Six New Hosts of *Bracon mellitor* (Hymenoptera: Braconidae), with a Review of Recorded Hosts

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ABSTRACT A complete list of hosts of *Bracon mellitor* Say is presented. Six new hosts, *Acontia cretata* (Grote & Robinson), *Anthonomus heterothecae* Pierce, *Phaneta mormonensis* (Heinrich), *Thyraylia bunteana* Robinson, *Mimoschinia rufofascialis* (Stephens), and *Schinia mitis* (Grote) were discovered. Overwintering fifth instars of *B. mellitor* were found in only three plant species, *Datura stramonium* L., *Grindelia squarrosa* (Pursh) Dunal, and *Heterotheca latifolia* Buckley.

KEY WORDS Insecta, *Bracon mellitor*, hosts, host plants

Bracon mellitor Say is the most commonly encountered ectoparasitoid of the boll weevil, *Anthonomus grandis grandis* Boheman. Its range extends from Texas to South Dakota and eastward to the Atlantic states, and it also occurs in the Hawaiian Islands (Muesebeck 1925). During the spring and fall, boll weevil larvae are not available to this parasitoid in central Texas. Thus, alternate hosts are essential for survival of this insect throughout the year. Many Coleoptera and Lepidoptera are reported to be hosts of this parasitoid in native vegetation (Pierce et al. 1912, Cross & Chesnut 1971, Marsh 1979). Possibly sowing or conserving (or both) of plants which are refuges of alternate hosts of this parasitoid could increase the efficiency of the parasitoid and reduce the dependence upon insecticides for control of the boll weevil.

This study was done to determine the insect hosts of *B. mellitor* in native, insecticide-free vegetation in central Texas. Specimens of *B. mellitor* and other braconid parasitoids of the boll weevil at the United States National Museum of Natural History, Washington (NMNH) were examined, and the literature to August 1986 was reviewed.

Materials and Methods

Initially, it was necessary to clarify some of the published host records. The original parasitoid specimens upon which existing host records had been based were located at the NMNH. Species determinations of these specimens were reevaluated using Muesebeck's (1925) key to *Microbracon*. The host remains that may have been preserved with these parasitoids were examined.

A survey for hosts was undertaken in the vicinity of College Station and New Clarkson, Tex., in 1981–1983. Buds, fruit, seed heads, and stems of plants in the families Solanaceae, Euphorbiaceae, Vitaceae, and Onagraceae were collected. Three specimens of each plant were pressed and identified using information by Correll & Johnston (1970); they were placed in a herbarium in the Boll Weevil Laboratory at Texas A&M University. Field-collected plant parts were held in the laboratory in 946-ml cardboard cartons for emergence of adults. These cartons were kept at room temperature with a humidifier to prevent desiccation of plant parts.

When the plants from which *B. mellitor* adults emerged were determined, host associations were established by collecting fresh parts of these host plants from the field and dissecting them to find hosts. Parasitized host larvae were transferred to electron microscope embedding capsules (size 00) to facilitate development. These capsules were held at 26°C and 71 ± 2% RH. The adults that emerged were identified. Approximately one-fourth of the unparasitized host larvae were killed in boiling water and preserved in 80% ethanol for identification. The remaining host larvae were reared to the adult stage when possible. Voucher specimens of parasitoids and hosts were placed in the insect collection in the Department of Entomology, Texas A&M University.

Because of variation in size, structure, and sculpture (Muesebeck 1925), absolute identification of *B. mellitor* was difficult. Therefore, cross breeding studies were performed between all field-collected *Bracon* species and laboratory-reared *B. mellitor*. *B. mellitor* is arrhenotokous, so the production of female progeny was evidence of successful mating; the mated parents were considered to be *B. mellitor*. Thus all identifications of *B. mellitor* were based on morphological characteristics and the results of these cross breedings. For the cross breeding studies, a laboratory colony of *B. mellitor* was maintained in a 38.7-cm^3 plexiglass sleeve cage with a constant supply of honey and distilled water

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at 70–80% RH, 26–29°C, and a photoperiod of 12:12 (L:D). The colony was obtained from cotton squares near Weslaco, Tex., in 1981. Adults were given access to large boll weevil larvae from the USDA GAST Rearing Facility at Starkville, Miss., for reproduction. Boll weevil larvae were held individually in enclosed parafilm cells (Tillman 1985). Parasitized hosts were held for adult emergence in a 946-ml carton.

