass of 14 eggs was laid on the apical stem of common broomweed, *Amphiachyris dracunculoides* (DC.) Nutt. (Asteraceae), that was growing in close proximity to the lower branches of a mesquite plant. Of the 86 total eggs deposited in the laboratory rearing study, 76 (88.4%) were viable. The 39 eggs laid on honey mesquite and 47 eggs on vinal developed in 12.7 ± 0.3 days and 13.3 ± 0.3 days, respectively (Table 1).

We observed eggs of *M. obtusa* in the field from late April to early October 1985 (Fig. 3). However, the appearance of 3rd instar nymphs in the 24 April sample suggested that eggs were present by 11 April. The egg population attained a maximum density of 1,333 per ha on 8 May.

Nymphs. *Mozena obtusa* passes through five instars before reaching the adult stage. The nymphs are predominantly greenish-tan, and are cryptically hidden on the tender vegetative shoots and buds on which they feed. The first instars do not feed and remain almost motionless near the egg shells until after they have molted to the second instar. The second and third instars from the same egg mass are gregarious feeders, whereas fourth and fifth instars rarely feed in large aggregations.

On honey mesquite, duration of the first, second, third, fourth, and fifth stadia averaged 4.1, 6.6, 5.0, 6.2, and 10.8 d, respectively (Table 1). The average duration of the nymphal stages was 32.7 days and laboratory survival was 43.6% (Fig. 4). The highest nymphal mortality occurred during the second instar on both host plant species and averaged 44.3%. Moreover, the high second instar mortality rate that we observed in this study appears to be the rule rather than the exception for sap-feeding coreids (Kumar, 1966). The second instar must be a critical feeding stage in the life cycle of *M. obtusa* because nymphal mortality was minimal for instars three through five (Table 1). Although survival of *M. obtusa* on vinal was comparable to that on honey mesquite (48.9%), nymphal development was longer (49.5 days). The average duration of the first, second, third, fourth, and fifth stadia for

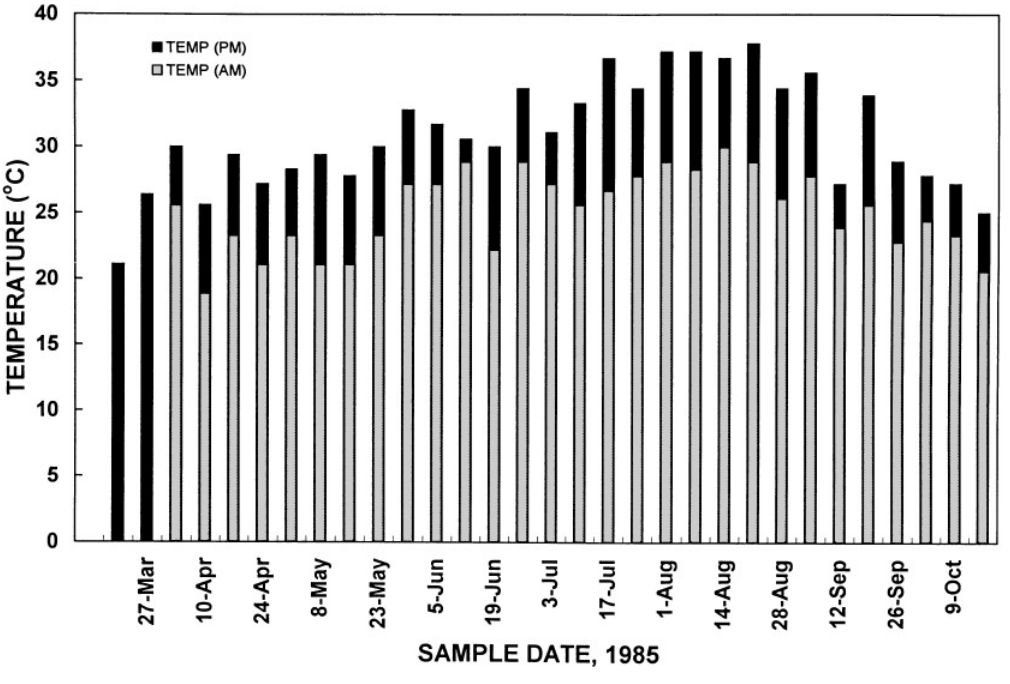

FIG. 2. Maximum and minimum temperatures recorded during the 1985 field season in the honey mesquite stand, Bell Co., TX, U.S.A., before and after the collection of field samples.

