INSECTS ASSOCIATED WITH THE FLOWERS OF TWO SPECIES OF *MALACOTHRIX* (ASTERACEAE) ON SAN MIGUEL ISLAND, CALIFORNIA

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The insects associated with *Malacothrix incana* (Nutt.) T. & G. and *M. implicata* Eastwood on San Miguel Island were sampled as part of a general analysis of hybridization between the two species on the island (Davis and Philbrick, 1986). On San Miguel Island, *M. incana* is widely distributed on unstabilized and stabilized sand dunes on slopes near the ocean or on sandy substrate on the upper surfaces of the island including the slopes of San Miguel Peak and Green Mountain. In contrast, *M. implicata* is generally restricted to the slopes near the ocean or the walls of canyons above the ocean. Hybrid plants were found only where *M. incana* and *M. implicata* were growing in a common area and constituted less than 1% of the total number of the three forms in these areas. Hybrid plants were most frequent on the slopes above Cuyler Harbor and above Tyler Bight.

Plants of *M. implicata* are spreading or erect perennials with large heads containing up to 80 florets. The ligules are white and have a purple stripe on the abaxial surface. Plants of *M. incana* are perennial and become mound-shaped after several years of growth. The large heads contain up to 100 florets with yellow ligules. The hybrid is also perennial and has large heads with pale yellow florets whose ligules often bear a reddish stripe on the abaxial surface.

During our visit to San Miguel Island in May, 1984 a majority of the plants of *M. incana, M. implicata* and the hybrid were in full bloom. Numerous open heads were present on plants of both species and one plant of *M. incana* had over 200 open heads. Herbarium label data indicate that the blooming period of *M. incana* generally coincides with that of *M. implicata* on other Channel Islands as well as on San Miguel Island and that flowering of both species reaches a maximum in the months of May and June.

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In cultivation, plants of *M. incana* have been found to be self-compatible and all have had a chromosome number of 2n = 14 while plants of *M. implicata* have all been self-incompatible and have had a chromosome number of 2n = 18. The one hybrid plant propagated from wild fruit was sterile and 16 univalents were found in meiosis. Tests using long and short wave UV light (366nm and 245nm) on flower heads of plants in cultivation indicate that the reflective pattern of *M. incana* is quite different from that of *M. implicata,* and that the hybrid has the same pattern as in *M. incana.*

Because of the differences between *M. incana* and *M. implicata* in flower color, breeding system, and UV reflectance it was clear that a study of the pollinators of the two species would contribute to a general study of the causes of interspecific hybridization.

The only mention in the literature of insects on *Malacothrix* on San Miguel Island are the records of six native bee species at flowers of *M. implicata* by Cockerell (1937), the recent synonomy of one of these bees by Rust (1984), and there were no data on pollinator choice among the three flower types (Miller and Menke, 1981; Miller, 1985b).

Methods

The present preliminary report is based on collections made on San Miguel Island, 24–27 May 1984, and data from Cockerell (1937), supplemented by earlier observations on this and other of the California Islands. On the May, 1984 trip most of the island was surveyed, with concentrated efforts on the slopes above Cuyler Harbor and Tyler Bight. Insect specimens are deposited in Santa Barbara Museum of Natural History, Natural History Museum of Los Angeles County, U.S. National Museum of Natural History, and California Department of Food and Agriculture collections. Our collecting emphasized sampling the diversity of insects present; time did not allow detailed observation of the abundance and activities of each species. Although our data are only preliminary, we feel that they are adequate to infer general patterns and suggest directions for future research, which should address seasonal and diurnal activity patterns of the insects, insect-flower interactions, and flower constancy of the insects (e.g. Hurd and Linsley, 1975; Hurd et al., 1980).