Results and Discussion

Review of Reported Hosts. A list of recorded hosts of *B. mellitor* is included in Table 1. Cross & Chesnut (1971) listed 39 previously published host records; because the sources of two of the host records are not known, Cross & Chesnut (1971) are cited as the reference for them. Marsh (1979) is the sole reference for two other hosts in Table 1; these two host records were obtained from data accompanying specimens submitted for identification (P. M. Marsh, personal communication).

Some published records are not included in the latest host record list compiled by Marsh (1979) because they were probably incorrect. Examination of specimens at NMNH revealed that *Baris transversa* Say is the host for *Bracon variabilis* (Provancher) rather than of *B. mellitor* as cited by Pierce et al. (1912). *Smicronyx tychodides* LeConte is the host for *Bracon cuscutae* Muesebeck, not for *B. mellitor*. *Crocidosema lantana* Busck is a questionable host of *B. mellitor* because Bridwell (1920) did not dissect the berries of the host plant, *Lantana camara* L. The host record of *Pyrausta penitalis* Grote is uncertain because Chittenden (1918) reported no information about rearing procedures. *B. mellitor* is reported by Underhill (1935) as a gregarious parasitoid of *Thamnospecia scitula* (Harris) and by Martin (1960) as a gregarious parasitoid of *Rhyacionia adana* Heinrich. However, *B. mellitor* is solitary rather than gregarious, indicating that the records by Underhill and Martin are incorrect.

Smicronyx constrictus (Say) is included in the host records of Balduf (1959), Cross & Chesnut (1971), and Marsh (1979), but *Smicronyx fulvus* LeConte is not listed. There are *B. mellitor* specimens at NMNH collected by L. O. Howard in 1925 that bear labels of *S. constrictus* as host. However, Bigger (1931) and Satterthwait (1946) reported *B. mellitor* as a parasitoid of *S. fulvus*. There may be a problem with species identification involving this *Smicronyx* host.

Pierce et al. (1912) stated that species determinations of *B. mellitor* from Lepidoptera probably were incorrect. Furthermore, Cross & Chesnut (1971) assumed that records of lepidopteran hosts were laboratory rearings. Because we found immatures of the parasitoid on larvae of pyralids, noctuids, and cochylids in native vegetation, we believe the records of Lepidoptera are correct.

Lepidoptera larvae that feed externally during the middle or late instars (or both) are unsuitable hosts for *B. mellitor*, which develops on hosts in enclosed habitats. Any valid publication of host records of these Lepidoptera should state that early instars were attacked by females. For example, Ohlendorf (1926) reported that *B. mellitor* females attacked early instars of *Pectinophora gossypiella* (Saunders) feeding inside cotton bolls, and Satterthwait & Swain (1946) recorded the parasitoid from early instars of *Homoeosoma electellum* (Hulst) feeding in seed heads of sunflowers. Similarly, we determined that only early instars of *Acontia cretata* (Grote & Robinson) were hosts of this parasitoid. Because Bibby (1942) did not include information about the host stage attacked or rearing procedures for *Heliothis zea* (Boddie), this host record is questionable.

The only rearing procedure by which a host association can be proved conclusively involves a thorough dissection of plant parts containing possible hosts and subsequent rearing of individual parasitoids to adults. The citations of some authors are not clear as to whether the parasitoids were observed feeding and developing on a "host." Insects other than the specified host are often likely to be feeding on the plant material, and unless the host is clearly established, the host record is questionable. Incomplete or questionable host records should be verified by additional rearings.

There are two cases in which host records obtained from emergence of parasitoids from plant material were later verified by other researchers. Ohlendorf (1926) and Lewis et al. (1970) confirmed the records for *P. gossypiella* and *Rhyacionia frustrana* (Comstock), respectively. This was accomplished by observing *B. mellitor* immatures on hosts and rearing these parasitoids to adults.

Attempted Confirmation of Recorded Hosts. Pierce (1907) records *B. mellitor* from the curculionid, *Anthonomus squamous* LeConte, in the plant *Grindelia squarrosa* (Pursh) Dunal collected near Clarenden, Tex. Because Pierce discussed life cycle data, we know that larvae of *A. squamous* were present in seed heads of the host plant, but we found that the host remains of a *B. mellitor* specimen collected by Pierce at Clarenden in 1905 from this plant were of a lepidopteran larva. We have determined that *B. mellitor* attacked a lepidopteran larva in *G. squarrosa* near New Clarkson, Tex. *B. mellitor* may have attacked the curculionid as well as the lepidopteran larvae in Clarenden. Nevertheless, the host record of *A. squamous* should be verified by field rearings.