TABLE 1

Duration and Survival of the Immature Stages of *Mozena obtusa* on the North American *Prosopis glandulosa* var. *glandulosa* and the South American *P. ruscifolia*[a]

	P. g. glandulosa					*P. ruscifolia*				
		Duration (d)		Cumulative			Duration (d)		Cumulative	
Stage	Percentage mortality (*n*)[b]	Range	x̄ (SEM)	x̄ Age	Percentage survival	Percentage mortality (*n*)[b]	Range	x̄ (SEM)	x̄ Age	Percentage survival
Egg	10.3 (39)	12–13	12.7 (0.3)	12.7	89.7	12.8 (47)	13–15	13.3 (0.3)	13.3	87.2
Nymph (Instar)										
I	0 (35)	3–5	4.1 (0.1)	16.8	89.7	2.4 (41)	3–5	4.2 (0.3)	17.5	85.1
II	48.6 (35)	5–8	6.6 (0.7)	23.4	46.2	40.0 (40)	7–26	12.4 (1.8)	29.9	51.2
III	0 (18)	4–6	5.0 (0.1)	28.4	46.2	4.2 (24)	5–22	9.3 (1.7)	39.2	48.9
IV	5.6 (18)	5–8	6.2 (0.5)	34.6	43.6	0 (23)	5–15	8.7 (1.0)	47.9	48.9
V	0 (17)	9–13	10.8 (0.8)	45.4	43.6	0 (23)	10–25	14.9 (1.2)	62.8	48.9
Adult[c]	0 (17)					0 (23)				

[a] Development of *Mozena obtusa* was prolonged on *P. ruscifolia* due to different temperature and humidity regimes in the quarantine glasshouse (see Materials and Methods).
[b] (*n*) Equals the number of individuals surviving each instar.
[c] For *P. g. glandulosa*, 7 males and 10 females; *P. ruscifolia*, 13 males and 10 females.

nymphs reared on vinal was 4.2, 12.4, 9.3, 8.7, and 14.9. The protracted nymphal developmental period on vinal could be attributed to the slightly cooler and drier conditions in the quarantine glasshouse where vinal was tested rather than differences in host plant suitability. The temperature and relative humidity in the quarantine glasshouse were 23.4 ± 0.4°C and 73.8 ± 1.8% compared to 24.0 ± 0.4°C and 75.8 ± 1.5% in the glasshouse where we reared *M. obtusa* on honey mesquite.

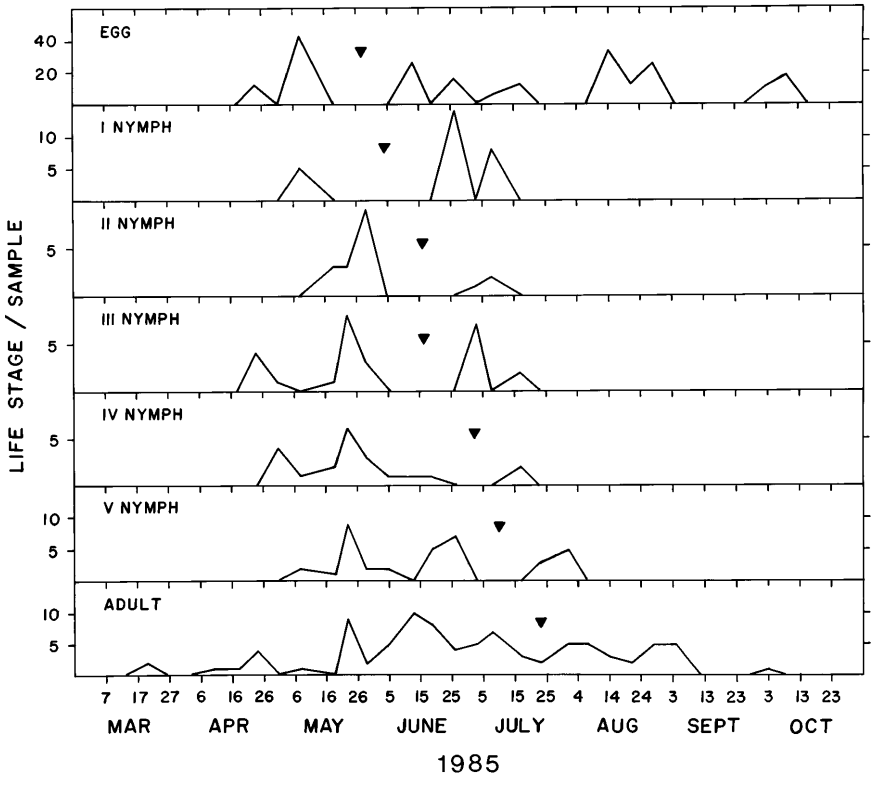

FIG. 3. Seasonal abundance of all life stages of *Mozena obtusa* on honey mesquite, Bell Co., TX, U.S.A., 1985. Arrows indicate initiation of the second generation.