RESULTS

In general, *Malacothrix incana, M. implicata,* and the interspecific hybrids are visited by the same suite of generalist bees and a few flies, as well as small beetles and true bugs (Table 1). Many of these species were seen on many other flowers in a variety of families including Convolvulaceae (*Calystegia macrostegia* subsp. *macrostegia* [Greene] Brummit) and Crassulaceae (*Dudleya greenei* Rose), in the Cuyler Harbor area. Because bees carry large pollen loads and move actively between flowers, they are probably the major pollinators of *Malacothrix,* although flies and beetles (as well as wasps which were not seen on flowers of *Malacothrix* on San Miguel Island) probably have some role in pollination.

It is probable that the most important pollinator is the native bee *Agapostemon texanus* Cresson, the relatively large metallic green females of which are abundant and active, especially in the early morning when the flowers of both species of San Miguel Island *Malacothrix* are open and receptive for pollination. Individuals of *A. texanus* were, in general, the most commonly observed bees on *Malacothrix* (although they were more obvious due to size and color than many of the small halictids), and were observed flying between *Malacothrix* flowers of the same and different colors. However, the relatively constant wind on the island made following individual bees for long periods impossible, so we have no data on flower preference or constancy. Pollen from the hind legs of eleven *A. texanus* females collected on *Malacothrix* was stained with cotton blue lactophenol and compared under a phase contrast light microscope with pollen of *M. implicata* and *M. incana.* The majority of the pollen grains from the bees were comparable to the pollen of *Malacothrix* in size, external wall structure, and other morphological characters although it was not possible to distinguish the pollen of *M. incana* from that of *M. implicata.* These observations are consistent with the biology of *A. texanus* in the laboratory (Roberts, 1969).

The insects found on flowers of *Malacothrix* on San Miguel Island in May, 1984 are listed in Table 1, which also includes records from Cockerell (1937). All of the taxa identified to species, except *Lopidea nigridea hirta* and the Hymenoptera, are San Miguel Island records first published here. All these species were

Table 1. Pollinating and herbivorous insects known from flowers of *Malacothrix* on San Miguel Island (X = observed in May, 1984; Ckll = observed by Cockerell in July, 1937).

	inc.	impl.	hyb.
Thysanoptera			
Undetermined	X		
Thripidae			
Frankliniella occidentalis (Pergande)		X	X
Thrips tabaci Lindeman			X
Hemiptera			
Anthocoridae			
Orius harpocrates Herring	X		X
Miridae			
Lopidea nigridea hirta Van Duzee	X		X
Coleoptera			
Chrysomelidae			
Diachus auratus (Fabricius)	X	X	X
Melyridae			
Trichochrous (s. l.) sp. A	X	X	X
Trichochrous (s. l.) sp. B		X	
Staphylinidae			
Tachyporus sp.		X	
Bruchidae			
Acanthoscelides napensis Johnson		X	
Coccinellidae			
Scymnus nebulosus LeConte		X	
Lepidoptera			
Tortricidae			
Argyrotaenia franciscana insulana Powell (larvae)			X
Diptera			
Syrphidae			
Allograpta exotica (Wiedeman)			X
Carposcalis sp.		X	
Copestylum mexicana (Macquart)	X		
Sphaerophoria contiqua Macquart	X	X	
Bombyliidae			
Lepidanthrax borius Hall	X		
Hymenoptera			
Anthophoridae			
Epeolus minimus (Robertson) = *E. eastwoodae* Cockerell		Ckll	
Hypochrotaenia suavis (Cresson)		X	

Table 1. (continued) Pollinating and herbivorous insects known from flowers of *Malacothrix* on San Miguel Island (X = observed in May, 1984; Ckll = observed by Cockerell in July, 1937).