Anthonomus signatus Say is a recorded host of *B. mellitor* in strawberries, *Fragaria* spp. (Chittenden 1893). *Rubus* spp. also are host plants of this weevil. Only dewberries, *Rubus trivialis* Michaux, were sampled in this study because they were more common than strawberries. Buds were collected from the plant and from the ground where they had fallen. Samples were obtained on many oc-

Table 1. Recorded hosts of *B. mellitor* and their host plants

Host species	Host family	Plant species	Location	Method[a]	Reference
Acrobasis vaccinii Riley	Pyralidae	*Vaccinium* spp.	Mass.	U	Marsh 1979
Anagasta kuehniella (Zeller)[b]	Pyralidae			U	Cross & Chesnut 1971
Anarsia lineatella (Zeller)[b]	Gelechiidae	*Prunus* spp.	Calif.	RP	Basinger 1935
Ancylis comptana (Walsh and Riley)[b]	Olethreutidae	*Fragaria* spp.	Md.	RH	Pierce 1908b
Anoncia leucoritis (Meyrick)	Cosmopterigidae	*Mentzelia decapetala* (Pursh Urb. & Gil.)	Tex.	RD	Puterka et al. 1986
Anthonomus albopilosus Dietz	Curculionidae	*Croton* spp.	Tex.	RP	Pierce 1907
A. eugenii Cano	Curculionidae	*Capsicum* spp.	Tex.	RH	Pratt 1907
A. fulvus LeConte	Curculionidae	*Callirhoe involucrata* (Torrey) Gray	Tex.	RP	Pierce 1907
A. grandis Boheman	Curculionidae	*Gossypium* spp.	Tex.	RP	Hunter & Hinds 1905
A. signatus Say	Curculionidae	*Fragaria* spp.	D.C.	RD	Chittenden 1893
A. squamosus LeConte	Curculionidae	*Grindelia squarrosa* (Pursh) Dunal	Tex.	RP	Pierce 1907
Baris transversa Say[b]	Curculionidae	*Ambrosia* spp.	Tex.	U	Pierce et al. 1912
Chalcodermus aeneus Boheman	Curculionidae	*Rhynchosia erecta* (Walter)	Ga.	U	Bissell 1940
Conotrachelus nenuphar (Herbst)	Curculionidae	*Prunus* spp.	W. Va.	RH	Pierce 1908a
Craponius inaequalis (Say)	Curculionidae	*Vitis* spp.	W. Va.	RD	Brooks 1906
Crocidosema lantanae Busck[b]	Olethreutidae	*Lantana camara* L.	Hawaii	RP	Bridwell 1920
Cryptophlebia illepida (Butler)[b]	Olethreutidae	*Acacia* spp.	Hawaii	RP	Bridwell 1920
Cylas formicarius elegantulus (Summers)	Curculionidae	*Ipomoea* spp.	La.	RD	Cockerham 1944
Ectomyelois ceratoniae (Zeller)[b]	Pyralidae	*Acacia* spp.	Hawaii	RP	Bridwell 1920
Elasmopalpus lignosellus Zeller	Pyralidae	*Glycine max* (L.) Merrill	Ga.	RI	Leuck & Dupree 1965
Frumenta nundinella (Zeller)	Gelechiidae	*Solanum carolinense* L.	La.	RP	Montgomery 1933
Grapholitha molesta (Busck)	Olethreutidae	*Prunus* spp.	Ont.	RP	Smith 1928
Heliothis virescens (F.)[b]	Noctuidae			U	Cross & Chesnut 1971
H. zea (Boddie)[b]	Noctuidae		Tex.	RH	Bibby 1942
Homoeosoma electellum (Hulst)	Pyralidae	*Helianthus* spp.	Mo.	RD	Satterthwait & Swain 1946
H. stypticellum Grote	Pyralidae	*Cirsium texanum* Buckley	Tex.	RD	Puterka et al. 1986
Hypera nigrirostris (F.)	Curculionidae	*Trifolium* spp.	Va.	RP	Underhill 1924
Laspeyresia caryana (Fitch)	Olethreutidae	*Carya* spp.	Ga.	U	Muesebeck 1958
Lema collaris Say	Chrysomelidae	*Tradescantia* spp.	Tex.	RD	Puterka et al. 1986
Microlarinus lareynii (du Val)	Curculionidae	*Tribulus terrestris* (L.)	Tex.	RD	Meinke & Slosser 1981
Mompha stellella Busck	Cosmopterygidae		N.J.	U	Muesebeck & Walkley 1951
Ostrinia nubilalis (Hübner)	Pyraustidae	*Zea mays* L.	Ont.	RP	Baird 1929
Paralobesia viteana (Clemens)	Olethreutidae	*Vitis* spp.	Pa.	RP	Johnson & Hammer 1912
Pectinophora gossypiella (Saunders)	Gelechiidae	*Gossypium* spp.	Hawaii	RP	Fullaway 1909
Platyptila sp.	Pterophoridae			U	Marsh 1979
Pyrausta penitalis Grote[b]	Pyraustidae		Mo.	RH	Chittenden 1918
Rhinocyllus conicus (Froelich)	Curculionidae	*Carduus nutans* L.	Va.	RD	Surles 1974
Rhyacionia adana Heinrich	Olethreutidae	*Pinus* spp.	Ont.	RH	Martin 1960
R. frustrana (Comstock)	Olethreutidae	*Pinus* sp.	Va.	RP	Cushman 1927
Rhynchites bicolor (F.)	Curculionidae	*Rosa* spp.	Wis.	RD	Balduf 1959
Schinia mortua (Grote)	Noctuidae	*Grindelia squarrosa* (Pursh) Dunal	Tex.	RD	Puterka et al. 1986
Smicraulax tuberculatus Pierce	Curculionidae	*Phoradendron* spp.	Tex.	U	Pierce et al. 1912
Smicronyx constrictus (Say)	Curculionidae	*Helianthus* spp.	N.Y.	U	Muesebeck & Walkley 1951
S. fulvus LeConte[b]	Curculionidae	*Helianthus* spp.	Ill.	RD	Bigger 1931
S. scapalis (LeConte)	Curculionidae	*Machaeranthera* sp.	Tex.	RP	Pierce 1907
S. tychoides LeConte[b]	Curculionidae	*Cuscuta* spp.	Tex.	U	Pierce et al. 1912
Sparganothis sulphurana (F.)	Tortricidae	*Vaccinium* spp.	N.J.	RP	Beckwith 1938
Stibadium spumosum Grote	Noctuidae	*Helianthus* spp.	Mo.	RH	Satterthwait 1948
Tachypterellus quadrigibbus (Say)	Curculionidae	*Crataegus* spp.	N.Y.	RP	Hammer 1936
Thamnosphecia scitula (Harris)[b]	Sesiidae	*Cornus* spp.	Va.	U	Underhill 1935
Trichobaris bridwelli Barber	Curculionidae	*Datura stramonium* L.	Tex.	RD	Cuda & Burke 1983
Tyloderma foveolata (Say)	Curculionidae	*Oenothera biennis* L.	Tex.	RH	Pierce 1908a