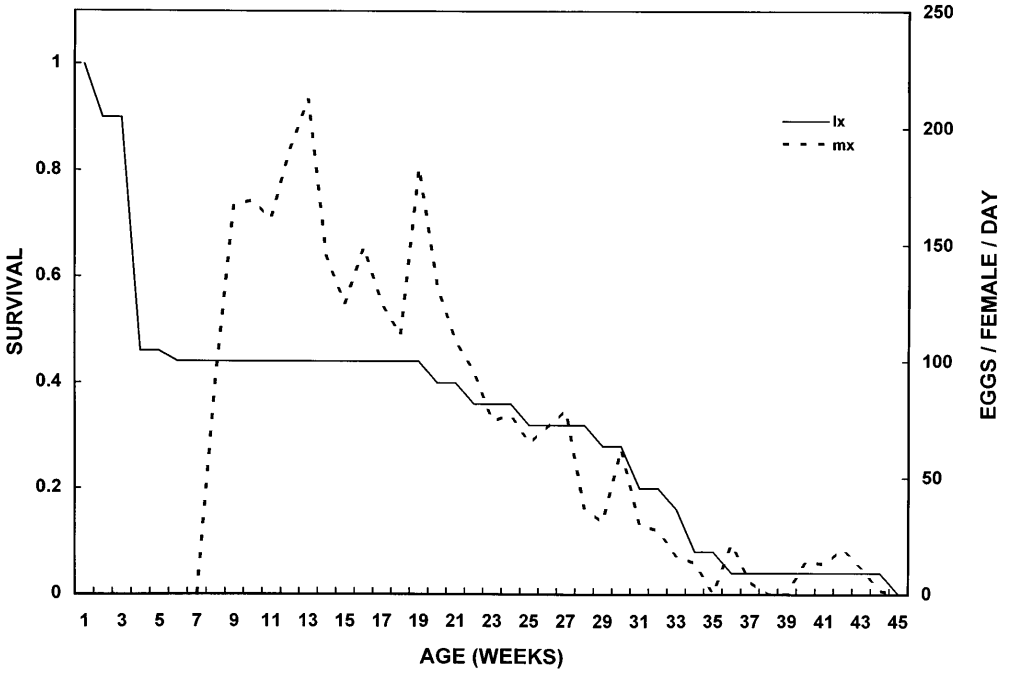

FIG. 4. Survival (l_x) and age-specific fecundity (m_x) of *Mozena obtusa* on honey mesquite at 24 ± 1°C and a 16:8 (L:D) photoperiod. Survival of the immature stages, age 0–6 weeks, is based on a separate cohort of eggs (see Table 1).

We observed first instar nymphs in field samples in early May and again in late June–early July (Fig. 3). The first instar population peaked on 26 June, attaining a maximum estimated density of 434 per ha. Second instars were also observed in the May and July field samples, with a maximum density of 279 recorded on 29 May. The third instar nymphs were observed from late April to the end of May and again in July. The density of third instars peaked at 248 per ha on 23 May. Fourth and fifth instars were most abundant in field samples during the months of May and June, and less commonly in July. A maximum estimated density of 186 fourth and 279 fifth instars per ha likewise occurred on 23 May.

Adults. The adults range from 1.4 to 2.1 cm in length and are greenish-tan to brown in color variegated with darker markings (Hossain, 1970). Despite their rather large size, the cryptic coloration and slow movement exhibited by both the males and females enable them to remain virtually hidden on the leaves and stems of mesquite. When disturbed, the adults (and presumably nymphs) produce a pungent defensive secretion containing a mixture of *n*-hexyl acetate, hexanol, and acetic acid (McCullough, 1973).

Mating pairs were observed frequently in the field. Under laboratory conditions, adults remained *in copula* for 95.0 ± 19.0 min (range 15–150 min), and were able to mate repeatedly. We observed one pair mating six times between 2 June and 6 September 1986. Mating generally occurred from 6 to 12 days after adult eclosion. The preoviposition period for nine newly emerged females mated in the laboratory was 24.7 ± 8.2 days (range 3–80 days).