	inc.	impl.	hyb.
Apidae			
Xeromelecta californica (Cresson)		X	
Bethylidae			
Goniozus sp.		X	
Braconidae			
Apanteles (s. l.) sp.	X		
Colletidae			
Colletes hyalinus gaudalis Cockerell	X		
Halictidae			
Agapostemon texanus Cresson	X	X, Ckll	
= *A. californicus psammobius* Cockerell			
Lasioglossum pavonotum (Cockerell)	X	X, Ckll	X
Lasioglosum titusi (Crawford)		X	
Dialictus megastictum (Cockerell)	X	X, Ckll	
Dialictus pilosicaudus (Cockerell)		Ckll	
Dialictus cabrilli (Cockerell)		Ckll	
Dialictus miguelensis (Cockerell)	X		
Dialictus perichlarus (Cockerell)	X	X	
Ichneumonidae			
undetermined		X	
Megachilidae			
Anthidium palliventre Cresson			X
Pteromalidae			
undetermined		X	

collected on flowers, but some of them spend more time on leaves and stems than on flowers. The interspecific hybrid is somewhat more poorly represented with respect to its insects because fewer plants were seen. *Lopidea nigridea hirta* was described as a San Miguel Island endemic (Van Duzee, 1921), but the status of *hirta* (as species, subspecies or synonym of a more widespread species) is unclear without revision of the very large genus *Lopidea*. Two tortricid moth larvae were reared from the flowers of the hybrid *Malacothrix* (SEM lot 84E1A, B), yielding adult females of *Argyrotaenia*, probably *franciscana insulana;* the various island populations once lumped under *insulana* are quite variable and need review. *Lepidanthrax borius* is here first recorded from San Miguel and San Nicolas Islands; Cockerell's (1940: 292) San Nicolas record of *L. angulus* Osten Sacken might be a misidentification of this. The five species of *Dialictus* were described by Cockerell (1937, in the genus *Halictus*) from San Miguel island. *Dialictus cabrilli* is still considered a San Miguel Island endemic (Rust, in Miller, 1985a), but this may be due to the poor taxonomic condition of this difficult genus. Observations on other islands (Miller, unpubl.) and, specifically, from San Nicolas Island (Table 2) suggest that a similar suite of general pollinators is active on *M. incana* on other islands. Pollinator collections made on San Nicolas Island in May, 1984 were superficial compared to those on San Miguel Island, but consist of the same dominant elements.

Other parts of plants of *Malacothrix* were examined as well as flowers, and three families of Homoptera were found on stems and roots. The western aster root aphid, *Aphis armoraceae* Cowen (Aphididae) on the stem of a hybrid plant on the slopes above Cuyler Harbor, was associated with the introduced ant *Lasius niger* L. (Hymenoptera: Formicidae). The black scale, *Saissetia oleae* (Olivier) (Coccidae) was taken on stems of *M. incana* near Cabrillo Monument, Cuyler Harbor, in May, 1977 (by SEM) and on the slopes above Cuyler Harbor in May, 1984. An unidentified mealybug (Pseudococcidae) was taken from the root of a plant of *M. implicata* at Cuyler Harbor, but the specimen was lost in the mail during attempts to obtain an identification.

Conclusions

All the forms of *Malacothrix* on San Miguel Island are apparently visited by the same suite of generalist bees and a few flies, as

Table 2. Associates of flowers of *Malacothrix incana* on San Nicolas Island (collected 11 and 31 May, 1984 by S. Junak from plants on stabilized sand dunes east of Corral Harbor, elevation about 20m).

Coleoptera
Melyridae
Trichochrous (s. l.) sp.
Diptera
Bombyliidae
Lepidanthrax borius Hall
Hymenoptera
Sphecidae
Bembix americana nicolae Cockerell
Podalonia mexicana (Saussure)
Eumenidae
**Stenodynerus* sp.
Anthophoridae
Hypochrotaenia formula (Viereck)
Halictidae
**Agapostemon texanus* Cresson
**Dialictus megastictum* (Cockerell)
**Evylaeus kincaidii* (Cockerell)

*Also collected on the hybrid *Malacothrix incana* × *M. polycephala* (ined.)

well as small beetles and true bugs. Circumstantial evidence suggests that the bee *Agapostemon texanus* is probably the most important pollinator. Future research should examine the specific nature of the insect-flower interactions. The simplified nature (fewer species of both plants and pollinators compared to similar mainland sites) of insect-plant interaction systems on the California Islands presents excellent opportunities for testing hypotheses of insect-plant interaction and evolution (e.g. Cruden, 1972; Thorp, 1979).

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