[a] Method of determining host association. RD, parasitoids individually reared from hosts obtained from plant dissections; RH, parasitoids reared from hosts, but procedure not stated; RI, parasitoids reared from hosts obtained in plant material, but hosts caged individually; RP, parasitoids reared from plant material infested with host; U, method unknown.

[b] Host record not listed in Marsh (1979).

casions in 1982 and 1983 at New Clarkson and College Station. Adults of *B. mellitor* did not emerge from the portion (50%) of buds held for emergence of adult parasitoids, nor were any immatures discovered when the remaining buds were dissected, although more than 5,000 weevils were obtained. Exposure of 110 weevil larvae to the laboratory colony of *B. mellitor* resulted in the development of 24 small parasitoids (21 males, 3 females). These laboratory rearings demonstrate that these weevils are not too small to be suitable hosts for this parasitoid.

If *B. mellitor* attack larvae of *A. signatus* in dewberries, they do so rarely in central Texas. They

Table 2. New records of hosts of *B. mellitor* and their host plants

Host species	Host family	Plant species	Plant family
Acontia cretata (Grote and Robinson)	Noctuidae	*Abutilon fruticosum* Guillemin and Penottet	Malvaceae
Anthonomus heterothecae Pierce	Curculionidae	*Heterotheca latifolia* Buckley	Compositae
Mimoschinia rufofascialis (Stephens)	Pyralidae	*Malvastrum aurantiacum* (Scheele) Walpers	Malvaceae
Phaneta mormonensis (Heinrich)	Olethreutidae	*Grindelia squarrosa* (Pursh) Dunal	Compositae
		H. latifolia	Compositae
Schinia mitis (Grote)	Noctuidae	*Pyrrhopappus multicaulis* de Candolle	Compositae
Thyraylia bunteana Robinson	Cochylidae	*Vernonia baldwinii* Torrey	Compositae

may be more abundant on *A. signatus* in other locations where this plant grows. A more likely explanation is that *B. mellitor* females prefer to attack the larger weevils in strawberries.