Females deposited eggs in single or double rows on the underside of mesquite leaflets and rachides (Fig. 5), or in small clusters on larger branches and the main stem or trunk. One female was observed ovipositing in the field on 6 June 1985. After the female landed on the mesquite leaf, she positioned herself on the underside of the rachis and exuded a glue-like substance from the tip of her abdomen onto the rachis. She then proceeded

FIG. 5. An egg mass of *Mozena obtusa* deposited on the underside of a honey mesquite leaflet.

to deposit a single row of 13 eggs before departing. The entire process lasted 25 min.

Adults of *M. obtusa* are long-lived and the females are very prolific. Longevity of the adult stage for the 11 females that we monitored was 166.5 ± 13.6 days (range 100–258), and for six males was 144.0 ± 18.9 days (range 95–224). A total of 431 egg masses was deposited in the laboratory. The females oviposited between the ages of 7 and 43 weeks (Fig. 4). Each female laid 39.2 ± 3.1 egg masses (range 28–54), and an average of 509.6 ± 48.3 (range 227–794) eggs during their lives. The mean number of eggs per mass deposited by each female in this study was 13.1 ± 0.3 eggs (range 2–34).

In the field, adults emerged from overwintering sites (presumably litter at the base of the plants) in mid March and were most numerous from May to July 1985 (Fig. 3). A 1:1 sex ratio was indicated since we observed a total of 45 males and 46 females in the field samples. In addition, we calculated that the population attained a maximum estimated density of 310 adults per ha on 13 June 1985.

Generation time and capacity for increase. We calculated basic population statistics for *M. obtusa* from laboratory data obtained on duration and survival of the immature stages on honey mesquite (Table 1) and oviposition and survival of the females (Fig. 4). The net reproductive rate (R_o) was calculated to be 1114.66 and the cohort generation time (T_c) was 15 weeks. Therefore, the capacity for increase (r_c) was 0.468. Under optimal conditions of ample food and no predation or parasitism, a population of *M. obtusa* would be expected to increase 1.6 times per week and 1.5 weeks would be required for the population to double.

Biotic mortality factors. *Mozena obtusa* is heavily attacked by predaceous as well as parasitic natural enemies in Texas. The predaceous wheel bug, *Arilus cristatus* L. (Hemiptera: Reduviidae), was frequently encountered in most field samples from June through October, and we observed one individual feeding on a gravid female *M. obtusa* on 13 June. The mantidfly *Climaciella brunnea* (Say) (Neuroptera: Mantispidae) was also regularly observed on mesquite plants in close proximity to early instar nymphs of *M. obtusa*. Although we were unable to confirm predation in the field, one specimen of *C. brunnea* held in captivity survived for 62 days entirely on a diet of *M. obtusa*, consuming 432 of the 504 first and second instar nymphs provided, or 86%.

All life stages of *M. obtusa* are susceptible to parasitism. Of 487 field-collected eggs, 43% were parasitized by a complex of hymenopterous parasitoids identified as *Anastatus semiflavidus* Gahan (Eupelmidae), *Ooencyrtus johnsoni* (Howard) (Encyrtidae), and *Gryon atrum* Masner (Scelionidae). In addition, the tachinid fly *Trichopoda pennipes* F. parasitized 8% of the fifth instar nymphs (n = 36) and 36% of the adults(n = 85). Apparently this represents new host records for all four species of parasitoids. The temporal distribution of total parasitism shown in Fig. 6 suggests that

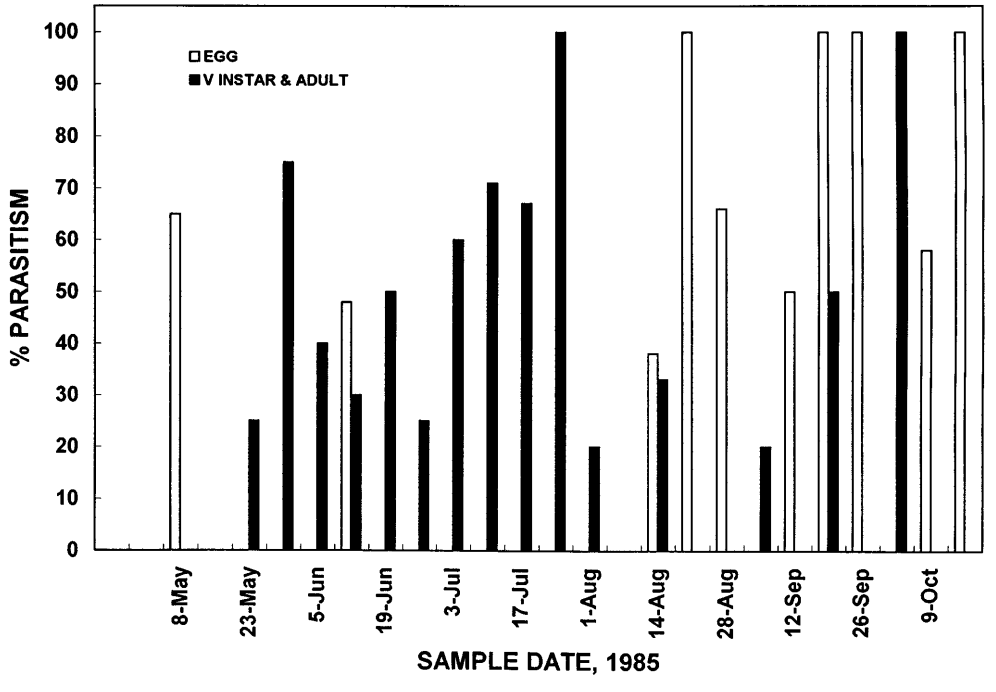

FIG. 6. Temporal distribution of the percentage of parasitism of *Mozena obtusa* by the tachinid *Trichopoda pennipes* and a complex of hymenopterous egg parasitoids.

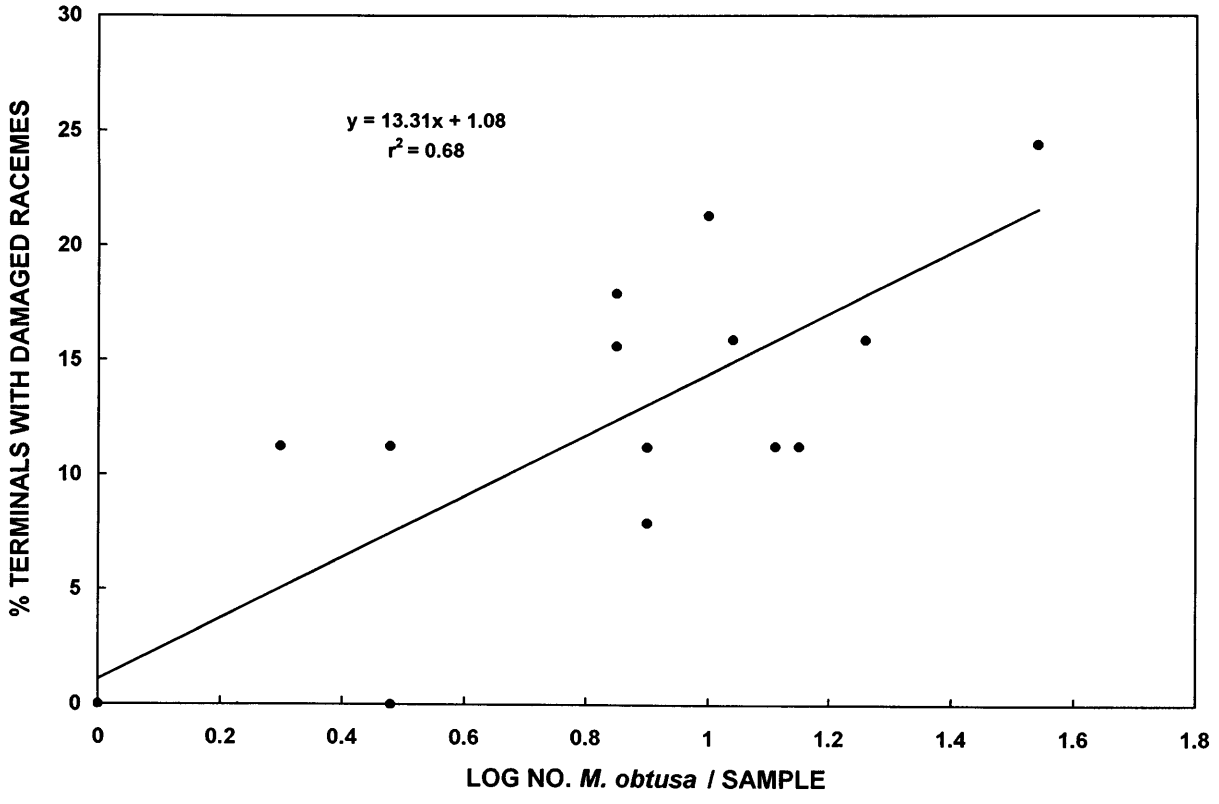

FIG. 7. Terminal branches of honey mesquite with dead or dying racemes as a function of the number of *Mozena obtusa* nymphs and adults observed in field samples.