Anthonomus albopilosus Dietz is a recorded host in *Croton capitatus* Michaux (Pierce 1907). Fruits of this plant were collected in 1981 and 1982 at College Station in areas where *B. mellitor* had been collected from another host a month previously. More than 4,000 larvae of *A. albopilosus* were obtained, but only five small males of a species of *Bracon* emerged. These males were too small for precise identification; they died before they could be mated with laboratory-reared *B. mellitor* females. If these males were *B. mellitor*, this parasitoid is rare on this host in College Station.

Bracon mellitor were found on medium and large larvae of *Anthonomus fulvus* LeConte in *Callirhoe involucrata* (Torrey) Gray, confirming Pierce's (1907) report that *A. fulvus* is a host. Fire ants frequently were seen attacking and killing immature *B. mellitor* on *A. fulvus*.

Cuda & Burke (1983) reported that *B. mellitor* attacks *Trichobaris bridwelli* Barber in *Datura stramonium* L. We determined that females parasitize medium and large weevil larvae in the fruit and stems of this plant; fifth instars of *B. mellitor* were found overwintering in the fruit.

New Hosts. Six new hosts of *B. mellitor* were discovered in Malvaceae and Compositae (Table 2). The noctuid *Acontia cretata* (Grote & Robinson) and an unidentified curculionid are the host insects in the perennial herb *Abutilon fruticosum* Guillemin & Penottet. Thirty-one and five *B. mellitor* were found on the curculionid and the noctuid, respectively. *B. mellitor* females oviposit and feed on middle to late curculionid instars and on early *A. cretata* instars. We were unable to collect adults of the curculionid in the field or to rear larvae to adults in the laboratory, thus the identity of this host remains unknown. Only one noctuid larva develops in each seed head. Although the curculionid and noctuid occurred at the same time, they never fed together in a single fruit. In one instance, however, immature *B. mellitor* were observed on both hosts in fruit collected on the same date from a single plant.

Middle to late instars of the cochylid, *Phaneta mormonensis* (Heinrich), in the annual herb *Grindelia squarrosa* (Pursh) Dunal also are attacked by *B. mellitor* females. Fifty-three *B. mellitor* were found on this cochylid species. Adult females feed on middle to late instars. Host larvae feed primarily on young seed heads. A single larva eats all the seeds inside a seed head, leaving a cavity in which to pupate. The gummy seed heads stay firm and closed even after a cavity is formed. Overwintering fifth-instar *B. mellitor* were collected in these seed heads in the late fall and early spring. These instars were relatively protected throughout the winter in these closed seed heads.

Two hosts, a curculionid, *Anthonomus heterothecae* Pierce, and a cochylid, *Phaneta mormonensis*, are found in the annual herb *Heterotheca latifolia* Buckley. Seven *B. mellitor* (Heinrich) were found on *A. heterothecae* and 10 were found on the cochylid. Females of *B. mellitor* oviposit only on the late instars of both these hosts. *A. heterothecae* larvae feed in the seed heads at the beginning of the season of this plant. A single curculionid larva completely consumes the seeds inside a seed head and pupates in the resulting cavity. Approximately a week after curculionid larvae are no longer present, cochylid larvae of the same species as that previously living in *G. squarrosa* begin infesting *H. latifolia*. The seed heads of *H. latifolia* are gummy, so seed heads containing overwintering fifth instars of *B. mellitor* remain firmly enclosed throughout the winter.

Females of *B. mellitor* attack all instars of the pyralid *Mimoschinia rufofascialis* (Stephens) in fruit of the perennial shrub *Malvastrum aurantiacum* (Scheele) Walpers. Twelve *B. mellitor* were found on this pyralid species. Individual host larvae consume the majority of seeds in the fruit and pupate either inside or outside the fruit. Females of *B. mellitor* also attack all instars of a noctuid, *Schinia mitis* (Grote), in the seed heads of the annual herb, *Pyrrhopappus multicaulis* DC. Thirteen *B. mellitor* were found on this noctuid species. Host larvae feed singly in immature and mature seed heads. Females of *B. mellitor* attack only late instars of the cochylid *Thyraylia bunteana* Robinson in the perennial herb *Vernonia baldwinii* Torrey. Thirty-seven *B. mellitor* were found on this cochylid species. Individual host larvae feed on large immature seeds in the seed heads.

We conclude that *B. mellitor* is a truly polyphagous species, attacking various species of Coleoptera and Lepidoptera. Host records have been confirmed for the families Curculionidae, Pyralidae, Chrysomelidae, Noctuidae, and Cochylidae.

Therefore, except for the host records already mentioned as questionable, it is reasonable to assume that the records in Table 1 are correct.

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