T. pennipes had a greater impact on the adult population between May and August 1985. In contrast, the egg parasitoids were more prevalent later in the season. Parasitism of the eggs of *M. obtusa* from August to November was greater than 76%.

Damage to mesquite. By sucking the juices from developing mesquite pods, *M. obtusa* causes premature pod abscission and reduced vigor of seedlings (Ueckert, 1973). In this study, we observed that feeding by *M. obtusa* on the racemes, the spike-like structures that bear the yellowish green flowers, causes them to collapse and die before they flower and produce pods. We postulate that preferential feeding by *M. obtusa* on the rapidly growing racemes may inhibit or prevent reproduction in mesquite. Regression analysis of the number of bugs per sample on the percentage of mesquite terminals with dead or dying racemes seems to support our hypothesis (Fig. 7).

CONCLUSIONS

Mesquites, *Prosopis* spp., have become problem weeds in many parts of the world, especially the United States (DeLoach, 1985; 1995), South Africa (Zimmerman, 1991; 1995), and Australia (Parsons and Cuthbertson, 1992). These aggressive woody plants reproduce only by seed and are usually spread by grazing livestock or wild animals. Passage of the seeds through the digestive tract enhances their germination potential.

In some areas of South Africa and Australia where mesquite was deliberately introduced without its natural enemies for shade, livestock feed, and soil stabilization, these plants now infest large tracts of land that were at one time considered prime grazing areas. To partially address the mesquite problem in South Africa, a selective biological control program was implemented which utilizes only seed-feeding insects introduced from North America. Although these seed-feeders are capable of destroying approximately 90% of an annual seed crop (Zimmermann 1991, 1995), additional agents are needed to further reduce the plant's biotic potential and ultimately its rate of spread.

The results of this study indicate that the leaf-footed bug *M. obtusa* could also be a good candidate for introduction into South Africa and Australia for classical biological control of weedy *Prosopis* spp. At high densities, *M. obtusa* is not only capable of reducing seed production but may actually prevent mesquite from reproducing by preferentially attacking the young racemes. *Mozena obtusa* is also capable of feeding and reproducing solely on young vegetative plant parts. This is a distinct advantage because the insect is able to

survive and maintain high populations in the absence of any reproductive growth. Furthermore, *M. obtusa* is not known as a pest of economically important legumes and appears to be restricted to plants of the genus *Prosopis*. Our research showed that *M. obtusa* was able to complete its development on the South American vinal (*P. ruscifolia*) as well as its natural host honey mesquite (*P. g. glandulosa*). Taxonomically, honey mesquite and vinal belong to the same Section Algarobia of the genus *Prosopis* as defined by Burkart (1976), but are in different Series. Honey mesquite is in the Series Chilenses and vinal in the Series Ruscifoliae. In addition, ongoing host-range tests by CSIRO scientists in Queensland, Australia, have shown that *M. obtusa* develops normally on all *Prosopis* spp. tested (R. van Klinken, Long Pocket Laboratories, Indooroopilly, unpublished data).

The temporal distribution of all life stages of *M. obtusa* indicates that there are at least two generations annually in Texas with the potential for more generations in the area of introduction, if climate and food supply are favorable. Biotic mortality by parasitoids (and possibly predators) is probably the key factor that prevents this insect from attaining high population densities in its native range. In this study, we observed a total parasitism rate of 40%. If *M. obtusa* were introduced into South Africa or Australia free of its natural-enemy complex, the insect's high reproductive rate, exceptional longevity, and ability to survive on vegetative growth in the absence of racemes or pods could reduce the invasiveness of mesquite without seriously compromising its ornamental, commercial, and ecological values (DeLoach, 1985). However, additional research is needed to define the host range of *M. obtusa* before this insect can be utilized for classical biological control of mesquites.

ACKNOWLEDGMENTS

We express our sincere appreciation to B. Weems, Bell County, TX, for allowing us to conduct this research on his property. We gratefully acknowledge the technical assistance of T. Robbins, USDA-ARS, Grassland, Soil and Water Research Laboratory, Temple, TX, T. Neidlinger, formerly with this laboratory, and J. Gillmore, University of Florida, Gainesville, FL. We also thank O. S. Flint and C. W. Sabrosky (USDA Systematic Entomology Laboratory, Beltsville, MD), G. Gibson and L. Masner (Biosystematics Research Institute, Agriculture Canada, Ottawa), and J. B. Woolley (Texas A&M University, College Station, TX) for identifying the predators and parasitoids of *M. obtusa*. Finally, special thanks are extended to G. Buckingham, D. Habeck, and P. Mitchell for critically reviewing this manuscript.

REFERENCES

Buffington, L. C., and Herbel, C. H. 1965. Vegetation changes on a semidesert grassland range from 1858 to 1963. *Ecol. Monogr.* **35,** 139–164.

Burkart, A. 1976. A monograph of the genus *Prosopis* (Leguminosae: subfam. Mimosoideae). *J. Arnold. Arbor. Harv. Univ.* **57,** 217–249, 450–525.

Cordo, H. A., and DeLoach, C. J. 1987. Insects that attack mesquite (*Prosopis* spp.) in Argentina and Paraguay: their possible use for biological control in the United States. *U.S. Dep. Agric., Agric. Res. Serv. Tech. Rep. ARS* **62**. 36 pp.

Cuda, J. P. 1988. Viewpoint: Comments on the proposed use of native insects for biological control of snakeweeds. *Rangelands* **10,** 262–264.

Cuda, J. P., DeLoach, C. J., and Robbins, T. O. 1990. Population dynamics of *Melipotis indomita* (Lepidoptera: Noctuidae), an indigenous natural enemy of mesquite, *Prosopis* spp. *Environ. Entomol.* **19,** 415–422.

DeLoach, C. J. 1978. Considerations in introducing foreign biotic agents to control native weeds of rangelands. *In* "Proceedings of the IV International Symposium on the Biological Control of Weeds, Gainesville, Florida, 30 August–2 September 1976" (T. E. Freeman, Ed.), pp. 39–50. University of Florida, Gainesville.

DeLoach, C. J. 1981a. Biology of a mesquite web worm, *Friseria cockerelli* (Busck), in central Texas. *Environ. Entomol.* **10,** 922–927.

DeLoach, C. J. 1981b. Prognosis for biological control of weeds of southwestern U.S. rangelands. *In* "Proceedings of the V International Symposium on the Biological Control of Weeds, Brisbane, Australia, 22–29 July 1980" (E. S. Delfosse, Ed.), pp. 175–199. CSIRO, Melbourne, Australia.

DeLoach, C. J. 1982. Biological studies on a mesquite leaf tier, *Tetralopha euphemella*, in central Texas. *Environ. Entomol.* **11,** 262–267.

DeLoach, C. J. 1983a. Life history of a mesquite looper, *Semiothisa cyda* (Lepidoptera: Geometridae), in central Texas. *Ann. Entomol. Soc. Am.* **76,** 83–86.

DeLoach, C. J. 1983b. Field biology and host range of a mesquite looper, *Semiothisa cyda* (Lepidoptera: Geometridae), in central Texas. *Ann. Entomol. Soc. Am.* **76,** 87–93.

DeLoach, C. J. 1985. Conflicts of interest over beneficial and undesirable aspects of mesquite (*Prosopis* spp.) in the United States as related to biological control. *In* "Proceedings of the VI International Symposium on the Biological Control of Weeds, Vancouver, Canada, 19–25 August 1984" (E. S. Delfosse, Ed.), pp. 301–340. Agriculture Canada, Ottawa.

DeLoach, C. J. 1994. Feeding behavior of *Melipotis indomita* (Lepidoptera: Noctuidae), a herbivore of mesquite (*Prosopis* spp.). *Environ. Entomol.* **23,** 161–166.

DeLoach, C. J. 1995. Progress and problems in introductory biological control of native weeds in the U.S. *In* "Proceedings of the VIII International Symposium on the Biological Control of Weeds, Lincoln University, Canterbury, New Zealand, 2–7 February 1992" (E. S. Delfosse, and R. R. Scott, Eds.), pp. 111–122. DSIR/CSIRO, Melbourne, Australia.

DeLoach, C. J., and Cuda, J. P. 1994. Host range of the mesquite cutworm, *Melipotis indomita* (Lepidoptera: Noctuidae), a potential biocontrol agent for mesquite (*Prosopis* spp.). *Biol. Control* **4,** 38–44.

DeLoach, C. J., Boldt, P. E., Cordo, H. A., Johnson, H. B., and Cuda, J. P. 1986. Weeds common to Mexican and U.S. rangelands: proposals for biological control and ecological studies. *In* "Proceedings of the Symposium on Management and Utilization of Arid Land Plants, Saltillo, Mexico, 18–22 February 1985," U.S. Dept. of Agric., Forest Serv. Gen. Tech. Rep. RM-135 (D. R. Patton, *et al.*, Eds.), pp. 49–67. Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Hossain, M. 1970. "A Revision of the Genus *Mozena* Amyot and Serville (Hemiptera: Coreidae)." Master's Thesis, Texas A&M University, College Station, TX.

Johnson, H. B., Polley, W. H., and Mayeux, H. S. 1993. Increasing CO_2 and plant-plant interactions: Effects on natural vegetation. *Vegetatio* **104/105,** 157–170.

Kumar, R. 1966. Studies on the biology, immature stages, and relative growth of some Australian bugs of the superfamily Coreoidea (Hemiptera: Heteroptera). *Aust. J. Zool.* **14,** 895–991.

Laughlin, R. 1965. Capacity for increase: A useful population statistic. *J. Anim. Ecol.* **34,** 77–91.

Mayeux, H. S., Johnson, H. B., and Polley, W. H. 1991. Global change and vegetation dynamics. *In* "Noxious Range Weeds" (L. F. James, *et al*., Eds.), pp. 62–74. Westview Press, Boulder, CO.

McCullough, T. 1973. Chemical analysis of the defensive scent fluid from the bug *Mozena obtusa* (Hemiptera: Coreidae). *Ann. Entomol. Soc. Am.* **66,** 231–232.

Morris, R. F. 1955. The development of sampling techniques for forest insect defoliators, with particular reference to the spruce budworm. *Can. J. Zool.* **33,** 225–294.

Neser, S., and Moran, V. C. 1985. Tactics for evaluating conflicts in the biological control of South African weeds. *In* "Proceedings of the VI International Symposium on the Biological Control of Weeds, Vancouver, Canada, 19–25 August 1984" (E. S. Delfosse, Ed.), pp. 359–363. Agriculture Canada, Ottawa.

O'Shea, R., and Schaefer, C. W. 1978. The Mictini are not monophyletic (Hemiptera: Coreidae: Coreinae). *Ann. Entomol. Soc. Am.* **71,** 776–784.

Panetta, F. D., and Carstairs, S. A. 1989. Isozymic discrimination of tropical Australian populations of mesquite (*Prosopis* spp.): implications for biological control. *Weed Res.* **29,** 157–165.

Parsons, W. T., and Cuthbertson, E. G. 1992. "Noxious Weeds of Australia." Inkata Press, Melbourne, Australia.

Schaefer, C W., and Mitchell, P. L. 1983. Food plants of the Coreoidea (Hemiptera: Heteroptera). *Ann. Entomol. Soc. Am.* **76,** 591–615.

Schaefer, C. W., and O'Shea, R. O. 1979. Host plants of three Coreine tribes (Hemiptera: Heteroptera: Coreidae). *Ann. Entomol. Soc. Am.* **72,** 519–523.

Smith, R. L. 1966. "Ecology and Field Biology." Harper and Row, New York.

Southwood, T. R. E. 1978. "Ecological Methods with Particular Reference to the Study of Insect Populations." Chapman and Hall, London, United Kingdom.

Ueckert, D. N. 1973. Effects of leaf-footed bugs on mesquite reproduction. *J. Range. Manage.* **26,** 227–229.

Uhler, P. R. 1876. List of Hemiptera of the region west of the Mississippi River, including those collected during the Hayden explorations of 1873. *Bull. U.S. Dep. Inter.* **5,** p. 30.

Ward, C. R., O'Brien, C. W., O'Brien, L. B., Foster, D. E., and Huddleston, E. W. 1977. Annotated checklist of new world insects associated with *Prosopis* (mesquite). *U.S. Dep. Agric. Tech. Bull. ARS Ser.* **1557.**

Zimmermann, H. G. 1991. Biological control of mesquite, *Prosopis* spp. (Fabaceae), in South Africa. *Agric. Ecosyst. Environ.* **37,** 175–186.

Zimmermann, H. G. 1995. Two seed-feeding bruchids as part of an integrated approach for the control of *Prosopis* spp., Mesquite, in South Africa. *In* "Proceedings of the VIII International Symposium on the Biological Control of Weeds, Lincoln University, Canterbury, New Zealand, 2–7 February 1992" (E. S. Delfosse, and R. R. Scott, Eds.), p. 453. DSIR/CSIRO, Melbourne, Australia.